

ERGONOMIC DESIGN / FIBRE TECHNOLOGY: CLOTHING FOR MASTECTOMIZED WOMAN WITH LYMPHEDEMA

Fatima GRAVE & Miguel CARVALHO

Abstract

Given the physical condition of the mastectomized woman with lymph sequel, the dynamics of ergonomic design in clothing therapeutic interaction and the pursuit of quality of life concerns lead the designer to investigate the condition of the textile industry related to service this cautious and complex market of pieces of therapeutic clothing. The textile technology, its plurality of therapeutic functions on its side by side walk with the diversity of pathological complexity within the trilogy Design/Technology/Pathology allows important benefits for the sanity of the body. This study involved the creation of two devices in different polyamide compositions, using the same proposed design, and its comparison with one already used in the market. The universe of the research included 60 women who underwent mastectomy with lymph sequels, with participation of two oncology clinics of São Paulo (Brazil). The study used a cross-disciplinary methodology, emphasizing explicit and implicit needs with subjective questions.

Keywords: Ergonomic design, fiber technology, pattern design, mastectomy, lymphedema.

1. Introduction

The design relates to the product through the ability to integrate the project to physical, psychological and physiological comfort, allowing the user wellness with quality of life. The design is the active innovation, is the new being incorporated all the time [1]. The society has been taking action through design, because it is through it that men can solve problems, improving their daily lives related to their individual and/or social needs [2]. The design when applied with a thorough vision creates solutions that in many areas, independently of its complexity, breaks the patterns, changing thoughts and behaviours, changing social traditions, maximizing or minimizing feelings/attitudes, benefiting or harming men, but always keeping its greater goal, which is to meet the individual needs [3]. However, regarding the technology of textiles, its characteristics and performances in clothing we can say that the creation and development of garments are responsible for much of the comfort of the individual, creating interaction and integration of the skin to the environment, making the textile multifunctional and improving, for example, the performance of athletes and the day-to-day life of an ordinary individual in their routine tasks. Thus, it can be stated that clothing acts as a second skin.

The need for the production of multi-functional fibers led to the diversity between "fashion" and sport or between "fashion" and therapeutic, such cumulative vision came to balance the market, being the case of *lingerie*, sports and therapeutic sectors lately, leading the market to offer comfortable and sensual pieces, applying multifunctional textile raw materials, linked to the proposed design, in therapeutic garments like brassieres and postsurgical girdles, used in recovery, mitigation and maintenance of health [1].

Considering cancer a growing evil, the *World Health Organization (WHO)* whose recent statistical indicators show that 12% of deaths in the world today are caused by cancer, in all its manifestations - which represents about six million people. In Lyon, France, the "*International Institute for Prevention Research*" presented at the "*World Breast Cancer Report 2012*" the news pointing female cancer with an annual growth of 3.1%, being breast cancer the most responsible for the increase. Whereas survival before the mastectomy is 30-40% and up to five years post mastectomy lymphedema (accumulation of lymph in the upper limb) can be present in these women. The mastectomized woman with lymph sequel changes her behaviour, makes constant use of drugs, can use orthosis and needs to protect the affected region by the lymphedema. It is necessary to extend the look of the garments and consider the range of its usability, functionality, the wide application of textile technology and the integration of multidisciplinary dedication to benefit a particular growing public and deserving of all the attention: the "Women with Mastectomized Lymphatic Sequels". Figure 1 shows mastectomy with lymph sequel.



Figure 1: Mastectomy with lymph sequel.
Source: author

With an interdisciplinary thinking and a multidisciplinary methodology, within the pluralist line the complexity of the experiment was studied in detail with a qualitative and quantitative comparative analysis. The evaluation of the produced samples for mastectomized women with sequel lymph was conducted using a survey of subjective questionnaire. So, the result of this work allows us to present a new alternative to the quality of life of women with mastectomies with lymph sequels, incorporating a armband with a bra in an unique piece with an ergonomic and technological design.

2. Literature Review

The female body is more exposed to the characteristics and cultural changes due to its strong human need for adequacy and hence social acceptance, according to the influence of time, the so-called concept of beauty. We can say that the body has been woven according to these important icons of beauty, however, subject to damage such as those caused by a mastectomy and lymph sequel. Meanwhile, the body in any condition has its own language has referred by SILVA, 2008: "The body speaks, if not through words, then through silence" [4]. Facing a breast cancer a woman becomes weakened, if not detected in time the process can lead to removal of the breast, i.e., the "mastectomy". The upper limb lymphedema or edema is a result from the death of part of the lymphatic system in the region [5]. The lymphedema makes the region bulky (the lymph) leaving the skin sensitive, which by itself causes discomfort and requires constant mental and physical therapies, being the most indicated the cinesioterapia, helping the lymphatic drainage together with the use of a armband. The lymph is a highly proteic fluid, whitish, circulating in the lymphatic's, is part of the circulatory nervous system and can be unilateral or bilateral [6]. Figure 2 shows the member with a lymphatic sequel.



Figure 2: Arm with lymphatic sequel.
Source: author

In this context the trilogy *Design/Technology/Pathology* unite to meet the needs that provide quality of life and comfort to the mastectomized woman with lymph sequel [10].

The textile and apparel industry seeking to respond to a more cautious and mysterious market through the offer of garments for therapeutically needs has been developing textiles incorporating high technology, adding to the plurality of therapeutic functions, walking side by side with the diversity of findings in the biological and medical sciences that led to the creation of products such as prosthetics, orthosis and others.

To meet the needs of the mastectomized woman with lymph sequel three devices were used. One produced with the polyamide microfibers *Emana*[®] identified in the study as sample "T". Produced with a polyamide 6.6, this yarn has "bioactive crystals" which have the ability to act as far infrared. The crystals incorporated in the mass of the polyamide during the extrusion process, can transform the body heat into energy and thus mutually influence, integrating body and clothing. That is, working the energy from inside out. The skin, while getting back its energy activates its cellular metabolic system and the microcirculation, developing the capacity for beneficial reaction in defence of health [7]. The second sample was a neutral device identified in the study as sample "N". It was made with the same design of sample "T" but using microfibers of a common standard polyamide 6.6. The effect of using these devices for the treatment of the mastectomized woman with lymphatic sequel who underwent mastectomy was compared with the effect provided by the use of a textile device already available in the market, identified in this study as sample "C", produced with a different design but also with a standard polyamide 6.6.

Seeking to meet the needs of comfort of woman in front of the ablations exposed to the body, she finds herself more forced to have greater dedication to herself.

On the other side, the design professionals must be cautions in creating products that carefully detail the body in the quest for wellness, given the fragility of women, detailing biomechanics, understanding comfort in all its levels, worrying about the discomfort and damage to the body, being responsible for generating expressions of physical and psychological discomfort: like the doom and gloom [1].

The items involved in the study during the development of the proposed design were [9]:

- Topography related to the pathology: Thoroughly knowing the body and the pathology;

- Anthropometry: Comprehending the physical body measurements, determining the size, balance and relating the dimensions to the need of usability that the clothes need, considering the proportions related to the anatomical and physiological state of the pathology;
- Goniometry: Measuring the opening angles for movement;
- Anatomical changes: Knowing the healthy body and the changes the disease imposes;
- Physiology: Meeting the specific needs of the pathological body;
- Psychomotor needs: Involuntary movements with or without physical changes;
- Vulnerability to cold and heat: Knowing the natural temperature corresponding to the pathology;
- Medications: External or internal application of medication;
- Supplement collectors: Handbag collection.

The study should lead to an orderly design cycle and thus comply with all its functions, as the use and functionality, as shown in Figure 3.



Figure 3: Cycle of use and functionality.
Source: author

The cycle provides restructuring and a new vision for the creation of the design, considering the use of the product and the interconnections related to discomfort and allergic reactions caused by fiber or even applying an inadequate pattern design, being aggressive to the mastectomy with lymph sequel.

3. Method and application

The "T" and "N" prototypes were distributed following a blindly distribution, so there could be no perception of the technological device. The distribution of the three samples "T", "N" and "C" was done in a pair format. Mastectomized women with lymphatic sequel aged between 25 and 70 years old were organized in three groups of 20 women each (A, B and C*), fulfilling 180 days each with the experiments, having been defined a use of 60 days for each sample. This calendar was accompanied by measurements for evaluation of the lymphatic drainage, with an initial measurement in the beginning of the first day, a second after 30 days, a third after 45 days and a fourth measurement after 60 days. Then, a survey was done to evaluate their opinion about each sample, fulfilling the timetable of six months of trials.

The research considered the characteristics of the experimental design. Statistical evaluation used the method of *Analysis of Variance* - ANOVA, *Tukey* and *Fisher* test [8]. The questionnaire was built with 20 questions devoted to: aesthetics; usability; therapeutic functionality; and sensory and tactile comfort, which resulted from the synergy between the properties of the raw materials (yarns of polyamide microfibers, elasthane, accessories). The characteristics of the textile construction, ergonomics and machinery used in

the manufacture of the proposed design allowed us to evaluate the psychological, physical, physiological and ergonomic comfort. Figure 4 shows the percentage of positive "Yes" answers, according to the issues.

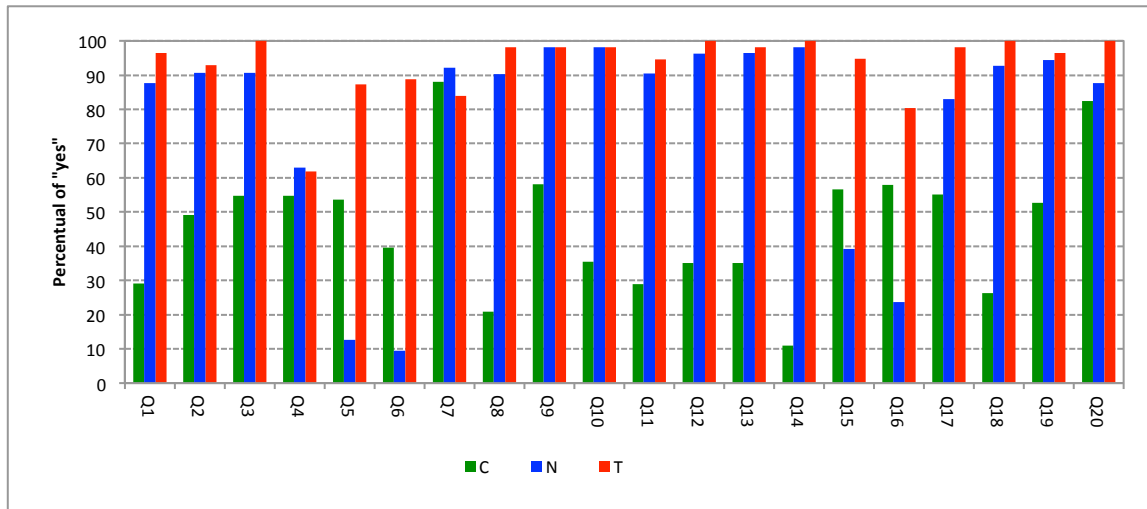


Figure 4: Percentage of positive "Yes" answers.

3.1 Analysis of questions

- Usability (Questions 2, 3, 4, 6, 7, 8, 9, 10, 13) - Related to dress and undress, maintenance, mobility. It appears that the design created (equal in samples "N" and "T") was perceived by most users with higher acceptance when compared to the design of the sample available in the market (sample "C"). The acceptance rates for the created design ranged from 90.7% to 100% while sample "C" had acceptable levels between 20.9% and 58.2% in the same categories. Sample "T" had 100% acceptance.
- Comfort/aesthetics (Questions 11 and 19) - The acceptance rates of the samples used for these aspects ranged between 90.6% and 96.5%, while for sample "C" the index was 28.9% (question 11) and 52.7% (question 19). The created design offered a differential in the psychological and aesthetic comfort aspects, being much better valued than sample "C".
- Sensorial comfort (Questions 12, 14, 17 and 18) - The sensory tactile perceived comfort was significantly different between sample "C" and samples "N" and "T". The acceptance of the created design got an acceptance between 83.0% and 100% and sample "C" obtained 10.9% to 51.1%. It is important to observe that sample "T" got 100% acceptance in issues related to comfort with the softness of the fabric, while for the seams the acceptance was 98.2%.
- Therapeutic functionality (Questions 5, 6, 15 and 16) - Sample "T" showed the highest rates to the "pain" and "swelling", 87.3% and 88.9% of positive responses, respectively, followed by sample "C" (53.7% and 39.6%), while the indices obtained for sample "N" has been modest, 12.7% and 9.4%, respectively. This result is attributed to the property of bio stimulation of the *Emana*® yarn, used in the production of sample "T" - the only difference between samples "N" and "T", as both were produced with the same design.

4. Conclusions

This research had its excellence in the use of design and textile technology, which together provided an aid to therapeutic mastectomy lymphedema and could experience the use of an high technological polyamide 6.6 - *Emana*®, which substantially added value to the final product, considering the low degree of compression used in all devices. Analysing the effect of sample "T", it was possible to observe that it acted as a stimulus element and the softness of the fiber used promotes collaborative tactile response with action, working to reduce lymphedema and, by the action of bioactive crystals, allows the action of the infrared rays, encouraging microcirculation. The device allowed the feeling of higher levels of psychological and physiological comfort caused by the positive stimulus, not impairing the neurological reaction of physiology, still allowing a gentle stimulus, accompanied by the rehabilitation and stimulation of physiology, offering a great opportunity to correct/educate/encourage the healthier part of the body as the degree of pressure exerted by the device was low when compared with the commercial device "C". Analysing the effect of sample "C", it was possible to observe that the therapeutic effect was often hampered by the poor usability

and may promote stagnation in the proximal region and also swelling. Sample "N" was acting as a comparison of the performance of the textile fiber technology effect of sample "T", allowing a validation of the created design. The resulting design proved to be effective acting as a protection to the member. The combination of a Jersey textile structure with a comfortably ergonomic pattern design allowed the adequate execution of the shoulder/arm movement in tasks such as in the cinesiotherapeutic and in their daily tasks.

Thus, it was possible to conclude that the objectives proposed in the beginning of this study have been fully achieved. It was possible to demonstrate the usefulness of the final product provided by the performance in terms of sensory and physiological comfort, but mainly by its psychological and ergonomic comfort, contributing to the improvement of the quality of life of mastectomized women.

5. Acknowledgements

The authors thank the support of: *Center for Mastectomized Women - Live Better from ABC (Centro de apoio à mulher mastectomizada Viva Melhor do ABC)* - Sao Paulo - Brazil;
Brazilian Institute of Cancer Control (Instituto Brasileiro do Controle de Câncer) - Sao Paulo - Brazil.
Promotes Physical Therapy Institute (Promove Instituto de Fisioterapia) - Sao Paulo - Brazil.
Doctor José Carlos Teixeira do Valle.

This work is financed by FEDER funds through the *Competitive Factors Operational Program (COMPETE)* and by national funds through *FCT (Portuguese Foundation for Science and Technology)* with the project PEst-C/CTM/U10264/2011.

6. References

- [1] GRAVE, F.: *O design e o vestuário: Sutiã ergonómico para Mulheres Mastectomizadas com Sequelas Linfáticas*. Tese de doutoramento em Engenharia Têxtil, Universidade do Minho, (2014)
- [2] MELLO, C.L., GOMES, C.M. PICHLER, R.F.: *Design para Inovação Social: União Entre Universidade e Sociedade*. 8^o Congresso Brasileiro de Gestão de Desenvolvimento de Produto. CBGDP, Porto Alegre, Brasil, (2011)
- [3] MANZINI, E.: *Design para a Inovação Social e sustentabilidade: Comunidades Criativas, organizações colaborativas e novas redes projetuais*. Ed. Papers, ISBN 979-85-7650-170-1, Rio de Janeiro, Brasil, (2008)
- [4] SILVA, E.: *Eu também tenho corpo: uma análise dos corpos femininos e das subjetividades no período de 1900 a 1945*. Mestrado em Ciências Sociais, Universidade Federal do Rio Grande do Norte, 26^a Reunião Brasileira de Antropologia, ISBN: 978-85-61341-16-9, Porto Seguro, Brasil, (2008)
- [5] CAMARGO, C.M., MARX, G.A.: *Reabilitação física no câncer de mama*, Roca, ISBN 85-7241-301-4, Sao Paulo, Brasil, (2000)
- [6] GRAVE, F., CARVALHO, M.A.F., GASI, F.: *A Complexidade do Design na Criação de Sutiã para Mulheres Mastectomizadas*, NT3, Conferencia de Integração de Engenharia, Concepção e Gestão de inovação, IDEMI, Porto, Portugal, (2013)
- [7] COOB, D.: *Ancient wisdom inspires 'responsive' Far Infrared fiber - INNOVATION IN TEXTILES*, Part 1. 2, Tradução livre, Apud Group Rhodia Solvay, Sao Paulo, Brazil (2013)
- [8] CASTRO, M.V.: *Relatório de Análise estatística sobre os dados de Dispositivos têxteis para drenagem linfática de pacientes mastectomizados*. Estatístico CONRE n° 1623. Apud Rhodia, Sao Paulo, Brasil, (2013)
- [9] GOMES, F.J.: *Gestalt do objeto: sistema de leitura visual da forma*, 5^a Ed. Escrituras, ISBN 85-86303-57-7, Sao Paulo, Brasil, (2003)
- [10] GRAVE, F. *A modelagem sob a optica da ergonomia*, Zennex Publishing, ISBN 85-98163-04-X, Sao Paulo, Brasil, (2004)

Author(s):

Prof. Fatima GRAVE, Ph.D.
University of Minho, School of Engineering, Department of Textile Engineering
Campus Azurem - 4800-058 Guimaraes - Portugal
Phone: +(55) 11 49 962 407 Fax: +(351) 253 510 293

E-mail: fatimagrave@hotmail.com

Prof. Miguel CARVALHO, Ph.D.
University of Minho, School of Engineering, Department of Textile Engineering
Campus Azurem - 4800-058 Guimaraes - Portugal
Phone: +(351) 919698062 Fax: +(351) 253 510 293

E-mail: migcar@det.uminho.pt