

Ergonomics, design universal and fashion

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Abstract. People who lie beyond the "standard" model of users often come up against barriers when using fashion products, especially clothing, the design of which ought to give special attention to comfort, security and well-being. The principles of universal design seek to extend the design process for products manufactured in bulk so as to include people who, because of their personal characteristics or physical conditions, are at an extreme end of some dimension of performance, whether this is to do with sight, hearing, reach or manipulation. Ergonomics, a discipline anchored on scientific data, regards human beings as the central focus of its operations and, consequently, offers various forms of support to applying universal design in product development. In this context, this paper sets out a reflection on applying the seven principles of universal design to fashion products and clothing with a view to targeting such principles as recommendations that will guide the early stages of developing these products, and establish strategies for market expansion, thereby increasing the volume of production and reducing prices.

Keywords: Ergonomics in fashion, universal design, people with disabilities

1. Introduction

People who lie beyond the "standard" model of users often come up against barriers when using consumer products, especially fashion and clothing products the design of which should the design of which ought to give special attention to comfort, security and well-being.

Universal Design can be defined as a concept that guides the design of products to cover all potential users of that product. The principles of universal design seek to extend the design process for products manufactured in bulk to include people who, because of their personal characteristics or physical conditions are at an extreme end of some dimension of performance, whether this is to do with sight, hearing, reach or manipulation.

Ergonomics, a discipline anchored on scientific data, regards human beings as the central focus of its operations and, consequently, offers several forms of benefits for applying universal design when developing products and environments. Although ergonomics with regard to fashion is still little discussed, it is understood that this scientific discipline is of fundamental importance in the design

and development stage of a project, since it makes it possible to ensure fashion products and clothing meet the different demands of users.

Martins (2005) [4] states that the production of clothing, which arose from a craft concept, was developed based on empirical procedures, but without a theoretical foundation that would support technical innovations. As a result, the processes of developing the design of this product were also grounded in this same empirical basis.

However, in recent years, technological innovations in technology and management have been observed, ranging from conceptualizing a garment to meeting market demands based on recognizing the importance of considering the abilities and limitations of a user, who has increasingly been rid of being stigmatized.

In this context, this paper sets out a reflection on applying the seven principles suggested by the Center for Universal Design of the School of Design at the State University of North Carolina, USA (STORY, 1998 [6]) in order to give direction to these principles such that they will be seen as recommendations that will guide the early stages of developing fashion products and clothing, by establishing strategies for

market expansion, thereby increasing the volume of production and reducing prices.

2. Method

The proposed method is exploratory and investigative, uses applied research, and covers the foundations of disability, the ergonomics of the product and usability and comfort in fashion products and clothing and at the same time applies the principles of Universal Design to conceptualizing such products.

2.1. People with disabilities

NBR 9050 (ABNT, 2004 [1]) defines the term "disability" as there being a reduction, a limitation or non-existence of abilities to perceive the characteristics of the environment, or of mobility and of using buildings, space, furniture, urban equipment and elements, on a temporary or permanent basis.

According to the 2010 Census, Brazil has 190,755,799 inhabitants. With regard to people who have some type of incapacity or disability, the Brazilian Institute of Geography and Statistics (IBGE, 2011 [2]), notes that in Brazil there are about 45.6 million people with some type of disability, thus representing 23.91% of the total population with such features. Simultaneously, the census noted the growth in the ratio of the population aged 65 or over more, which had reached 7.4% of the total population in 2010.

According to Smith and Martins (2000) [5], apart from needs resulting from their disabilities, which are obviously crucial, the needs of people with disabilities (PD) are the same as those of users without special needs in terms of aspirations, individuality, values and status.

Thus, designing a fashion product that is more accessible to groups of people with and/or without special needs, is to ensure user satisfaction, regardless of their physical and cognitive states.

Clothing, also referred to as a *Second-skin*, can be seen, therefore, "as the packaging of the body or as a textile architecture in which each line has a meaning and which manifests a specific taste which localizes it in time and space" (MARTINS, 2005 [4]).

3. Interface of ergonomics and universal design for accessibility to fashion

There is a lack of parameters that serve the fashion and clothing market in its specificities, and problems relating to usability and user comfort in order to make these features compatible with the needs, potentialities and limitations of performance of all users.

The interface of ergonomics with design aims to design and produce fashion products and clothing that are appropriate to its users' needs for comfort, mobility and usability.

Thus, under an appropriate universal design approach, these users should also be included when defining requirements during the initial phase of designing and developing a product.

In this context, universal design can be defined as a project that guides the design of products to cover all potential users of that product. The principles of universal design aim to extend the design process to products manufactured in bulk so as to include people who, because of their personal characteristics or physical conditions are at an extreme end in some dimension of performance (such as vision, hearing, reach and manipulation).

Universal design is a proposal, or even an attitude, to design and/or tailor products, environments and systems so that 'everyone', without exception, can enjoy these, by taking into account the diversity of human beings including their various activities, regardless of people's abilities and limitations, and to do so easily and securely (MARTINS, 2008 [3]).

In turn, it is important to clarify that the fact of including the elderly and (temporary or permanent) PDs, in the design process does not mean there is a guarantee that all products and equipment will be designed to be used by all individuals indiscriminately.

4. Principles of universal design in developing fashion products and clothing

Recommendations for developing fashion products and clothing, on applying the seven principles of universal design set out by Story et al (1998) [6]:

1. *Equitable use* - the design is useful and accessible to all people and has the same mode of use; it avoids discriminating against any user; it ensures

privacy and security and is attractive both visually and to the touch and smell.

- Attributes of equitable use: easy for anyone to use, usability, functionality, comfort.
- Recommendations:
 - i - Easy for anyone to use with regard to maintaining the garment, such as easy to clean, changing trimmings and other components.
 - ii - Usability of the garment and accessories such as handbags, backpacks (with straps that follow the anatomical curvature of a woman's breasts, for example); non-slip, comfortable shoes that do not compress feet, do not interfere adversely with circulation and posture; heels with a good support base and preferably not high heels.
 - iii - Functionality of the garment, related to the activities and tasks performed by the user during the day and/or night, which respects the body's physiological range.
 - iv - Comfort when using the garment, which should not cause a postural change greater than an expectant mother and or elderly person already faces by changing their center of gravity.
 - Examples: the shoes made for diabetics, which confer a high degree of comfort and are nowadays used by people who have some type of pathologies in their feet or difficulty when walking, as in the case of the elderly, such shoes providing greater security and stability when walking. They are also called anti-stress shoes because they pay special attention to physical comfort and the functions of their use.

2. *Flexible use* - the design suits multiple individual preferences and abilities; it permits access and use (right and left), facilitates precision and accuracy and provides adaptability of mobility.

- Attributes of flexible use: flexibility, mobility, articulation, adaptability.
- Recommendations:
 - i - Flexibility of use related to climate and the environment. The fibres used should be the softest and most flexible ones, easily washable and capable of maintaining a comfortable body temperature.
 - ii - Mobility when using clothing products. The textile materials, i.e. the textiles chosen for clothing should facilitate the motor function. Hence the importance of selecting materials which in their composition or construction per-

mit heat exchange and breathability as do fibres of natural origin, either by obtaining them naturally, such as organic cotton, or by an artificial process, such as by obtaining viscose from bamboo, cutting-edge fabrics (mesh) or woven fabrics that stretch or relax under the action of the body in movement.

iii - Good conditions for articulating the upper and lower limbs. To meet these requirements, the fabrics need to have a small percentage of spandex in their composition so as to provide mobility and freedom of movement without compressing the skin and body segments, thus allowing the movements of extension and flexion, adduction and abduction of the arms, legs and other body segments.

iv - Adaptability in the choice of materials and modeling (responsible for adjusting clothing to the body and the ease of dressing and undressing) will provide appropriate physiological comfort, especially a thermal regulator, responsible for heat exchange. For example, keeping the internal temperature of the body stable, when it is cold, and enabling rapid removal of body moisture when it is hot:

- a) Examples: clothes made of fabrics with a frame (order of warp and weft) that allows perspiration to evaporate, which facilitates the escape of sweat from the fabric thus accelerating keeping it dry, thus keeping the fabric next to the body light and dry; or reverse fabrics, which do not allow cold air through, thus maintaining the body's internal microclimate and temperature, which provides thermal comfort when it is cold.

Another good example is "smart clothes" developed by British researchers and inspired from bionics - the science that studies the "ideas of nature" so they can be applied to products. "Smart clothes" use micro technology to produce a material that allows air to cool the user when the temperature is high and expels air when the temperature drops. The system is the same as that used by coniferous trees to open up and shed their seeds, besides being the same as that used for performance materials, namely to increase performance in aerobic sports by using fabrics that facilitate the escape of sweat, thus speeding up making it dry.

It is also worth drawing attention to shoes with soles that 'breathe' which allow transpiration but which stop moisture entering the shoe.

3. *Simple and intuitive use* - the design is understandable and readable regardless of experience, knowledge, language skills or levels of cognition and concentration; it eliminates unnecessary complexity, by meeting users' expectations and intuition; it provides effective and timely information during and after access and use.
 - Attributes of simple and intuitive use: legibility, comprehensibility, autonomy.
 - Recommendations:
 - i - Readability related to activation and manipulation of the parts that should be simple and intuitive, by eliminating complexity, levels of knowledge and the need for previous experience.
 - ii - Comprehensibility of the components, does not require concentration to activate. It should be noted that one should avoid buttons and trimmings and other complicated or complex components of fastenings or mechanisms for adjusting, opening and fastening and openings for putting on and taking off clothes.
 - iii - Autonomy and conditions of easy access so as to dispense with help from others. They need to be planned and take comfort, safety and well-being into consideration.
 - Examples: magnetized fastening mechanisms that facilitate handling, zipper with an anthropomorphic tag for easy handling, adjustment devices by means of adjustable elastic used in baby clothes and which can be used in clothes for the elderly and the obese, zipper tag embedded in a 'pocket' to avoid abrasion between the skin and the plastic or metal material of the fastening system of this trimming.
4. *Perceptible information* - the design has the information needed for use, regardless of environmental conditions and users' sensory capabilities; the design is readable, and uses multiple modalities to communicate, whether these be verbal, tactile, or pictorial ones; it is perceptible, provides adequate contrast between the information (activators such as: zippers, buttons, straps) and the surface of the product.
 - Attributes of simple and intuitive use: readability, perceptibility.
 - Recommendations:
 - i - Readability regarding warning information or to care needed to maintain the garments. These should be clear and visible and in the case of clothing for the blind or the more severely visually impaired, the information should be printed in Braille, and forming with such information a tactile surface with the required information. The same goes for recognizing the colors of clothes, with information in Braille containing the color of each piece, thus giving autonomy to the visually impaired when choosing and the composition of how they will look, and this will permit them to choose the colors of their clothes for themselves on their own.
 - ii - Perceptibility of symbolic information, thereby allowing the user to obtain psychological comfort related to aesthetics, appearance, fitness for purpose, biotype and socio-cultural environment.
 - Examples: mechanisms with sensory stimuli; labels with clear texts and objectives, with easy to read symbols and figure-background color contrast.
5. *Tolerance for error* - the design minimizes the dangerous consequences arising from accidental or unintended actions; it provides safety features should there be error; it prevents and deflects involuntary actions being performed in tasks that require vigilance; it visually warns of hazards and errors.
 - Attributes of tolerance for error: safety, quality of the product, tolerance and constraints.
 - Recommendations:
 - i - Product safety, i.e. the clothes should be made with soft fabrics such as worsted fabric, plain fabric with fibers of natural origin, and have materials that do not mark the skin and can be self-adhesive, a waistband that is slightly elastic, should not have small buttons, or any with sharp edges or other trimmings or fastening/ unfastening systems that put pressure on the circulation or cause bruising. To do so, there is a need to observe the safety of items of clothing as well as the trimmings they bear, and so too for clothing accessories such as handbags, belts, shoes and costume jewelry or jewels. In the case of skirts, extra attention should be given to length, because they make movement and the first steps difficult. Also pants, shorts and bermudas deserve the same attention because exaggerated lengths or cramped widths

make it difficult to bend the knees, which may lead to incidents or accidents.

ii - Quality of the product related to the user's health, namely, the materials should be light, produced from natural fibers or from artificial ones from a natural origin, derived from chemical processes, but with frames, i.e. the construction of fabrics that allow transpiration; they do not produce moles or cause respiratory problems. If produced with synthetic materials, they should be anti-allergic, allow breathability and not cause irritations of the skin. There are, moreover, textile materials such as bacteriostatic yarns and finishes; those that offer protection against UVA and UVB solar rays; finishes against insect bites; and those that are flame retardant, antibacterial and antimicrobial.

iii - Tolerance for constraints, allowing more than one way to use the product or to dress or undress. It should be emphasized that trimmings and other components for fastening/unfastening clothes should be avoided below the cervical region, waist-line, hips, buttocks, due to the discomfort they cause on contact with the skin, in the activity of sitting down, bending and lifting and because they hinder freedom of movements.

The trimmings should not have sharp edges that can injure the skin, and thick seams should be avoided on parts of the body responsible for body movements such as the cervical region, armpits, wrists, waist, hips, groin and crotch.

Special attention should be paid to underwear, which should not leave marks on the waist and hips; the bra should have wide straps so as to distribute better the weight of the breasts.

- Examples: bags and backpacks with wide straps for greater weight distribution and more than one possibility of use; backpack straps modelled such that they follow the curvature of the breasts, fastening systems and clothes regulators that allow for different compositions and forms of dressing, and shoes with a Velcro fastening or an elastic and adjustable fastening system.

6. *Minimum physical effort* – the product can be used efficiently and is convenient with a minimum of fatigue; it can be worn while keeping the body in a neutral position, and reduces the need to repeat actions; it minimizes physical exertion.

- Attributes of minimum physical effort: efficiency, convenience.

- Recommendations:

i - Efficiency in actioning accessories or of buttoning which are awkward or demand effort when they are used. Trimmings and materials should be used that do not hurt the skin or cause irritations or allergies.

ii - Convenience, by virtue of modeling that allows mobility without sacrificing movements and blood circulation.

7. *Dimensions appropriate for use and comfort* – they provide space and dimensions to ensure flexibility, reach, manipulation and use regardless of the user's size, posture and mobility; the components are within comfortable reach; they provide widths and heights suitable for use and mobility with flexibility.

- Attributes of dimensions appropriate for use and comfort: appropriate dimensions, flexibility, reach.

- Recommendations:

i - Appropriate dimensions, the forms should not be adjusted and tightened, thus respecting the need for movement. Special care taken with trimmings and components that may cause suffocation.

ii - Flexibility of movements, based on appropriate models appropriate for the anthropometric profile of possible users. Clothes should be easy to use (to put on and take off), for example, in the case of hygiene - bathing, changing diapers; clothes - should provide security without requiring sudden movements and avoid constraints and discomfort. The aesthetics of clothes cannot supplant these issues.

iii - Easy reach of the devices or accessories for fastening-unfastening, dressing-undressing.

Some kinds of means of buttoning are awkward or there may be places that are easy to access.

- Examples: fastening mechanisms, whether these be to open and close, fit in to, fix, tie or adjust clothes, by considering the type of slider and tag to be used; as well as the fact that their location should allow for the mobility and independence of the actions required to dress and undress.

Developing and producing products that can be used by the largest numbers of users possible, including people with disabilities, whether these be the elderly, babies, people with limited mobility or motor functions, visual or cognitive impairment, and so forth; this is an economic and social strategy which contributes to the success of the product. This

is justified to the extent that by expanding the market, the products become cheaper than those produced in smaller quantities as is the case of products for "special populations". Vanderheiden (1990) [7] argues that in some cases to design a product that is more accessible to both people with and without special needs contributes to: reducing the costs involved in manufacturing or maintaining a product; and enhances the functionality of users without special needs, including benefits such as reducing fatigue, improving operating speed and reducing error rates.

5. Final remarks

As discussed earlier, the fact of including the elderly and people with disabilities in the design process does not mean guaranteeing that all products and equipment will be designed so they can be used by all individuals indiscriminately.

However, a reflection on the Recommendations for developing fashion products and clothing, at an early stage of project design, and which applies the principles of universal design and considers ergonomics and usability, can contribute to a strategy of market expansion by optimizing processes, adding value and quality to products which in turn will contribute to increasing the useful life of the product and its emotional connection with its user and a consequent reduction in its environmental impacts.

Designing on the prerogatives of universal design appears to be a difficult task, mainly due to the complexity of fashion products and clothing. To this end, knowledge is needed on human skills and limitations and great attention must be paid to detail. Ergonomics shows itself to be capable of helping to reduce these difficulties, by enabling conditions for increased mobility, reach, ease of dressing/undressing, thermal comfort and use for pleasure. However, the recommendations presented here do not have the pretension of exhausting but rather of instigating discussion about the extending and applying principles of universal design to fashion products and clothing, besides prompting research in the area of ergonomics into the comfort of a wide range of product options with a high content of fashion.

Finally, there is a need to consider whether the design choice we make leads us in this direction.

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