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## Session Abstracts

# MUNICIPAL THEATER OF MYTILENE

# Green energy solution for reliable electricity generation in the Greek Aegean Sea Islands. The case of Lesbos Island.

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**Abstract**

Aegean Archipelagos includes a great number of islands of various sizes, divided in the North Aegean Prefecture and the South Aegean one (i.e. Cyclades and Dodecanese Complexes), on top of Crete island. All these islands cover their electrification needs (excluding a small number of islands already interconnected with the mainland network) on the basis of 31 autonomous electrical power systems (EPS) of various sizes (Figure 1), the Crete and Rhodes non-interconnected EPSs excluded. Unfortunately all these EPSs are based on the operation of autonomous thermal power stations (APS) consuming imported and heavy polluting oil at a very high electricity generation cost [1]. This excessive cost is covered by the Greek society via services of general interest (YKO), surcharging the electricity consumption bills all over Greece.

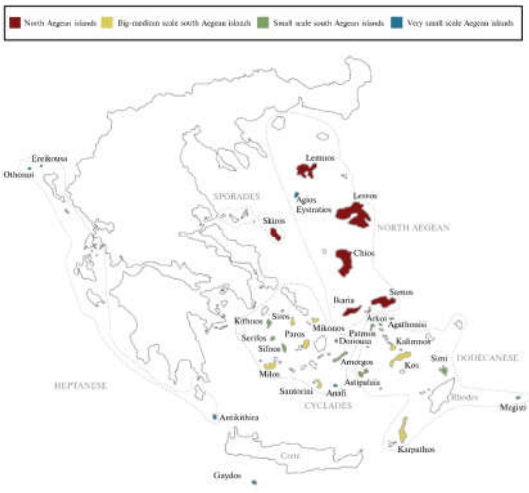


**Figure 1**. The Aegean Archipelagos APS

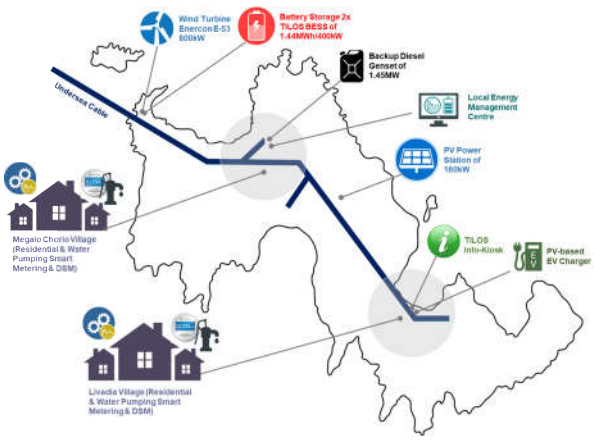


**Figure 2**. The Tilos island smart microgrid

In order to improve the energy autonomy and the energy supply security of the various islands of the Aegean Archipelagos, an integrated clean-green solution is proposed based on the exploitation of the available RES (wind, solar, biomass and geothermy if available) potential in collaboration with the utilization of an appropriate energy storage installation [2]. The proposed integrated solution is now under development on the small island of Tilos, under the European Commission Horizon 2020 (Call

for Local/small-scale storage-LCE-08-2014) TILOS program [3]. Actually Tilos being the first real world example of an island based on RES and energy storage (Figure 2) is going to be the challenging example in order to apply similar and properly designed solutions for the vast majority of the Aegean Archipelagos islands.

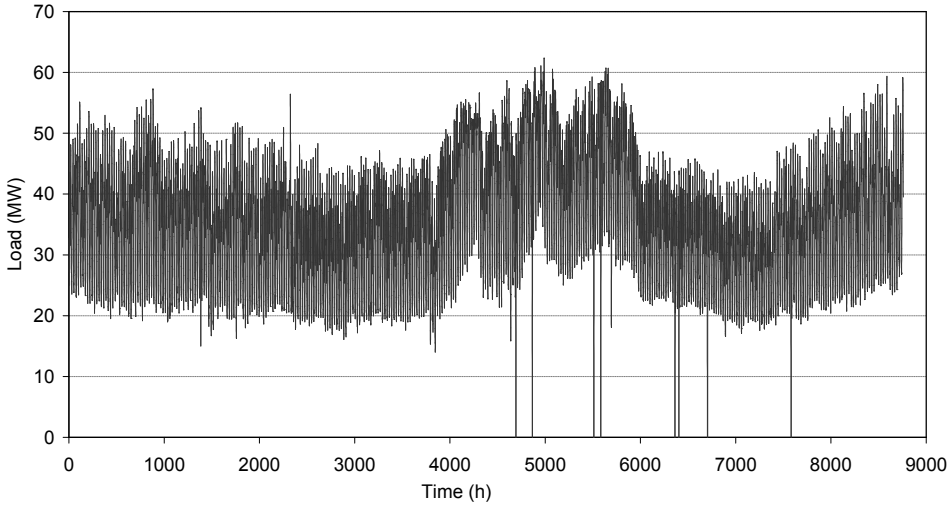


**Figure 3**. Profile of electricity consumption of the island of Lesbos for a representative year

On the other hand, Lesbos is among the biggest of the Aegean Archipelagos islands, located in the North-Eastern part of the Aegean Sea [4]. It represents a typical case of a medium-large sized Greek island which faces significant electricity generation problems being related with several black-outs especially during summer. During the last decade the peak demand of the island varies around 60MW (Figure 3), while 85% of the local electricity consumption is covered by the outdated thermal power station of the island, consuming significant oil quantities (approx. 60,000 tn per year) and contributing considerably to the local environment degradation. At the same time, the mean electricity production cost of the existing thermal power station may reach 250 €/MWh during peak load demand hours.

Taking into consideration the high wind and solar potential, along with the medium enthalpy geothermy of the island, a green-clean solution may be implemented in Lesbos, significantly reducing the contribution of oil in the local fuel mix. On top of these, the island possesses remarkable biomass potential, based of agricultural residues and animal by-products that may contribute on covering both electricity and heat/cooling demand. In this context, an integrated solution is proposed incorporating the Tilos project experience in order to improve the life quality and the energy security of the local population at reasonable financial cost.

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# Air permeability characterization of glass fiber nonwoven fabric for liquid composite molding applications

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**Abstract**

Due to their tailorable and superior specific mechanical properties; the use of fiber reinforced polymers is increasing steadily. Nonwoven fabrics from randomly oriented glass fibers are commonly used reinforcement fabrics in composite industry, and their resin infusion and final composite performances are largely dictated by its porosity that is quantified by air permeability. This research dealt with air permeability characterization of nonwoven fabric from randomly-oriented chopped glass fibers. Number of layers and fabric test face direction were selected as product input variables, while pressure drop and test head area were selected as test input variables. Front and back faces of the fabric stacks with single, double and triple layers were subjected to air permeability test with test head areas of 20 and 30 $cm^2$, and across a pressure drop of 100 and 200 Pa. As expected, multiple fabric layers exhibited lower air permeability. While test face of the fabric and test head area did not affect the air permeability; measurements performed under 200 Pa pressure drop resulted in higher air permeability than that of 100 Pa at statistically significant level that was explained by Bernoulli Equation from fluid mechanics.

**Keywords:** glass fiber, nonwoven fabric, air permeability, liquid composite molding

## 1. Introduction

Affordable price, good mechanical properties, and resistance against harsh environmental conditions render glass fibers attractive in technical textile applications. They are extensively consumed in protective clothing against flame and chemicals, filter media in severe circumstances, and reinforcement fiber in polymer composites [2]. Among textile fabric manufacturing techniques; nonwoven fabrics eliminate yarn production and following conversion of yarn into fabrics processes that enhance the production speed and lower costs dramatically. Controlled placement of fibers enhances the isotropy of the nonwoven fabrics that cannot be achieved easily in woven and knitted fabrics. Nonwoven fabrics from randomly oriented short glass fibers are consumed in large quantities by liquid composite molding industry. Resin infusion performances of these fabrics in single- and multiple-layer form is largely dictated by their permeability in z-direction. Completely wetted and void-free composite production depends on the accurate air permeability characterization of reinforcement fabric stacks [3].

In this study, air permeability of single-, double-, and triple-layer randomly oriented glass fiber nonwoven fabrics were measured from both front and back faces of the fabric stack, along a pressure drop of 100 and 200 Pa, with test head areas of 20 and 30 $cm^2$. The results of this study will guide people working on liquid composite molding and its modeling.

## 2. Material ve methods

Emulsion bonded chopped strand mat provided by Şişecam Cam Elyaf Sanayi A.Ş. was used to characterize air permeability behavior of nonwoven fabric from glass fiber. Specimens with an area of 20x25 $cm^2$ were cut from the fabric roll. The specimens with different combination of number of layers were used for air permeability test on SDL ATLAS M021A according to ASTM D737-04. Air permeability unit was selected as $cm^3/(cm^2/s)$.

## 3. Results and discussion

### 3. 1. The effect of number of fabric layers on air permeability

Data analysis indicated that increasing number of fabric layers resulted in statistically significant decrease in air permeability (Figure 1). Each layer level showed statistically significant air permeability than the others (Table 1). Increasing number of layers from one to two layers lowered air permeability at 34 %, while increasing it from two to three layers lowered air permeability at 22 %. Two- and three-layer fabric stacks exhibited less air permeability variation than single layer that was attributed to formation of more uniform air flow channels by closure of big and non-uniform pores in one layer by the adjacent layer.

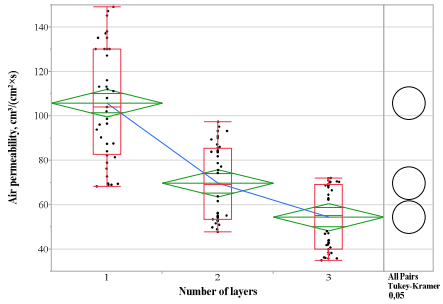


**Table 1.** Number of layers versus air permeability report

| # of layers | | mean | sd | LL | UL |
|---|---|---|---|---|---|
| 1 | A | 105,78 | 25,74 | 97,55 | 114,01 |
| 2 | B | 69,70 | 16,86 | 64,31 | 75,09 |
| 3 | C | 54,44 | 14,46 | 49,82 | 59,07 |

**Note:** levels not connected by the same capital letter are significantly different. sd: standard deviation, LL: lower limit, UL: upper limit. Limits are based on 95% confidence level.

**Figure 1.** The effect of number of layers on air permeability
**Note:** The top and bottom of each green diamond represent the 95% confidence interval for each layer level. Comparison circles (given on the right column) for means those are significantly different either do not intersect, or intersect slightly.

## 4. Conclusion

This study investigated the effect of number of fabric layers, test face of fabric, test head area of the device, and the pressure drop along the flow of the air on air permeability of nonwoven fabrics from randomly oriented chopped fibers. Due to closure of open straight channels with enhanced tortuosity in flow channels; increase in number of fabric layers lowered air permeability. The striking face of air over front or back face of the fabric did not affect the air permeability. Similarly, comparable air permeability measurements were obtained at both test head areas of 20 and 30 $cm^2$. Air permeability measurements obtained at pressure drop of 200 Pa resulted in higher values than those at 100 Pa that was explained by Bernoulli equation where the total energy of flowing fluid is constant along a streamline of the fluid.

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# The effect of spacer monofilament material on impact behavior in a weft-knitted spacer fabric composite

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In this paper, the effect of spacer monofilament material in 3D weft knitted spacer fabric composite coated with silicon rubbers is investigated. To do this, total of 27 samples in three different groups of materials consisting of Nitinol, Polyamide and Steel are knitted and low velocity drop weight test is performed on all samples. Results showed that samples made of Nitinol superelastic wires as spacer monofilament, provided higher energy absorption capacity and therefore are better choice for cushioning applications.

**Introduction**

Utilizing cushioning pads as protective equipment is a mitigating measure towards reducing the effects of trauma or impacts to human body during sports and daily activities. Characteristics such as high compressibility, air permeability, elastic recovery and impact resistance of 3D spacer fabrics [1-3] have made them proper choice in fabrication of lightweight composites with superb mechanical performance as cushioning element in protective applications. As one the major properties, impact resistance has been studied in several researches with the focus on spacer diameter, density, inclination angle of monofilament and fabric thickness [4,5] while none of them considered material factor to enhance the energy absorption capacity of such structure. This paper investigates the effect of spacer material on impact resistance of silicon filled weft-knitted spacer fabric composite.

**Materials and methods**

In order to investigate the effect of spacer material in silicon coated 3D spacer fabric composite, three groups of samples were knitted out of Polyamide, Steel and Nitinol (Shape Memory Alloy with superelastic properties in room temperature) monofilaments. Each group consists of 9 samples with 0.1 mm spacer diameter and all samples are coated with A/B two-component silicon rubber using dip/immersion method. The outer layer of all samples was fabricated using 300D/96F polyester multifilament The low-velocity drop weight test has been performed on samples in three different energy levels (10 J, 15 J and 20 J) and to capture the average experimental data, for each energy level, three samples of each group have been tested. The experimental setup is shown in figure 1. In all tests, the height of striker was held constant whereas different energy levels were obtained by different mass of striker.

**Figure 1.** low-velocity drop weight test setup

**Results and Discussion**

Reacting time and peak force are two indicative parameters in cushioning materials characterization. In constant energy level, longer period of reacting time, results in lower peak force which states better energy absorption capacity, therefore, in order to compare samples with this criteria, maximum contact force is considered which is obtained through acceleration-time diagram of drop weight test machine. As depicted in figure 2, contact force in Nitinol samples are lower than polyamide and steel samples under the same energy level. In addition to this, the tearing threshold for steel and Polyamide samples was on 10 Joules and 15 Joules respectively (figure 3) whereas Nitinol samples tolerated 20 Joules without getting close to tearing threshold. Nitinol samples showed better elasticity behavior due to the superelastic properties in room temperature which in fact this feature enhances the compressibility and impact resistance of spacer fabric.

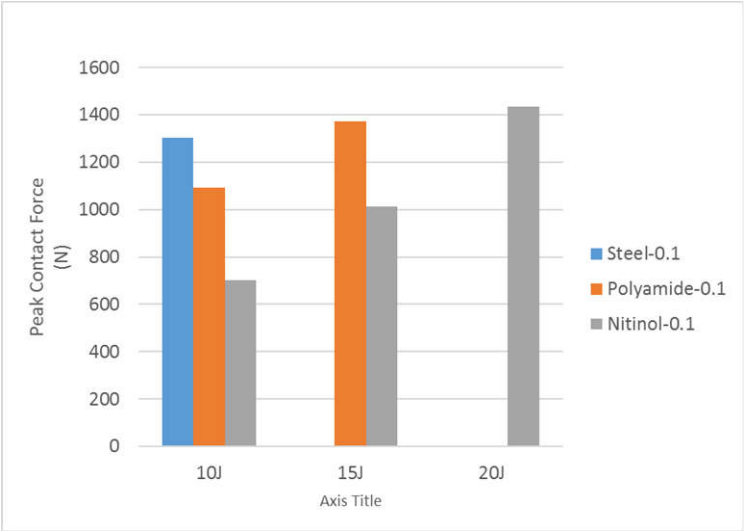


**Figure 2.** Peak contact force in different energy levels.

(a) (b)

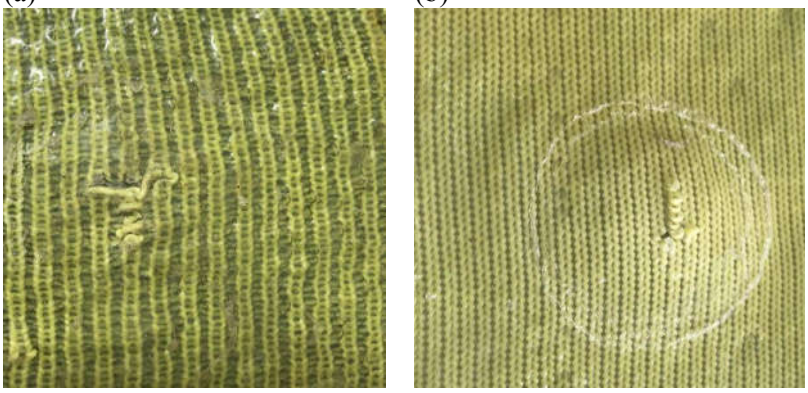

**Figure 3.** (a) Spacer fabric composite sample with Steel monofilament after 10 J impact energy test , (b) Spacer fabric composite sample with Polyamide monofilament after 10 J impact energy test

**Conclusion**

The effect of monofilament material on impact behavior of silicon coated spacer fabric composite was investigated in this paper. Out of Nitinol, Polyamide and Steel monofilaments, Nitinol found to be a better choice as spacer yarn due to higher energy absorption capacity and lower contact force under the same energy level which is attributed to its superelastic behavior and higher bending rigidity compared to Steel and Polyamide.

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# An investigation on the performance properties of rubber fuel hose reinforced with 2D biaxial braided e-glass yarn

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Hoses are manufactured using a range of material and configurations depending on their function. There are several types of hoses such as air intake, radiator, fuel-oil, vacuum, breather, power steering and brake hoses. They can be used in a wide range of application areas like automotive, construction equipment, railways, defence, farm track equipment, etc. These hoses can be produced using a single material, or multi-layered structure and reinforcement layers can also be used in order to increase durability, resistance against coolant, fuel oil, chemicals, high pressure, vacuum, etc. Formed hoses which are normally with reinforcement are mandrel built. First, the tube is extruded with specific ID, and then the reinforcement (braiding or knitting) is applied on it followed by cross head extrusion for cover applications with specific wall thickness [1].

In automotive industry, transportation of fuel and air are critical factors for the operation. Fuel hoses are designed for the transportation of fuel-oils in engine and fluids in hydraulic systems. Hoses made from rubber have been the primary means of carrying fuel or air although metal tubes have also been used in some instances. In the production of hoses, generally fuel, oil, and heat resistant rubbers like Nitrile, Viton, and Polyacrylic are used depending on the application. Also, highly ozone resistant and oil resistant Neoprene, Hypalon, and ECO are used for cover applications (Fig.1). Recent trend has been led to develop multilayer hoses using hybrid materials with special functionalities and specific requirements [1, 2].

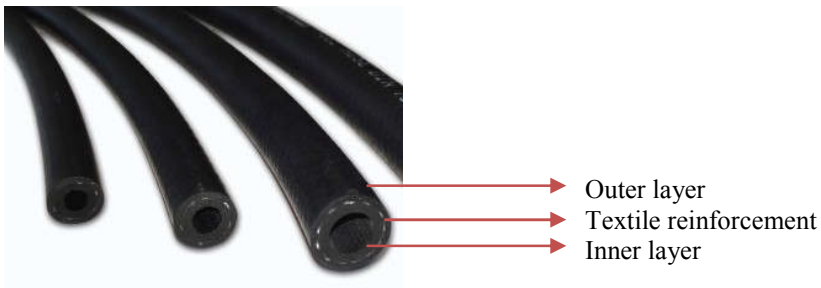


**Figure 1.** Layer configuration of a fuel hose [3].

The aim of this study is to investigate the performance properties of a NBR (Acrylo-Nitrile Butadiene rubber) / CPE (chlorinated polyethylene) fuel hose reinforced with braided e-glass yarn. For this purpose, NBR/CPE fuel hose was manufactured and for the production of the reinforcement layer, braiding technology was used. With an attempt to discuss the effect of braiding angle on the performance characteristics of the reinforced multi-layered hose, the speed of the radial braiding machine (Fig.2) was altered. E-glass yarn was used for the production of 2D biaxial braided fabrics. Then CPE rubber was again used for the cover application.

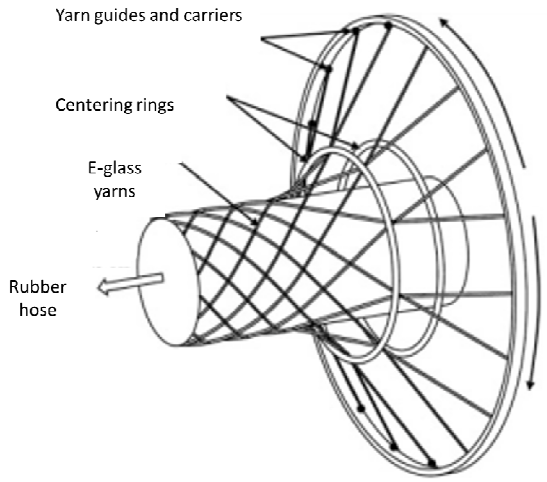


**Figure 2.** Schematic view of the radial braiding machine

Some performance properties of the fuel hose such as bursting pressure and diametric expansion (at room temperature and at $100^0$C) (ASTM D380, FIAT 9.02138), vacuum collapse (at room temperature) (ASTM D380), and adhesion between layers (at room temperature) (DIN 53530) were measured and evaluated according to the requirements in the above given standards.

**Acknowledgements**
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# Initial designs of wheelchair rugby gloves

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## Introduction

Wheelchair Rugby, also called quad rugby or murder ball, is a relatively new sport that was designed as a team sport for male and female athletes with a disability (even though many non-disabled people are also participating). As in any other sport, athletes are always looking to improve their performance. Evaluating athletes' performance is crucial for both coaches and athletes, as it allows for better planning of the training session to improve athletes' weaknesses and for a continuous improvement of the athlete and the wheelchair-user interface (1–3).

The very few available previous studies have found that the gloves are a major concern in wheelchair rugby. All these studies found that there are no gloves that are specific for wheelchair rugby, which causes the athletes to modify the existing ones in order to accommodate the performance requirements (4–7). Even the International Wheelchair Rugby Federation acknowledges that "many different types of gloves are available to choose from", however, none are sport-specific. Further, they state that "Many athletes prefer using rubber coated cotton gloves (…) because they are inexpensive and provide considerable grip to the player. Using tape to secure gloves to your wrist is a common practice and is highly recommended". Nonetheless, this information is only available on their website (8), the document with the International Rules for the Sport of Wheelchair Rugby (9) does not provide any information about gloves. The study of (4) tried to determine the effectiveness of different glove types on mobility performance in wheelchair rugby. The authors found that the gloves performed significantly better when they were modified and adapted for the specific athletes' needs. However, they believe that this might be caused by many different reasons. Hence, they advise that further research is needed to evaluate the athletes' interaction with different types of gloves.

The work of (5) has also evaluated the effect of different gloves on standardized wheelchair rugby performance compared with not using gloves at all (however, the tests were done in able-bodied participants). This study lead to the conclusion that the use of different types of gloves significantly influenced performance. Nonetheless, some gloves helped the athletes to perform better than others (NFL – US National Football League – gloves were the most favourable ones, whilst multipurpose were even worse than not wearing gloves at all).

In these two studies it was clear that there is a real need to develop gloves specific to this sport that fulfil the athletes' specific needs and requirements. As such, the purpose of this paper is to present an initial prototype of a pair of gloves specifically designed to fit the needs of wheelchair rugby players.

## Methods

The design of the glove started with the identification of the end-users' needs. This was done by means of both direct observation (with the capture of several videos and photographs) as well as

interviews. The sample used for this study was composed by a wheelchair rugby team of approximately 25 athletes based in the United Kingdom. The videos, photos and interviews were conducted over the course of several training sessions.
Once identified the needs, several potential designs were created. These designs were then evaluated by a team of experts who selected the one that fulfilled the criteria better. This design phase also included the selection of materials to be used.

**Results and Discussion**
The prototype developed took in consideration most of the users' requirements (Figure 1). It is important to mention that each athlete has a very person way of interacting with the wheelchair and the ball. As such, it is very difficult to develop a product that suits everyone's needs in the same way. Consequently, the selected design responds to the needs of the majority of the athletes. Nonetheless, it would still be possible to slightly change this design to accommodate users with different needs.

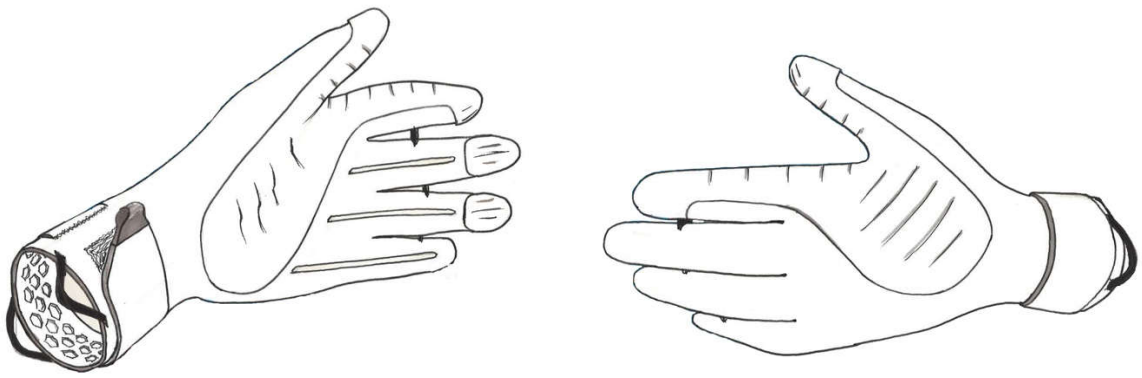

**Figure 1.** Draft of the prototype.

The selection of the materials was also based on the users' needs. As such, the selection of thick neoprene as the main element of the gloves was mainly due to the fact that this is a durable, breathable and comfortable material. Preference was given to a thicker neoprene as in this way it already provides some padding for extra comfort.

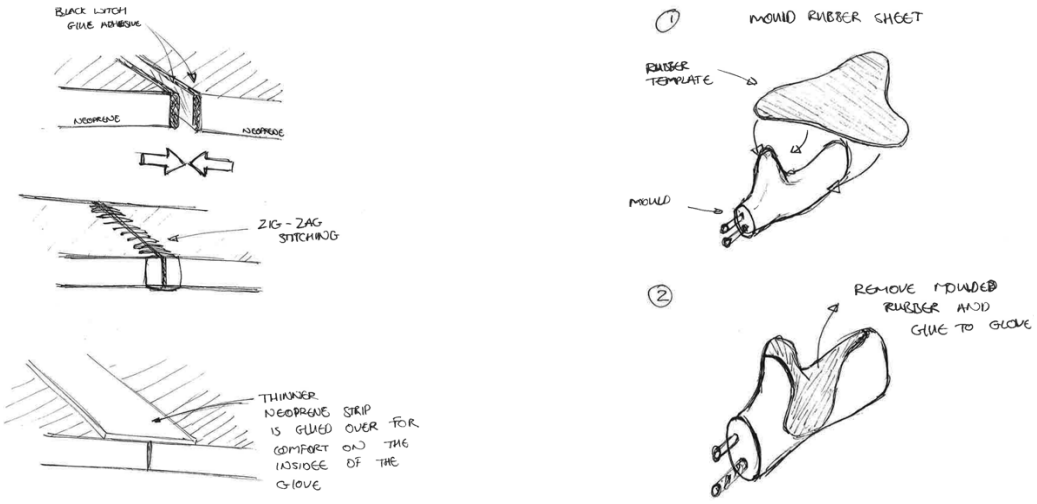


**Figure 2.** Stitching on neoprene ad vulcanised rubber moulding breakdown.

The selection of vulcanised rubber for some parts of the glove was mainly due to its durability and high resistance to wear and tear.
The construction of the glove using these materials can become quite complex as they are somewhat difficult to work with when such used in an intricate manner. Figure 2 shows how the stitching of the neoprene was made (with the addition of a thinner neoprene layer to avoid the rubbing of the seams with the skin) and how the vulcanised rubber should be moulded (to fit the parts of the hand that need more grip).

**Conclusions**

This first prototype of a pair of gloves specifically design to accommodate the needs of wheelchair rugby players fills a gap in this area of research. To the best of the authors' knowledge there is no other scientific publication that present any sort of wheelchair rugby glove.
The major limitations of this study are the fact that this design has not yet been tested by the end users and that is does not satisfy the needs of every single user. As such, as future work, the authors intend to test and evaluate this first prototype with the same sample that provided the initial feedback.

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***Oral Presentation***
***Topic Garment Engineering***

# Sewability Interdependence on Rigid Structures

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**Abstract**
Garment make-up is the final stage of textile processing were all the efforts from previous stages, in form of labour material, science and know-how collaborate to assemble the prime or auxiliary materials and convert into a final product.

Sewability has always been a major aspect of textile processing but quite often has not been given the correct attention by the textile manufacturers. The final product quality depends much on this ultimate stage, while a well-designed fabric with good fabric characteristics and prosperous financial forecast may result in a commercial disaster if it performs poorly in the final stage of stitching.

Sewability is the ability of the fabric to be sewn without faults and comprises merely two basic aspects; namely tailorability and sewing damage which is usually expressed as seam puckering. Tailorability intends to represent the ease of fabric processing at a satisfactory level and can help prediction and avoidance of problems which may occur in the subsequent garment sewing stage. Sewability is attributed to fabric properties, pretreatment, finishing, sewing conditions and mishandling. Finishing treatments influence fabric properties and hence the handle of the final product which is known to be an important criterion for customer selection. Fabric softeners have demonstrated that can significantly help meeting customer demands. In addition, such treatments affect the ease of sewing processing of garments, which is mostly reflected by the needle penetration force through the stitched fabric.

The needle penetration force can be accurately measured using the L&M sewability tester. In regard to the above statements, an investigation was conducted with the scope to identify and analyse the fabric inherent properties which affect needle penetration force and hence its sewability. An additional insight was given by a statistical analysis of the effect of fabric treatments on all properties under investigation. The investigation focused on the examination of woven fabrics of a rigid structure which are usually problematic in the stitching process. The samples were examined in their untreated treated, and control state. The inherent fabric properties examined focused solely on bending length, elongation and strength and mass per unit area, as per previous findings have shown to be interdependent to the needle penetration force. Results have confirmed previous findings and the existence of a statistically significant correlation between the needle penetration force and the fabric inherent properties was eminent in a linear manner.

While further statistical analysis in previous work had showed that fabric treatments affect the fibre lubrication and hence their mobility, altering the inherent fabric a reduce effect was noticed in the current study of the rigid fabrics in the decrease of the needle penetration force probably due to softener composition and to low level of application of treatment.

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# Measurement of Sewing Damage in Woven Fabrics

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Sewing process is one of the most important operations in the clothing industry. Every day, millions of products ranging from shirts to automotive airbags are sewn [1]. Sewing a textile fabric is a very pointed operation which is governed by a broad spectrum of parameters like the type of sewing machine, the stitching velocity, the structure of sewing operation, the method and the ability of worker, the selection of stitching parameters, etc. Seam appearance and seam tensile performance is the result of combination of all these factors [2]. A good compatibility between sewing thread and materials will influence the product quality and productivity. Otherwise, during the sewing process, the fabric is damaged, or the machine stops at unanticipated time intervals [3].

Sewing damage is one of the most troublesome problems in the clothing industry leading to poor seam appearance and performance [4]. Sewing damage caused by the needle penetrating through the fabric can create severe sewability problems. Needle cutting, or yarn severance occurs due to the stiffness of the fabric yarn and its lack of the mobility. Instead of moving and deforming when the needle penetrates the fabric structure, the yarn is ruptured or burned [5]. Sewing damage are commonly classified into two types according to their causes:

- Needle heating damage (thermal damage), viz. the scorching or fusing of fibers (particularly thermoplastic fibers) in the fabric due to the high temperature of needle which arises from the needle penetration through the fabric [4].
- Mechanical damage is a fault that includes yarns being broken by the penetration/withdrawal of the sewing needle. Sewing damage in woven fabrics was attributed to the friction of yarn on yarn in the fabric and yarn on steel during needle penetration [6].

The major cause of both types of sewing damage is the resistance to needle penetration which may result in high needle temperature and cutting or bursting of yarns. The risk for sewing damage depends on fabric and sewing parameters. The most important parameters that have an influence on the sewing damage of the woven fabrics are: fabric construction (fiber content, yarn construction, structure, tightness); chemical treatments of the fabric (softness, dyes, finishes, washing); needle thickness and design; sewing machine settings (presser foot design and pressure, sewing speed); and sewing threads [4, 7].

The sewability of a fabric, or the degree of its resistance to needle damage, can be determined in different ways. One measure of this property is the proportion of fabric yarns cut by the needle. Another measure of this property is the loss in fabric strength caused by needle damage. Needle cutting or yarn severance in a fabric is objectionable because it may result in reduced seam strength or poor appearance or both due to frayed yarns [8]. Also, most researchers investigated sewing damage in fabrics by undertaking sewing trials or by measuring needle-penetration forces [6].

This work covers the experimental techniques to measure the sewing damage of woven fabrics. Four methods (needle penetration force, yarn severance, seam efficiency, and photographs taken with an optical microscope) were compared under same sewing conditions.

Woven fabrics with different weights and constructions were sewn together using a 1-needle lockstitch sewing machine with SSa seam type. Sewing thread of 100% spun polyester was used at the upper and lower thread at lockstitch machine with different needle points and different needle sizes.

The needle penetration force tests were performed with a L&M Sewability Tester. The sewing needle penetration force is the quantitative measure of the damage which appears in a garment as the result of the sewing process. A high penetration force means a high resistance of the fabric and thus a high risk of damage [5, 9].

The test of "The needle-related damage due to sewing in woven fabrics" was conducted according to the ASTM D 1908 test method for needle related damage due to sewing in woven fabrics. For each sample, needle cutting index was determined using the following formula [10];

$$\text{Needle cutting index (\%)} = \frac{\text{Number of yarns cut/cm}}{\text{Number of yarns in fabric/cm}} \text{ x } 100 \quad (1)$$

Experience has demonstrated that the strength of many woven fabrics is considerably reduced by the sewing operation. The result of such reduction is the shortening of the overall life of a garment. The measurement of the loss in fabric strength due to needle damage consists of sewing a seam in the fabric, breaking the fabric at the line of stitching, and establishing a ratio between the original and seamed fabric strength [11]. Seam efficiency was calculated by the following formula,

$$\text{Seam efficiency (\%)} = \frac{\text{Seamed fabric strength}}{\text{Original fabric strength}} \text{ x } 100 \quad (2)$$

Photographs were taken with an optical microscope. The study of sewn fabric surfaces after removing sewing thread from fabric was done using digital microscope.

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# Mathematical approach to sifting significant technological factors into the sewing industry

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The paper deals with damp – heating processing (DHP) in sewing industries. DHP is essential for quality and productivity in the manufacture of clothing. This process is a complex process where heat and mass transfer in ironing is realized through application a plurality of physical processes like convection, radiation, and diffusion. Their joint impact on DHP in steam-presses is not sufficiently revealed. From this point of view we can conclude that our object of investigation appears to be a virgin land, thus the main goals should include application of statistical methods.
The goal of this paper is to investigate the importance of factors influencing the quality criteria (the shrinkage of textile materials after ironing with a steam-press), then to select the most significant factors, and finally to sort out the factors of their degree of influence on the quality criterion. To achieve these goals we make use of a specialized statistical method - the method of classifying correlation.
We have created a special table with 13 factors which influence the shrinkage of textile materials after ironing with a steam-press.
The significance of all above listed factors and their influence on DHP is investigated in numerous publications. Correlation has been studied between Time and Temperature in DHP of cotton textiles is examined as well the correlation between the ironing surface and the composition of processed materials. Correlation has been studied between Continuance of DHP and the Number of processed layers.
In general the significance of all above listed factors is proven. The problem is how to arrange them in accordance to their impact on the fact "Quality".
For this purpose we make use of the inquiry card which was filled in by 12 specialists from the sewing industry and lecturers at universities. The ranking matches closely the factors' significance.
The only limitation set is that by filling in the inquiry card there shouldn't be equal evaluations of the different factors.
The results are shown in a matrix (table 1.).
The information was evaluated by using Kendall's informational and statistical methods which deal with the grade of concordance in ranking completed by more than two experts and by using a large number of factors.
For this purpose we should define first Kendal's quotient of concordance:

$$W = \frac{12\sum_{i=1}^{n}\left(C_i - \overline{C}\right)^2}{k^2 n\left(n^2 - 1\right)} \qquad (1)$$

To calculate it we should define the sum of each factor evaluated:

$$C_i = \sum_{j=1}^{k} x_{ij} \qquad (2)$$

where: k – number of experts; n – number of factors to be ranked; Xij - ranking evaluation;i- factor and by j-th expert (table 1).

**Table 1.** Ranking matrix

| factor / expert | 1 | 2 | ... | i | … | N=13 |
|---|---|---|---|---|---|---|
| 1 | $X_{11}$=7 | $X_{21}$=13 | … | $X_{i1}$=11 | … | $X_{13\ 1}$=2 |
| 2 | $X_{12}$=10 | $X_{22}$=12 | ... | $X_{i2}$=8 | … | $X_{13\ 2}$=1 |
| … | … | … | … | … | … | … |
| j | $X_{1j}$=7 | $X_{2j}$=8 | … | $X_{ij}$=12 | … | $X_{13\ j}$=3 |
| … | … | … | … | … | … | … |
| K=12 | $X_{1k}$=9 | $X_{2k}$=13 | … | $X_{ik}$=10 | … | $X_{13\ k}$=2 |

Conclusions (results):

- Factors are ranked according to their degree of influence on the quality criterion,
- The results show that it is reasonable to reduce the number of controlled factors for the multifactor experiment in order to mathematically model the DHP,
- Considering all above stated we have chosen the most significant three factors to mathematically model the DHP.

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# Design of smart garments for sports and rehabilitation

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**Abstract**
Studies have shown that physical activity has positive effects on the prevention and treatment of several diseases, such as cardiovascular disease, diabetes, cancer, hypertension, obesity, osteoporosis, and depression, and it can prevent sports injuries, reducing the incidence of sports injuries to one third [1].

Strength training is commonly prescribed for health and fitness, athletic training, and prevention or rehabilitation of muscle and bone injuries [3]. An injury may only be detected in the weight room, but it may not have occured there. This can happen because an athlete may get injured in the field or court, without telling anyone, fearing prejudice, and the injury only worsened in the weight room [4].

In order to increase the quality of training, for athletes, rehabilitation patients or other pratictioners, preventing injuries and other health issues or to avoid their worsening, it is important to monitor the person while exercising. Previously, a prototype of a seamless long sleeve t-shirt for cardiac and muscle activity monitoring was reported [5]. In this paper, the design and development of a set of sportswear garments – long-sleeve t-shirt and leggings – that integrates textile sensors for real-time monitoring of the person's activity and physiological data is proposed and described.

**Materials and Methods**
In this phase, only the shirt will be produced, using seamless technology, which allows the production of a garment without side seams, as well as the integration of conductive elements (i.e.: electrodes, sensors and tracks) in the same textile substrate. The garment will be produced with two layers of fabrics – the inner layer having the knitted conductive elements and the outer layer being a flat black surface. This allows the integration of technology in an invisible way.

The garments include electrocardiography (ECG) and surface electromyography (sEMG) electrodes, breathing and temperature sensors, and a control unit for data processing and transmission.

Four ECG electrodes, positioned along the torso perform a 3-lead ECG, to monitor cardiac activity. The breathing sensor is located on the chest and the temperature sensor is located on the waistband of the legging, to monitor breathing rate and skin temperature, respectively. The chosen muscles were *deltoids*, *pectorals*, *biceps brachii*, *brachioradialis*, and *trapezius*, for the top; and the *quadriceps*, *biceps femori*, and *gastrocnemius*, for the leggings. The electrodes' positions are the ones shown in Figure 1. Note that, although the illustration shows the conductive parts, the only visible element is the control unit.

Signal acquisition tests will be executed in order to determine the performance of the electrodes and sensors in monitoring cardiac and muscle activity, and breathing rate. The temperature sensor will not be tested in this phase, since only the shirt will be produced.


**Figure 1.** Illustration of the garments, showing the conductive elements.

## Results

In previous tests [5], it was possible to obtain a good ECG response, with two electrodes located under the armpit and the other two locates in the waistline. It was noticed that there is more noise when moving the arms, since the shirt stretches, making the electrodes under the armpit lose contact with the skin. It was also possible to see that pressure has a positive effect in the signal, as can be seen from Figure 2.

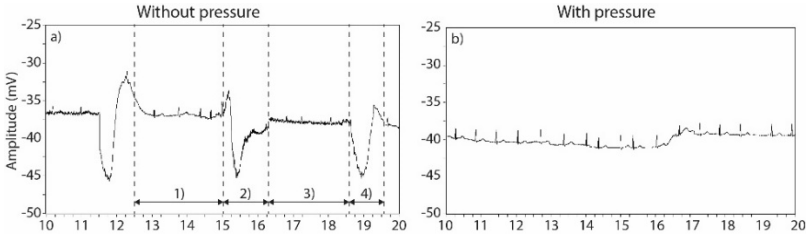


**Figure 2.** ECG response, while moving the arms, with and without pressure over the electrodes [5].

## Conclusion

A way of integrating technology into clothing invisibly, thus maintaining the looks of a conventional garments, is illustrated. The outer layer will be produced as a flat knitted layer, but other structures, yarns or colors can be used, for aesthetics or functional purposes.

Previous ECG tests have shown promising results, but the sEMG, breathing and temperature sensors are still to be tested, to determine if the above configuration provides an adequate response.

## Acknowledgments

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# Digital Twin and Men's Underwear Design

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**Abstract:** Based on 3D body scanning technology, KES properties of real knitted materials, new body measurements for digital twin generating, we developed the virtual method of men's underwear try-on. The results show that by means of virtual software 3D CLO we can simulate well the body characteristic, the underwear structure, the knitted material elongation, and the compression pressure distribution. New underwear design can have a good presentation in customization and mass production.

**Key words:** men's underwear design; 3D simulation; digital twin; pressure; knitted material

## 1. Introduction and the aim of the research

The current 3D simulation technology provides great convenience for apparel design and product development [1,2]. Most of 3D simulations are only about the common clothing pattern or the material simulation [3]. Few studies are concerned on system "body-clothing" and tight-fitting/compression clothing [4,5]. The negative ease allowance is often designing required because the tight-fitting underwear fitness truly reflects the human body morphology [6]. Nowadays, men's compression underwear also needs to be customized due to different needs, comfortable satisfaction, and shape characteristics. For this purpose, we examine the system "body-underwear" from several points of view such as structure, wearing effect, material deformation, and pressure distribution. We also compared various underwear sizes with corresponding body to verify our new classification of body size.

## 2. Experimental methods and steps

We used VITUS Smart to measure 115 Chinese (18…28 age young males) and used KES to test 14 kinds of knitted materials. Some basic research has been done before to establish databases of reasonable pressure values, ease range etc. [7]. Then, we simulated knitted materials "shell" and six pieces underwear to measure pressure values (38 points per piece). We used the software CLO 4.1 for virtual and actual differential testing. Next, we used new method of underwear design (basic and functional types). We designed the virtual underwear in 12 sizes $S^{--}$, $S$, $S^{+}$, $S^{++}$, $M^{--}$…$L^{++}$ (*S, M, L* is type of hip girth, "$^{+}$" and "$^{-}$" are different type of waist girth and so on), and change its eases from -20 to 0 %.

## 3. Main results

The KES parameters - *G* (shear stiffness) and thickness - were used to correct pressure values in CLO 4.1. After checking, the deviations of pressure difference were obtained ± 0.19 kPa (Figure 1), the pressure were measured under the knitted material "shell" strapping the body $P_B$, the same way in

virtual $P_V$, and virtual underwear $P_V'$. Figure 2 shows the several examples of pressure distributions under underwear and the rating evaluations. As for this, five grades are applicable to evaluate the compression underwear from low pressure to high. The range includes five grades: **1** (very low pressure/loose underwear), **2** (low pressure/fit), **3** (comfort pressure/close-fit), **4** (high pressure/very close-fit), **5** (very high pressure/extra close-fit) to evaluate the final score which was equal to the average grades measured in six parts per underwear. After, we checked the two underwear patterns – basic and functional types, and rate the body pressure sensibility and underwear deformation at various parts.

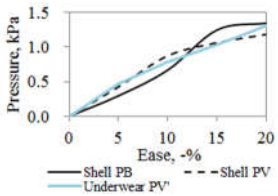


**Figure.1** Pressure comparison

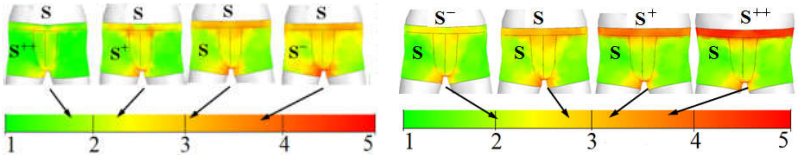


**Figure.2** Virtual evaluation of pressure distribution when underwear has the ease = -19.5%

## 3. Conclusion

After our correction, the CLO software can simulate well. The simulation experiment demonstrates the rationality of our design method and classifications. The body wears matching underwear size performed the best fitting and reasonable pressure distribution. Next, we will apply these results to the underwear factory for the verification of real products.

**Acknowledgments**

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# Evaluation of clothing fit

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**Background**
Nowadays different textile materials are developed – tendencies in the market is to produce textiles with smart applications. Smart applications in terms of garment include not only textile properties – it is complex system within human body and environment [1]. Clothing can increase the ability of body to function in different environments. Although all clothing is functional, the functional clothing design focuses on garments with special purposes. In order to meet all the determined functional and comfort requirements for clothing, patternmaking is one of the most significant steps. Pattern should be suitable for users' body type and its specifics, as well as for the specifics of the garment itself. Clothing is produced according to certain size charts (considering few main measurements – body height, chest, waist and hip horizontal girth) [2]. However, the figure of each individual is very different; therefore, it is hard to meet the classification due to the various proportions, which are rarely taken into account when designing clothes for production.
Non-fitting or ill-fitting functional clothing can reduce and/or lose ones' functionality – for example the insulation [3] between the top and the lining of the garment is tightened/flattened losing the air interlayer, thus the product's heating ability is significantly reduced, discomfort could be also caused by the limited movement ability.

**Materials and methods**
Measurements of subjects were obtained using both methods, for the contact method using measuring tape and anthropometer (device), but for the noncontact method using 3D anthropometrical scanner Vitus Smart XXL® (©Human Solutions GmbH and VITRONIC GmbH) with data processing system AnthroScan. Target of the research is to create a prototype for a system to experimentally determine the extent to which clothing clings to the wearer's body (or other clothing layers), how the clothing fit affects the wearer's comfort and ensures that garment meets all the functional requirements. For this sensors elaborated in textile system can be used [4], also 3D prototyping an ease evaluation is useful.

**Results**
The result of this research will improve the development and operational process in functional clothing industry. The result of the research will show solutions on multi task and multidisciplinary approach – including benefits for textile producers, pattern makers and end users. In the terms of 3D prototyping and ill-fitting detection, research gives advices on improvement of patterns. Research tasks performed within it give opportunity to make conclusions regarding causes of pattern alterations, their depiction in computer simulation, measuring possibilities and thereby the prevention of the causes of such

alterations thus easing the work of pattern maker. Also smart solutions of ill-fitting detection are suggested.

**Discussion and conclusions**

The research will boost further the use of design systems in apparel industry and trade, and reduce the number of trial and error experiments by producers when selecting garment sizes for special target groups. The project supports the Sustainable Development Goals, i.e. – the need for sustainable development - provides a comprehensive approach bringing together economic and environmental considerations in ways that mutually reinforce each other. As functional clothing is expensive and material consuming process – the improvement and enhancement of the design process and adjusting the design to end user will be boosted within project result.

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*1. Indicate your option for the presentation:* ***Oral****.*

*2. Indicate the option for the* ***topic:*** *5. Garment Engineering.*

# Evaluation of the knitted fabrics stiffness through dynamic testing

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Human activities involve exposure to vibrations, which are coming from various sources, either from power tools, industrial machines or riding in trains, planes, auto vehicles. The energy gathered from these sources is dissipated in the form of vibrations, some of which being transmitted to the people [1]. In this context, the knitted fabrics behaviour at vibrations testing is of special interest, as these materials can be promising for development of the equipment's for anti-vibration purpose. In this regard, numerous kinds of antivibration gloves have been developed to protect people from injuries during working. Most of such gloves are made from either rubber or air bag. However, the wearing comfort of these materials is poor due to their inferior air and moisture permeability [2].
The spacer warp knitted fabrics characterised by their interesting 3D structure, the good resilience to compression, the high volume with relatively lightweight, a very good moisture permeability for thermoregulation, have found their utilization in a considerable range of applications, including protective articles against vibrations. An ideal spacer fabric developed for anti-vibration purposes, should have the capacity of absorb energy efficiently, still having sufficient stiffness to avoid its collapse and an acceptable thickness in order to maintain a sense of touch and dexterity to complete the tasks [3].
The paper aims at introducing a method for qualitative evaluation of the warp knitted spacer fabrics stiffness, through the measurement of their natural frequencies, considering the direct relationship between natural frequencies of the textile fabrics and their stiffness. The stiffness of the textile fabrics constitutes the basic feature determining their suitability for a specific use [4]. The equipment used as fabric's exciter consists of an impact hammer Piezotronics and the natural frequencies were measured with an accelerometer PCB B52 Piezotronics type. The signal was processed with a data acquisition card 6023 National Instruments. Fast Fourier Transformation-FFT has been applied and the Spectrum Analyzer application from the LabView software was employed to record the natural frequencies of the system [5-7].
The spacer mesh warp knitted structures have been produced on double flat needle beds warp knitting machines, with 4-6 guide bars, threaded in various ratios, and different thickness values. The fabrics are made from PA, PES yarns and monofilaments as spacer yarns, and they can be used for sports shoes, bags, protective vests, gloves, helmets, cushions, mattresses.
A critical analysis of the fabrics response to vibrations is performed related to the main parameters of influence. It has been discovered a comparable dynamic behaviour on wale and course direction of the fabrics, attributed to the fact that the vibration mechanism does not involve any movement or distribution of the yarns in these directions. The highest values of the fabrics natural frequencies were found on perpendicular testing direction, due to the knitted fabric placement on one massive plate,

increasing thus the system rigidity. The level of natural frequency of each material is giving indications about system rigidity, being directly related to it, the higher is the natural frequency, and the higher rigidity is expected. The testing results confirmed the influence of the fabric thickness, the samples having lower thickness being characterized by the highest level of natural frequencies and stiffness.

In order to validate the results, another method has been used for the fabric's stiffness evaluation, using the determination of the bending length as a measure of the interaction between fabric weight and stiffness, namely the Cantilever Test for Stiffness [8]. Although it is static and not dynamic, this test provided a comparison of knits stiffness hierarchy, strengthening the validity of the dynamic test results. The recorded natural frequencies of the knitted fabrics can be also a helpful tool in materials selection for vibration isolation purposes, such as: people protection during a particular work, sensitive devices protection during transportation, packaging or cushioning.

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Conference Topic: Textile Engineering

# Sustainable entrepreneurship in the reuse of textile waste. H Sarah Trading case study.

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## Introduction

Sustainable entrepreneurship has taken up space in the creation of new companies that seek to adapt their products and services, from different industrial sectors, according to the requirements of a new conscious consumer, that is emerging. Its growth is also justified by the need to strike a balance between financial profitability and economic growth with justice and social welfare, environmental conservation and the rational use of natural resources [1].

In this way, most of the industrial sectors start to make use of sustainable entrepreneurship, as an agent of social and economic transformation, to find solutions to the negative impacts that are generated by the productive processes. In the textile sector, the issues related to the management of its discards become even more evident, due to the relevance of this segment in the world.

In Europe, for example, 5.8 million tons of textile waste are discarded each year, 75% of which are sent to landfills or for incineration and only 25% to recycling [2]. Specifically in Portugal, 5% of the 4607 tons of urban solid waste consists of garments or household textiles that end up in landfills or are uncontrolled[3].

The context presented impels us to understand the changes that are being implemented by the textile and clothing sector in search of new waste management systems that can incorporate the concept of sustainability in an attempt to minimize ecological and social crises, aiming at the maintenance and perpetuation of resources for future generations [4].

Thus, this article aims to conduct an exploratory study to analyze the actions that are to be carried out by Portuguese companies, focusing on sustainable entrepreneurship, in order to minimize the impacts caused by waste, through the reuse or recycling.

## Methods

This study was carried out in a first phase through a review of literature in current indexed studies that investigate the theme of sustainable and social entrepreneurship applied to the textile sector. In the second moment, a qualitative research was carried out, through a case study, of H Sarah Trading Ltda. This company has been operating in the Portuguese market since 2006 and is a holder of a license to operate in waste management. It presents itself as a liaison between the citizen and the textile recovery cycle. Its activity aims to reduce the quantities of textile waste destined for landfills through the reuse / recycling of these materials, contributing to the awakening of a sustainable awareness among citizens [5]. Data collection, took place through semi-structured interviews, in loco, applied to two managers of the company. In addition, available technical materials, reports and the company's website were

consulted. The data were duly documented and analyzed according to the following parameters: i) analysis of the systemic structure ii) identification of the environmental, economic and social benefits of the business, iii) relevance of the business to the network of partnerships, iv) communicational actions for project visibility and v) innovation drivers for sustainable entrepreneurship.

**Results**

Research shows that today's societies are experiencing changes in their production and consumption systems to ensure the survival of future generations and reduce environmental impacts. This fact makes emerge the need for radical changes with the adoption of sustainable postures, both in people's daily lives and in production systems, which need to find innovative solutions for their waste. The productive chain of the textile and clothing industry continues to follow these trends and starts to create industries and services focused on sustainable entrepreneurship. The case study carried out in Portugal with waste management company H Sarah Trading, represents an innovation that is largely based on the Triple Bottom Line [6] which contemplates actions in the environmental, economic and social areas.

The business structure is based on innovation and creativity to meet complex environmental problems caused by the harmful impact of incorrect disposal of post-consumer textile waste. The use of containers in the public spaces of the cities, to collect the textile discards, presents itself as a strategy of involvement with the consumers to awaken a sustainable conscience. The results of the projects implemented with different stakeholders of the organization, strengthens the partnership network and gives visibility to the company's positioning.

**Conclusion**

It can be perceived that sustainable entrepreneurship, applied to environmental, economic and social management, has consolidated itself as a path without a return to the companies and appears as a promising alternative for the textile sector to manage the impacts of its discards, in a way creative, innovative and financially viable. Also,it is emphasized that through sustainability and innovation, companies can create new markets for sustainable products, influencing their productive chain that becomes more sensitive to sustainable issues.

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***Options indication***

*1. Indicate your option for the presentation:* ***Oral,***

*2. Indicate the option for the topic:* ***Marketing, branding and fashion consumer***

# An evaluation of usability of warp knitted spacer fabrics as hip protector

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As the people are getting older, the incidence of falling, fracture and vulnerability to injury increases due to their decreased physical capabilities. The populations of many countries are both ageing and feminizing, meaning hip fractures now occur in around one in four women and one in eight men. More than 90% of hip fractures result from a fall [1-3]. A sideways fall produces a high-energy impact, which increases six times of the risk of a hip fracture compared to a backward or a forward fall, even in young subjects [4,5]. Therefore, reducing the rate of falls and the resulting hip fractures is an increasingly important part of healthy ageing.

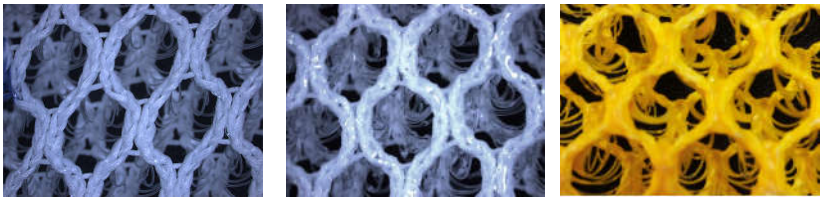
Hip protectors are hard or soft plastic shields embedded into pants or undergarments in proximity of the outside of the hip, just over the trochanter. The aim of hip protectors is to reduce the energy transmitted to the trochanter during a fall below the force causing a fracture, referred to as hip fracture threshold [4,6]. Mainly, hip protectors can be either "rigid pads" designed for spreading the energy of the impact to the soft tissue of surrounding of the hip or "energy absorbing" soft materials that decrease the force of the impact ultimately transmitted to the bone [7,8].

Several studies have been indicated that hip protectors are not often used for reasons such as uncomfortable (too tight/poor fit), wearing difficulties, urinary incontinence and physical difficulties/illnesses [9-14]. Attention has been paid to the features of the hip protector garment concerning comfort, appearance and fit. Changes in the design of hip protectors making them more comfortable and acceptable to users justify new studies addressing the effectiveness of hip protectors [15]. The aim of this study is to examine the usability of warp knitted spacer fabrics as a hip protector, in order to eliminate the complaints frequently encountered in the market, due to their higher air and water vapour permeability, thermal conductivity, good compressibility and lightweight.

This study reports the physical and performance properties of silicone and latex coated warp-knitted spacer fabrics. With an attempt to discuss the effect of coating and fabric structural parameters on the physical and performance characteristics, seven warp knitted spacer fabrics were produced by varying thickness (12.5 and 15 mm) and mesh structure (small and large hexagonal mesh) (Table 1). Then, fabrics were coated with silicone and latex by using vacuum infusion process in order to improve the force attenuation capacity of the fabrics (Fig.1). The fabrics were coated with these substrates in a 1:2 weight ratio.

**Table 1.** Specifications of the fabrics

| Fabric type | Yarn thickness (dtex/mm/dtex) | Space distance (mm) | Mesh size (Finished width of the samples) | Courses /cm | Fabric pattern |
|---|---|---|---|---|---|
| 1 | 167f48x4-334f72x3 /0.243/ 167f48x4-334f72x3 | 12.5 | Large (160 cm) | 5.25 | Two side open structure |
| 2 | | 15.0 | Large (160 cm) | | |
| 3 | | 12.5 | Small (110 cm) | | |
| 4 | | 15.0 | Small (110 cm) | | |
| 5 | 167f48x4/0.200/167f48x4 | 12.5 | 130 cm | 6.5 | Two side close structure |
| 6 | | 15.0 | 130 cm | 6.5 | |
| 7 | 334f72x3/0.170/334f72x3 | | 130 cm | 5 | Face side open/back side close structure |



(a) (b) (c)

**Figure 1.** Surface photos of (a) non-coated, (b) silicone coated, (c) latex coated fabrics.

Mass per unit area, thickness, air permeability, compressibility, dimensional stability and compression set properties were measured and evaluated statistically.

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***Options indication***
*1.* ***Oral***
*2. Textile Engineering*

# Thermal Comfort Properties of Firefighters' Clothing with Underwear

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Protection together with comfort is a very important subject for firefighters' performance and health. Heat and moisture transfer from the skin through the multilayer textile structures has a direct influence on the performance and safety of the firefighters. Thermal protective garments and firefighters uniforms are produced using special multilayered fabrics which are bulky and heavy. Thermal protection from fire and metabolic heat stress generated by the human body due to metabolic activities must be balanced [1-7].

The firefighter garments typically consist of three single layers of technical fabrics; outer shell fabric, moisture barrier fabric and thermal barrier fabric. Besides firefighter uniforms, firefighters also wear underwear garments inside their clothings. In this study, we have developed a new fire resistant underwear. The main purpose of this study is to evaluate the single fabric layer thermal comfort behaviours of underwear, outer shell, moisture barrier and thermal barrier fabrics together with their three-layered and four-layered combinations to understand their multilayer fabric performances. One firefighter garment type was selected for the study.

**Table 1:** Fabric properties

| Fabric Code | Fabric Type | Mass per unit area ($g/m^2$) |
|---|---|---|
| Outer Shell | 75% Meta Aramid-23% Paraaramid-2% Antistatic | 200 |
| Moisture Barrier | 85% Metaaramid-15% Paraaramid<br>PU membrane laminated to FR nonwoven Fabric | 120 |
| Thermal Barrier | Aramid felt quilted to Aramid/Viscose FR nonwoven fabric | 115 |
| Underwear | 78% FR Viscose Paraarmid 20%, 2% antistatic | 220 |

Thermal comfort properties of the firefighter clothing and underwear were evaluated considering three comfort properties, thermal resistance, water vapour permeability and moisture management properties of fabrics. The sweating guarded hot plate apparatus was used to measure the thermal resistance of clothings ($R_{ct}$) ($m^2K\ W^{-1}$), under steady-state conditions according to ISO 11092 (ISO,

1993) [8]. The temperature of the guarded hot plate was kept at 35°C (like human skin) and for the determination of $R_{ct}$ of the fabrics, the standard atmospheric conditions were set as 65% R.H and 20°C. Water vapour permeability is the ability of a material to allow water vapour to pass through it. Water vapor permeability of the samples was measured using the dish method, according to ISO 15496 (ISO, 2004) [9]. This method involves determination of weight loss with the evaporation time (24 h) of water contained in a cup, the top of which is covered by the cover ring. The difference in water loss between a cup covered with the reference fabric and one with the test fabric enables to study the relative rates of moisture movement through the test fabrics, so that the moisture vapor permeability of the test specimen can be calculated. Moisture management tester (MMT) is used to evaluate moisture management properties [10]. This method quantitatively measures the liquid moisture transfer in one step in a fabric in multidirections, where liquid moisture spreads on both surfaces of the fabric and transfers from one surface to the opposite.

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# The Perception of Tactile Feeling and corresponding Textile Attributes Worldwide

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Different types of fabrics are usually classified according to their physical characteristics that influence the quality of the textile products. Among several attributes of textile quality one of the properties that motivates the acceptability of the consumer and repeat their purchase, is comfort.
The textile comfort has been studied by instrumental and sensorial methods. Descriptive sensory analysis, much explored by the food and cosmetic industries, can characterize the attributes of different product types qualitatively as quantitatively [1,2].
Among the methods of sensory analysis, researchers from France [3] and Portugal [4] adapted the Quantitative Descriptive Analysis (QDA), with the purpose of quantifying the quality of touch in textiles. The researchers used this method to develop lexicons for the evaluation of the tactile sensorial attributes in textiles. Each national panel creates its own consumer-based word for the evaluations of a product type.
A Brazilian lexicon was developed by Nagamatsu et al. They used the same method as the French and Portuguese researchers, resulting in a lexicon of 11 attributes [5].
After the three lexicons were compared, seven terms reveled to be common among the three countries: three bipolar (light & heavy; thin & thick; Cold & warm) 2 describe the surface (soft; plush) and 2 describe the material (elasticity; falling) [6].

## MATERIALS AND METHODS

The procedure of selection and identification of the descriptors was adapted from ISO 11035 [7].A panel of 14 reviewers was invited to describe the touch sensations of 20 fabric samples of different types. They generated 299 terms that were reduced in four steps, the first three by the panel during 3 meetings. 1st eliminated hedonic terms (177); 2nd rejected descriptors with same meaning (49); 3rd combing singular terms (21); and in the fourth reduction, the panel quantified the perceived intensity of the attributes and these data were treated by means of statistical methods.

The map of PCA (Fig. 1) showed some differences and similarities between the attributes, that some tend to group similar correlated terms as Itches and Rougged; Rilief & Rough. Soft & Smooth and Fit and Flowing.

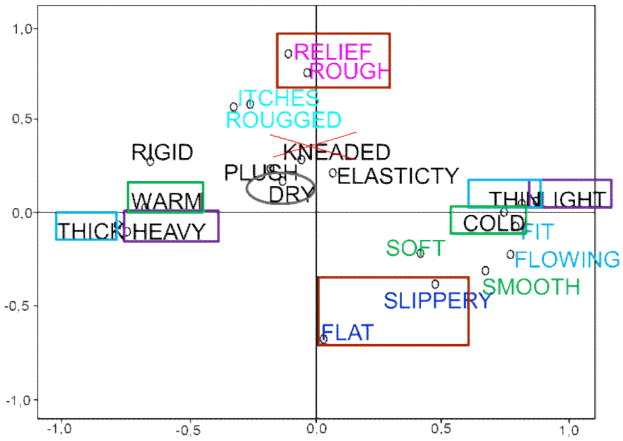

Figure 1. – PCA of 21 attributes to evaluation sensory hand textile

## CONCLUSION

For the development of the tactile sensory comfort lexicon for Brazilian textile products, four statistical models were applied. In Geometric Analysis it was possible to classify the order of perceived intensity. The interpretation of Correlation Analysis and the PCA allowed the identification of similar attributes (positive correlation) and opposites (negative correlation) that contributed to the classification of the bipolar terms. The analysis of the results of the application of the statistical models in the 21 attributes allowed decision making for a more precise formation of the Brazilian lexicon. The final list is composed of 11 most significant attributes (table 1).

**Table 1.** The final list of attributes

| **Bipolar Attributes** | **Surface Attributes** | **Material Attributes** |
|---|---|---|
| Light-Heavy | Soft | Elastic |
| Rough-Flat | Plushy | Rigid |
| Gross-Fine | Rugged | Fit |
| Fresh-Hot | | |
| Dry-Humid | | |

**Key words:** Tactile Feeling, Thermal comfort, Textile Lexicon, Attributes

**Acknowledgments**

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***Options indication***
*1.* ***Oral presentation***
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# CONFERENCE HALL OF NORTH AEGEAN REGION

# Solar energy contribution on covering the energy consumption of the Center of Environmental Education of Lesbos island

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**Abstract**

The Center of Environmental Education (CEE) of Lesbos island is located in Asomatos village (Figure 1) and has been operating since 2004 in order to offer short courses and specialized seminars about environmental issues and sustainable development for high school students and tutors across Greece as well as for the local population of Lesbos. According to official data, the CEE consumes annually approximately 10000kWh of electricity and almost 12000kWh of heat, with the corresponding specific annual primary energy consumption being almost 350kWh/m$^2$.

**Figure 1**. The Center of Environmental Education of Lesbos island

On the other hand, Lesbos island, and more specifically Asomatos village, possess quite high solar potential since the annual solar energy per square meter at horizontal plane varies between 1500-1600kWh/m$^2$. In this context, the Soft Energy Application & Environmental Protection Laboratory of University of West Attica in collaboration with the scientific personnel of the CEE has studied and proposed an integrated clean-green energy solution [1] based on the exploitation of the local solar

irradiance. More specifically, the proposed solution [2,3] includes the installation of a small photovoltaic generator of 5-7$kW_p$, used to cover the major part of the CEE electricity consumption via the net metering technique, Figure 2. Subsequently, the heat load and the hot water consumption may be partially/totally covered by the installation of the appropriate solar collectors. Finally, special emphasis is paid also to install the necessary measurements' apparatus in order for the entire installation to be available for experimental measurements by the hosted students/tutors.

**Figure 2**. Schematic installation of PV panels at the CEE of Lesbos island

The main results of the proposed solution implementation include air pollutants and $CO_2$ emissions reduction due to the replacement of heavy oil by solar energy, the considerable reduction of the energy related operational cost of the CEE [4] and the familiarization of the young visitors and local population with the advantages and the prospects of solar energy applications [5].


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# Circular Economy and Eco-design: an integrating study for sustainability in fashion sector

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The garment industry is embedded in a competitive environment where there is increased risk or unaffected by productive processes. Thus, organizations must adapt existing strategies or adopting new ones to meet the demands and deal with the compatibility between productive activities and environmental [1]. In this context, the circular economy (CE) is considered an important component of sustainable development and is seen as a new business model that could lead to a more harmonious society [2] and the design process is critical, since many aspects of sustainability of a product are determined by the choices that are made in the design stage and the main change is associated with the echo of material factors and ethical issues in production, aspects that must be present in the product design fashion [3, 4]. The presente study aims to analyze how the eco-design aspects can integrate the circular economy to promote sustainability in the fashion sector.

Therefore, this research is characterized as a qualitative study, descriptive and exploratory accomplished by literature. The information was retrieved from the selected databases to search. The VOSviewer tool was used in the analysis of bibliographic data.

The results consist in proposing an integrative analysis of circular economy and eco-design aiming the product life cycle. Also reveals that the circular economy concept can be used to inspire some long-term systematic changes in the fast fashion industry to sustainable operations, for example, the use of sustainable materials in the manufacture of products and the preparation of sustainability reports. It was found that eco-design through the activities of designers and intermediate production processes can support the complexity of integration of circular economy to sustainability in the industry, with emphasis on product design, which reduces the costs if changes are necessary.

As a result, shows the eco-design integration possibility to circular economy as potentially possible due to the goals that have both complement each other. It's expected to contribute to the production of knowledge to the interested areas, a manufacturer clothing and the whole society, as it will address aspects which aim to minimize environmental impact and waste generation with the eco-design products to meet the wishes of consumers-users.

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# Industry 4.0 concepts applied in the Portuguese garment industry: some evidences.

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## Introduction

The Portuguese clothing industry is a traditional, important and mature industrial sector. The textile and clothing industry (ITV) includes 6,000 societies and 5,600 individual companies, employing a total of about 130,000 direct workers, producing 6.4 billion Euros and generating € 6.8 billion in turnover, in which € 4.8 billion are due to export activities [1].

The Fourth Industrial Revolution is taking place in this new millennium, called the Digital Revolution, through technologies such as the Internet of Thing (IoT); Artificial Intelligence (AI); Virtual Reality (VR); Social, Mobile, Analytics and Cloud (SMAC) interaction, etc., to transform the real world into a digital world. In 2013, the new keyword "Industry 4.0" starts to emerge from a German government report that mentions this phrase in terms of high-tech strategy [2]. Also German Chancellor Angela Merkel refers to Industry 4.0 at the World Economic Forum in Davos in January 2015. Industry 4.0 has now gone beyond the German project framework and became an important part of the Fourth Industrial Revolution with the participation of many other countries and organizations.

Industry 4.0 is the current trend of automation and data exchange in manufacturing technologies. The concept of Industry 4.0 is based on the integration of information and communication technologies, industrial technology and is mainly dependent on building a Cyber-Physical System (CPS) to prepare a digital and intelligent factory [2], in order to become more digital, customized and also green. The purpose of Industry 4.0 is to build a highly flexible production model of personalized and digital products and services, with real-time interactions between people, products and devices during the production process [3].

According the last data of Digital Economy and Society Index 2017 [4], the Portuguese companies have integrated the Digital Technology in their processes and 44% of them are using Electronic Information Sharing (EIS) and 8% RFID.

## Methods and results

The research method will be the case study and documental analysis [5]. This paper will show how a Portuguese clothing company (GUIMA) is preparing their processes, skills and resources to be in the Industry 4.0. This clothing company belongs to a bigger textile group (SOMELOS SGPS), with vertical production (spinning, warping, sizing, weaving, dyeing and finishing) and own brand in their

fabrics. SOMELOS Tecidos is the main supplier of raw materials of GUIMA (fabrics to produce the shirts). The research team is following the industrial process during four months, starting from the reception and quality control of raw materials and accessories, until the orders expedition to different customers.
Some results already obtained shows how the digitalization is yet in a preliminary stage in the clothing industry. Even the stocks of raw material were without a suitable organization to advance to digitalization of manufacturing.

**Conclusions**
It is clear that the Industry 4.0 is an important tool to the competitiveness of the clothing industry. The two most important factors in manufacturing for the 4.0 industry are the horizontal and vertical integration. Horizontal integration is the connection between devices, workstations or separate plants, and it is also the cooperation between the companies involved. Vertical integration in manufacturing is involving the actuators, sensors, controllers, production management, production and business planning starting from the suppliers till the customers. But is necessary prepare the entire resources from the clothing company (human and technology) and organize the systems and processes to achieve this stage in GUIMA clothing company.

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# Millennials: is ‘green’ your colour?

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## Introduction

Fashion is the way in which our clothes reflect and communicate our individual vision within society, linking us to time and space, and clothing is the material thing that gives fashion a contextual vision in society [1]. The fashion industry is evolving at a fast pace and on one hand consumers are becoming conscious of the impact of their purchasing behaviour, and willing to support a more sustainable fashion industry but on the other hand are complying with unsustainable business models [2]. Consumers are an important part of the fashion system and can create a valuable influence in the pursuit of sustainability in the fashion industry. Encouraged by low prices and influenced by marketing campaigns and trend changes, consumers tend to speed their fashion consumption [3].

The generation Y (Millennials) is defined as a group of people born between 1980 and 2000 [4] and maintain a positive attitude in relation to sustainability in general. However, there is a clear contradiction between how Millennials think about sustainability and what they do when it comes to a sustainable consumption [5].

Since only studying the green attitudes will not produce conclusive results on the behaviour of young consumers to buy sustainable products, it is interesting to determine what factors influence the attitude-behaviour relationship. Several studies suggest that there is a difference of attitude of green purchasing behaviour due to the complex nature of personal and situational influences [6]. Personal factors are internal influences. The attitude is a personal factor important in the purchase of sustainable products but doesn't explain why the young consumers don't buy this type of products. Other examples of personal factors are awareness, trust, priorities, emotion and control (to the extent that a consumer believes to have control over the events that affect) [6]. The awareness factor, for example, is defined as the amount of time that was spent in the processing of information about green and sustainable products [7] so the academic background will play an important role in this personal factor. Situational influences are the external influences that a person cannot control, but which affect the relation attitude-behaviour. Examples of situational factors: time, opportunity, money or the ability to perform the desired behaviour [8]

## Methodology

The main goal of this paper is to study the Generation Y’s perceptions regarding sustainability and their ‘green’ consumption habits of footwear in Portugal. The research method will be through the analysis of three focus group only with a total of 30 Millennial participants. The analysis of the focus groups allows a better understanding between the gap of what Millennials think about sustainability

and how they perceive it, with their actual consumption habits regarding footwear. In order to design a solid focus group, some influencing factors were selected from the literature review and will be further subject of analysis: Consumption habit; Economic availability; Physical availability; Personal benefits; Consumer consciousness and Personal perceived importance. For example, the literature states that the economic availability to purchase 'green' products has a strong negative influence on the 'green' purchasing behaviour. A necessary condition to buy products of this type is that the price and quality of the 'green' products must be comparable to the regular products that a consumer would normally buy [6]. But do the Portuguese Millennials feel the same way? This paper will analyze each of the influencing factors stated above allowing a better understanding of the Generation Y's sustainability perceptions and consumption habits in the footwear industry in Portugal.

## Conclusions

After selecting and analyzing the influencing factors that can positive or negatively impact the gap between Millennials' attitude and behaviour concerning sustainability and sustainable fashion, some interesting conclusions are now possible to obtain. Portuguese Millennials are fully aware of their role in society and therefore know that they should consume green and that by doing so they are contributing positively to the environment and improving their lives as well. All agreed that being green adds value to their life and that is extremely beneficial. In what comes to footwear, no participant could name a sustainable brand. They also stated that they feel limited in terms of design choices and that is one of the main barriers that keep them from buying 'green' footwear. Also, the economic availability to purchase 'green' footwear presented as one of the strongest negative influences on their green purchasing behaviour. In sum, it is possible to conclude that even though Portuguese Millennials have a very positive attitude towards sustainability and green products, this attitude is not reflected in actual behaviour.

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# How to communicate a new brand of men's accessories through social media and public relations' perspective: strategy of a Portuguese brand.

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## Introduction

The world fashion industry is highly competitive and fragmented. The economic changes led towards the reduction of production costs and, the outsourcing to other producers, demanding lower prices of raw material from suppliers around the world but also the pursuit for more favourable conditions in local market. There are economic, cultural and social changes that were accelerated through new and different communication infrastructures [1].

Nowadays, in a society driven mainly by image and appearance, fashion has a highlighted, important and democratic presence [2]. Fashion is a form of nonverbal communication and can be transmitted through globally comprehensible images. Since imagery became more dominant in the last decades, aesthetics arises to be a critical point in these new digital approaches [1]. To summarize, fashion matters for the economy, to society, and to each of us personally. What we wear tells the story of who we are, or who we want to be. Hence, fashion is the most immediate form of self-expression. [3]

The main focus of branding strategies is changing because of interactivity and connectivity, as well as a continuous relationship between the brands and the consumers. In recent years, there was a drop in investments in traditional marketing strategies. This points to new modalities to communicate fashion such as public relations and social media. These practices have already been adopted and used by many companies as sources for gathering relevant information, establishing brand awareness and creating relationships with their prospective customers. On top of that, influencing a large number of individual acceptance and the usage of products and services, with minimal effort attempts required to influence them [4]. Angela Kim and E. Ko [5] stated that even luxury brands had resorted to using digital platforms to survive, increasing competition within the market.

Therefore, brands and consumers are able to communicate with each other without any restriction of time and place. As a result, the traditional process of one-way communication changes to a two-way communication in a scenario where brands can benefit their exposure to fortify relationships with their customers and, consenquently, increase their sales [6].

This research explore the branding strategy relevance through social media and public relations' perspective in order to understand how new digital marketing platforms have been used and integrated by fashion industry professionals.

## Methods and results

For this investigation, a qualitative methodology was chosen more appropriate as the researchers are investigating a small sample. Mark Saunders [7] stated that the classification of the types of study that

are most used in research methods are exploratory, descriptive and explanatory, however each of the embodiments may have more than one purpose.
A case study is an important research strategy when the researcher wants to comprehend the complex social phenomenon and allows him to focus on a case and maintain a holistic perspective [8].
According to Menard Scott [9], in the longitudinal analysis, the variables are evaluated repeatedly over different periods, thus allowing the measurement of differences or changes in each variable which can obtain some interactions between them.
The expected results in this case study include some answers to relevant questions: which is the best way to position a new brand in the market, how to identify trends in brand communication, what is the importance of creating an effective communication plan, how is the impact of branding on consumer behaviour, how social networks could be used as a fashion communication channel, how social media guidelines can be used to increase global recognition of the brands, how the public relations strategy, bloggers and celebrities can influence consumers, among others.
It is known that there is no ready recipe for brands to follow and be succeed. However, the aim of this research is to identify the key issues to position a new brand in the market, in order to create a method that can be applied to these new Portuguese fashion brands. The main idea is to obtain the necessary support to indicate more easily the major problems in the current communication of fashion brands and to propose suggestions for improvement and innovation according to each brand's principles, goals, target audience, considering the theoretical basis studied on branding and fashion communication.

**Preliminary Conclusions**

New fashion brands have to deal with strong competitors, high market share, established and notorious brands and to generate brand awareness in potential markets. On the other hand, there are always market opportunities in some niche markets, further to innovative and differentiate products or quality services, even if the brand is new.
Keeping in mind that the transition from a mass market to a segmented market contributed to change the consumer's habits, it is important to emphasize that we – as fashion communication researchers – need to discover how to achieve an effective brand strategy to surprise this consumer, if we want to build a successful and valuable brand.
This abstract describes part of an ongoing Master's Thesis research study aiming to contribute to the subject of Fashion Design and Garment Industry. The consumers are using even more new digital channels to interact with their love brands and the social networks are quite important in these cases.

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# Pattern design methods for non-conventional bodies

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## Introduction

The moment to fit a garment can be considered decisive to sale the clothing products. The consumer evaluates attributes, aesthetic and technical, from the interaction of his body with the product. According to authors, the Fit performance is considered one of the most important attributes in the buying decision [1]–[3]. It is considered that "fit is the ability to be the right shape and size" [4]. It is also directly connected to the anatomy of the body and its volumes [5] and its ability to fit into the body [6]. However, the inefficiency of the adjustment of clothing to the body, lead consumers to dissatisfaction and consequently to refute the product [2], [7].

In the industrial clothing production are commonly used traditional methodologies for the construction of patterns blocks. This methodology is based on the transfer of body measurements (3D) to a flat surface (2D) ) [5], [8]. In traditional methodologies, the measures transferred are based on anthropometric tables. These are agreed upon from the data collection of a given sample, in order to serve a segment of the population or a target audience [1], [8], [9]. The pattern blocks still have the function of acting as guides for the stylization of different clothes style, corroborating to the success of fit in a collection [1].

Due to the great dependence of the measurements and anthropometric tables required by the traditional methods of development of blocks of modeling, diverse study of data collection are made in order to understand and to contemplate the greater number of individuals. However, tables, however developed from large sampling, individuals with unconventional characteristics are excluded and marginalized from the consumption of industrial products [5], [10]. Difficulties of equal impact occur in the anthropometric standards identification in populations of high ethnic diversity [11].

The availability of new methodological and productive possibilities occur due to the continuous technological development. An example of this is the three-dimensional digitization promoted by body scanners and virtual prototyping enabled by 3D CAD software that enable advances in the efficiency of ergonomic validation of projects in several product segments [1], [5], [8], [12], [13]. Tools already available in the market for more than a decade, but they present regular evolutions and availability of new possibilities. The article presented here aims to explore new technological methodological possibilities for the construction of modeling bases, focusing on the users of non - conventional bodies.

## Methodology

The research procedure of this study falls within the exploratory field of qualitative character. The techniques adopted were; direct documentary research with the bibliographical survey and

experimental research, with direct documentation of the data obtained from the development from the development of modeling blocks through three different methodologies: (1) Pattern-making block developed from the tracing methodology and table of measurements as an anthropometric basis ESMOD; (2) Pattern-making block developed from ESMOD tracing methodology parameterized according to the individual measures of the individual studied and; (3) Pattern block extracted from the surface of the digitized 3D body of the individual studied. This study aims to compare the pattern-making work methods and the ability to fit in the individual context. In other words, when attending the unconventional proportions population.

## Conclusions

In order to find the perfect fit and democratization of access to quality clothing for all, this study sought to verify the performance of new methodological possibilities for the construction of pattern blocks for individuals with non-conventional bodies. To do so, based on a user that did not fit the standard industry measures, we compared three different methodologies, in order to understand their differences and degree of efficiency. They are: (1) Flat pattern blocks developed from the measurement table, (2) Flat pattern blocks parameterized with the individual measurements and (3) Flat pattern blocks extracted from the digital model surface.

It was possible to observe distinct performances from the overlapping of the lines of the pattern blocks of the three different methodologies, caused by different interpretations of the same volumes and measures. The first methodology proved to be inefficient due to ignoring the measures of the individual studied. The two subsequent methodologies reached interesting results regarding fit. However, they resulted in different planned designs. In addition, it was possible to verify that in the situation of the extraction of the bases by means of 3D CAD systems. In a first stage, the pattern blocks is not useful, due to the inexistence of looseness for vestibilidade. Additionally, they do not represent points of reference for future stylizations. In the case of parametric pattern blocks, it presented inferior performance in fitting to individuals of non-symmetric bodies. The results presented here represent the early results of a broader investigation of technological possibilities in the development of pattern design and clothes design validation.

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## Design thinking as necessary constituent of creative industry

**Abstract.** Creative management has now announced itself as a real-life knowledge area. Moreover, it becomes universally accepted. Creative management is closely linked to the innovative management that operates with the intellectual product. Creative management is implemented at the pre-design and design stages of the innovation cycle and considers the innovative product as a complex structural. Accordingly, the management associated with the creation of a new system of knowledge, skills and abilities must be in a certain way divided into a number of constituent elements. Thus, we can say: innovative management, on the one hand, creative - on the other, have the same object of consideration, but study it in one case (innovative) from the outside, as ready, in another (creative management) - from the internal, as the process of creation. It should also be noted that creative management should be aimed at the full disclosure of creative abilities of people. The design thinking activates the development of knowledge, skills and abilities, because through the use of a qualitatively different methodical device raises the creative potential to a higher level.
Creative management is closely linked with the development of such areas of management as personnel management, strategic management, innovation management, "self-management", organizational culture of the enterprise, marketing. Experience shows that the use of creative-heuristic techniques in scientific and technical creativity can increase the efficiency of the work of scientific and engineering teams several times. However, this rich experience is hardly ever used to improve managerial decision-making in the economic and organizational spheres. The activity of future managers is related to work with people, it is aimed at strengthening and better utilizing the creativity of the collective (creative management), as well as the fact that the staff has activated its own intellectual abilities. There is a certain contradiction between the constant growth of knowledge and the low creative level of students. A number of researchers state [1-3] that the development of intellectual - creative potential of youth is on the lower boundary of the average norm. At the same time, it was determined that high indicators of creative potential of a person and personal qualities of future managers influence the efficiency of management activity and their self-realization. Thus, the program of shaping the thinking of future marketers should include the following directions:
- acquisition of skills and skills in the formation of creative thinking;
- studying methods of solving non-standard tasks;
- ability to apply forms of a creative approach to management activities.
Creative management, promotes the development of skills of non-trivial creative decisions in business. In creative management, you can distinguish the following main goals:
- assessment of the creative potential of a person - a specialist who wants to be involved in solving creative problems;
- creating a creative atmosphere in a team that has worked for a long time and has its own traditions, informal leaders, the distribution of role functions that has justified itself.

# “Do as I say, Not as I do” – a systematic literature review on the attitude-behaviour gap towards sustainable consumption

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A consequence of the growing number of conceptual and empirical studies in sustainable consumption is the need to adopt systematic approaches to evaluate and assemble research outcomes that provide a balanced and objective summary regarding a particular topic. The paper reports on the adoption of such approach - systematic literature review - to the published studies relevant to topics within the sustainable consumption domain. So far, research on sustainable consumption is scattered across different disciplines and lacks integration, giving raise to many different definitions of the concept. Research into the responsible, ethical, sustainable, green and socio-political aspects of consumption has grown considerably since the 1990s. The most consistent finding within this literature has been inconsistency between what people say and what they actually do —the so-called “attitude-behaviour” and “intention-behaviour” gaps [1-3]. For instance, in a study of the Millennial generation, [4] observed that even though consumers have a very positive attitude towards sustainability and green products, this attitude is not reflected in actual behaviour.

This paper contributes to a consolidation of the field by narrowing down the gap between sustainable consumption “attitudes/intentions” and actual consumption “behaviour”. Based on a systematic literature review with an initial sample of more than 1000 publications, this paper considers the following inclusion and exclusion criteria throughout the review: research scope, conceptualisation of the terms (e.g. “Sustainable consumption”; “Ethical consumption”; “Green consumption”; “Green consumerism”; “Responsible consumption”), research design (e.g. quantitative, qualitative experimental studies), segments of consumers (Generation X, Y and Z) and time frame (since the start of the literature).

A qualitative research approach will be adopted in this paper, to safeguard the inclusion of methodologically diverse studies. Additionally, because the mentioned concepts have evolved over time and raised so many different interpretations, a qualitative approach is considered more pertinent.

The focus of the review is to build up coherence regarding the sustainable consumption attitude-behavior gap. However, the review also reveals that there are serious methodological challenges and shortcomings in existing approaches, namely with regard to conceptualisation issues, selection of participants and study designs. The paper concludes with a discussion of challenges and recommendations for future work in the field, namely, the need to encourage and educate consumers to live a more sustainable lifestyle and to design and implement responsible marketing tools to communicate the value of sustainable consumption.

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*1. Indicate your option for the presentation:* ***Oral.***
*2. Indicate the option for the* ***topic*** *Marketing, Branding and Fashion consumers*

# Overview of textbooks published for Hungarian fashion design students

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Year 2015 two unique books were published by the Hungarian National Labour and Adult Educating Office, for fashion design students. Textbooks *"Collection development"* and *"Design of fashion accessories"* were issued with a goal to create comprehensive, high-quality professional literature for the Hungarian young professionals in their mother tongue. The article reviews the challenges of the writing, introduces the market target, the latest sales statistic, the experience of the lecturers, and the influence of the books on the domestic fashion education.

**Chapters of the article:**



## Introduction

Fashion surrounds us! It has never employed as many people in the history as today, and along with this, it has never been given work to a so gigantic staff! Never, not in a single age, we did not care so much about our appearance, and we did not consume so many fashion items! In our age, the World of Fashion seeks continuous supply; every year a new generation of designers – full of energy, authenticity, and enthusiasm – is born, looking for a place in this unique business.

Fashion has always been a glamorous profession, attacking thousands of young people who believe they're just as talented as their idols, and with much persistence and a bit of fortune can be successful as they are. Thus, entering of an accredited institution (a college, a faculty or a university), with the aim of gaining the necessary knowledge and receiving a diploma, has always been the culmination of the dreams and the fulfillment of the hopes of the talented. Therefore, development of a competitive course curriculum, and providing of quality professional knowledge, associated by value literature in the mother tongue of the student, is essential in educating and training of the national fashion intelligence of every country.

The fashion industry is a complex market, with cruel rivalry rules. The process of creating new goods needs to be designed in the spirit of sustainable development today. [1] Along with this, fashion collections are produced not only for their own benefit anymore, but based on the market demands, and are created with aim of profit for the benefit of the company. [2] Consequently, development of a

fashion collection requires a designer who has artistic and technical insights at the same time, in addition to this knowledge about the marketing of fashion goods and fashion accessories. In the present time designer should be a creator, a graphic artist, a writer and a poet in a single person! Consequently, the designer is a person who's able to create a collection of fashion goods arranged according to professional rules (according to the current demand of the fashion market), uniting artistic aspirations with the client's goals.

**Methodology of editing of the structure of the books**

The books *"Collection development"* [3] and *"Design of fashion accessories"* [4] (Figure 1.) are based on the knowledge attained from the subject *"Fundamentals of fashion design"*, enhancing them with supplementary theoretical and practical contents, and the competitive skills, necessary for recruitment.


**Figure 1.** Covers of books *'Collection development' (left)* and '*Design of fashion accessories' (right)*

Proposal of the books were edited upon the curriculum of the subjects. The course material is extended with interesting (at the same time popular) practical exercises, short teaching contains short readings, and curiosities.

**Short description of the contents**

The article contains the concise display of books *'Collection development'* (Fig. 1, left) and *'Design of fashion accessories'* (Fig. 1, left). Precedents for the books did not exist (anything like it was published in Hungarian). Topics of the books were compiled on the basis of curricula of professional education institutions and are based on contents of the available foreign literature. The book *"Collection development"* has 260 pages, and contains 297 colour illustrations. The chapters and titles of the book are detailed in the article, followed by some of the unique figures taken from the entire book.

The book *"Design of fashion accessories"* – as the "younger sister" of the book *"Collection development"* – is both thematic and structurally considerably more complex than the previous one. It can be said that, even at the level of world literature, a similar book does not exist. Themes of this book are based partly on the curriculum of professional education institutions and on some of the

contents of the relevant foreign literature. This book has 174 pages and contains 204 colour illustrations. Some of the chapters and titles of the book – without the ambition to comprehensively mention all – are detailed in the article.

**Brief summary of the results**

Peer revivers of the books emphasizing their value and quality, highlight their contribution to the assimilated competencies gained during the training. *"A very thorough, detailed analysis that encompasses virtually every field of expertise based on the theme of the curriculum. Topics are integral to tasks, deepening the acquired knowledge, and encouraging students to acquire new ones. Quotations that capture individual chapters, characteristically sumptuous examples and outstanding images make the book a very pleasant read. Short stories of interestingness enable versatile orientation and thorough student education, providing support for the work of teachers and professors."*[1] *"Outstanding Book! The writing style is dynamic, the structure is logical, the illustrations are interesting. The book reads with pleasure. The author of the book not only with the text but also with the pictures helps students to acquire the necessary competences. Tasks are interesting, issues are coherent to the text of the textbook. And with its look and professional literature, which is textually in line with the age of potential readers, who are already willing to become fashion designers when reading the introduction."*[2]

**Conclusion**

The article summarizes the challenges of the writing of a valuable textbook for college and BA students, for course *Designing of Fashion Collection*, and course *Design of Fashion Accessories*. Books have been written in Hungarian and were published by the Hungarian National Labour and Adult Educating Office, year 2015 with a goal to create comprehensive, high-quality professional literature to the young professionals in their mother tongue.

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***Options indication***

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*2. Topic:* ***5. Garment Engineering or 6. Marketing, branding and fashion consumers***

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[2] Gabriella Dr. Parajné Toth, pedagogical peer reviewer of the textbook *"Design of Fashion Accessories"*

# Fashion brands strategies and contemporaneous consumer behavior on social media in Portugal

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## Introduction

Nowadays, people connect, interact and share experiences with other people and brands in just a few seconds. The increase in social media users is growing more and more, reaching huge numbers worldwide. According to Marktest Bareme Internet study, the number of social network users (social media) in Portugal increased three-and-half times between 2008 and 2017, from 17.1% to 59.1%. In total, there are 4.262 millions of social networks users in Portugal from 15 to 64 years [1,2]. According to André Carvalhal [3] it is not only the attitude of consumers that has been changing in the last decades. Contrarily to the past, age, gender and social status have now insignificant importance on the public and on people behavior itself. These concepts are no longer used, being completed outdated. The contemporaneous consumer is now more fluid. It has more information, possibilities, purchasing power, critical sense, and consequently he is not identified with just one style or brand [3]. These aspects lead to a process of customization in which an evolution occurs from a childlike state of identification to a state of greater awareness and differentiation [3]. In this sense, it is possible to observe this change through the growth of homonymous brands of young designers who fit in the behavior of contemporary consumer. These changes bring the perspective that these are the "new consumers" of information and products in general. All these aspects indicate that fast fashion networks and social media approaches will need to reposition themselves in the market and work on product development lines differently. Their fast, degradable and unsustainable posture is no longer attracting as many consumers as it did before.

In this way, several brands have recently born with traditional fashion proposals. This traditional fashion goes through all stages of creation and development of the products in the four seasons of the year and its presentations occur punctually and not every month or week. In addition, these brands work with life care concepts and communication elements in social media that are aligned with their values and customer target. This generation of new consumers is transversal to the age, gender, nationality, religion and social status and its distinguishing characteristic is the capacity to be informed and conscious about these abovementioned aspects. The aim of this work is to understand the strategies of Portuguese fashion brands to approach the social media and websites, and understand new consumers' behavior in these new communication channels. It is intended to analyze three fashion brands to understand if their communication is consistent with their concepts and also if there is in Portugal a change in consumer behavior

**Experimental**

The first step of this work consisted on the brands selection. ModaLisboa show is one of the most important fashion events in Portugal and several new designers/brands have every year the opportunity to show their work. Brands that have shown their collection on recent ModaLisboa fashion catwalk were identified and it were also defined other mandatory requirements: Portuguese origin; Women's and men's clothing; Be present on social media Facebook and Instagram; Produce 2 to 4 collections per year; Not included on fast fashion and on slow fashion. According to these aspects three brands were selected: Patrick de Pádua, Luís Carvalho and Nair Xavier. This study uses a qualitative research methodology with mixed techniques for data collection and analysis procedures [4]. According to Saunders et al. [5], the case study is a research strategy that involves empirical research of a contemporary phenomenon in the real-life context where multiple sources of evidence are use. Thus, simultaneously, the case study of three Portuguese fashion brands will be carried out with longitudinal analysis of their social networks Facebook and Instagram to study their changes and development over a period of time and to identify their behaviors, patterns and changes. The collection of data on consumers in Portugal will take place from the perspective of self-selection sample through structured interviews with standardized questions [4].

**Results and discussion**

The paper will show that the strategies followed by these three Portuguese fashion brands concerning social media are quite different. It will be shown how these fashion brands communicates in the Facebook and Instagram profiles their collections, taking advantage of ModaLisboa reputation and social media presence.

**Conclusions**

Social media, contemporaneous consumers and fashion brands are the hottest topic in sustainability discussion. But is necessary answer an important question: Are they aligned to the same main goal? The younger Portuguese designers, a new generation more aware to the importance of a correct brand and image strategy to their collections, are doing a very good work to promote the global image of the Portuguese fashion and designers. And they are dealing in a different way with the social media and global commerce on the web.

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***Options indication***
*1. Indicate your option for the presentation:* ***Oral****.*
*2. Topic:6 – Marketing, branding and fashion consumers*

# TEXTILE WASTE FOR CHEMICAL AND TEXTILE INDUSTRIES FEEDSTOCK (PRESENTATION OF EU PROJECT)

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***Abstract***
*The RESYNTEX project aims at designing, developing and demonstrating a new industrial symbiosis between textile waste and the chemical industry. The new original symbiosis is based on the chemical/enzymatic transformation of textile waste in a form that facilitates the easy take up as feedstock by the chemical industry in order to produce high added value chemicals. The parallel production of various high added value products ensures competitive production costs for the chemical market. As a result, economic advantages can be provided besides prevention of industrial environmental problems. The project will consider and demonstrate the whole value chain starting from the citizen behaviour change and the textile collection of unwearable textiles, improving and automatizing the industrial sorting, demonstrating the production of the transformed textile components and the symbiosis with the obtained chemical products and finally analysing the best economic models and policy actions for a successful introduction in EU markets.*

**Keywords:** textile waste, recycling, chemical depolymerisation, enzymatic transformation, circular economy.

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RESYNTEX

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# Assessment of acrylic based textile wastes as energy source

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Textile fibre consumption continuously increases in parallel with the increase in population, standards of living and dominating of the clothing industry by just-in-time and fast fashion [1-3]. Therefore, millions of tonnes of textile waste are generated annually. Since the re-using and recycling ratio of textile wastes is very low, large amounts of wastes are disposed by landfilling. Moreover, when recycled textile materials are considered, after completion of their primary post-recycling lifetime, a secondary recycling is not generally possible due to the substantial fibre damage. For this reason, recycled textile materials also become waste for disposal. Therefore, rather than disposal, the use of textile wastes for energy conversion will be advantageous in terms of natural resource consumption.

Emissions of greenhouse gases resulting from the use of fossil fuels are causing environmental problems such as global warming, acid rain and air pollution. For a sustainable production, increasing the share of the use of renewable energy sources is of great importance. An important class of renewable energy sources is biomass. Hence, textile wastes have the potential to be utilized as biomass and can be used as energy source. On the other hand, due to being heterogeneous, bulky and porous, energy density of textile wastes are low and it is difficult and problematic to process textile wastes at existing power generation facilities. Therefore, they should be converted into homogeneous, dense and carbon-rich structure to be used as energy source, called biochar. Biochar is a renewable feedstock with reduced $CO_2$ emissions and is used either for energy output or as carbon source [4].

This study investigates the fuel characteristics of biochars obtained from acrylic based textile wastes through low temperature pyrolysis (torrefaction). For this purpose, wastes composed of 100% acrylic fibres and acrylic blends with various fibres such as polyester, wool and viscose were collected. The pyrolysis experiments were carried out in a laboratory scale fixed bed reactor in nitrogen stream. Pyrolysis temperatures were selected to be 300, 350 and 400 °C. Textiles wastes and resultant biochars were characterised through biochar mass yield, elemental analysis, heating value and energy efficiency determination.

The results indicated that acrylic based textile wastes could be converted into biochar through torrefaction with a high mass yield (43-80% depending on the temperature and blend). The increase in torrefaction temperature led to a decrease in mass yield. The HHV (higher heating value) of the resultant biochars were found to be quite high (between 26-30 MJ/kg depending on the blend) and it was found that torrefaction temperature did not have a considerable effect on higher heating value. O:C and H:C atomic ratios showed that the resultant biochars had similar properties to bituminous coal. It was investigated that the ash content of biochars was very low (<1%) and the sulphur content was below the measurement limit, unlike the biochars obtained from other biomass sources. According to these results it can be concluded that the use of biochars obtained from acrylic based textile wastes as energy source is of advantageous.

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***Options indication***
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*2. Option for the topic:* ***Textile Engineering***

# Regarding the effect of finishing processes on some properties of stretch denim fabrics

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Traditionally, denim is a strong and durable cotton fabric, produced with 2/1 or 3/1 twill weave constructions, in which the warp yarns are dyed with blue pigment obtained from indigo dye and the weft yarns are white. It is used for making jeans, jackets, shirts, skirts and many other garments for men and women of any age, as well as for children. Denim fabrics are widely used in clothing industry because they bring together a number of features highly appreciated by the consumers. Denim garments are comfortable, durable, versatile, affordable, and always fashionable, being a good choice for all age groups [1, 2, 4].
Since the people prefers comfortable and fashionable clothing, denim brands have become more interested in improving both the comfort and functional properties of their products, providing customers the opportunity to feel better while wearing these products. Consequently, a major area of innovation and development is devoted to diversify the range of denim fabrics, by using varied types of fibres, yarns and finishing treatments [3,4]. Among these approaches, one important trend is represented by the manufacture of stretch denim fabrics. These fabrics, in which the weft system incorporates elastic core-spun yarns, exhibit a high elasticity compared to other types of denim and ensure valuable comfort properties for the garment, such as formability, fitting to the human body and shape retention after wearing [5, 6, 7].
The supply chain for denim products includes among other things, the steps required by production of denim fabric, garments manufacturing and finishing of denim garment. Generally, after weaving, the denim fabric is subjected to mechanical and chemical treatments designed to ensure dimensional stability, soft surface and to prevent contraction in subsequent finishing and washing processes. Furthermore, by applying various fabric finishing processes, denim manufacturers have the opportunity to diversify their production and get a varied range of denim fabrics. Additional, the finished denim fabrics may be subjected to diverse type of washings in order to obtain those aesthetic features expected by the customers for the garment products. This is a marketing strategy that results in a number of competitive benefits such as quicker response to market and fashion demands, higher flexibility in production, more design options available already in fabric stage, large variety of possible wash-down effects and increased added value. For this reasons, the denim companies make substantial investments in machines and equipment as well as in the development of processes and techniques allowing them to achieve a flexible production and to meet quickly the continuous changing in fashion trends.
The effects of different mechanical and chemical finishing processes as well as of various washing treatments on physical and mechanical properties of denim fabrics have been studied and reported in several papers [8, 9].

The present study aimed to evaluate the effect of some finishing and washing processes on the properties of stretch denim fabrics. The investigations has been carried out using stretch denim fabrics with composition of 98% cotton/2% elastane and 3/1 Z twill weave. Starting from a greige denim fabric, through the application of different types of finishing treatments, several variants of finished denim fabrics were obtained. Finished fabrics were then washed using different washing recipes to attain the appearance and properties as close as possible to those of the garment products to be made of these materials.

The effect of finishing treatments and washing processes on the denim fabric properties was assessed by measuring certain structural and physical-mechanical properties. Have been selected and determined by usual laboratory testing methods - as objective assessment - those fabric properties that can be also subjectively assessed: fabric weight and thickness, fabric extensibility and flexural rigidity. These properties are important because they contribute to obtain a certain sensorial perception of the customers when handle the fabric and may influence their decision regarding the buying those garment items [10].

The obtained results showed significant changes of the fabric properties both after industrial finishing treatments and washing process. These confirm the possibility of obtaining a whole range of denim fabrics featuring various properties, starting from a single type of greige fabric, by using different types of finishing treatments and washing processes. For the denim producers this is a good strategy, allowing them to be more flexible and to respond in a quick manner to the changing demands of market and customers.

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***Options:*** *Oral; Topic 10: Textile Engineering*

# Adhesion of 3D printing polymers on textile fabric

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Applications of 3D printing in fashion industry are numerous, including 3D printing geometries on textile fabrics, printing parts of the garments, or even the entire garment. A crucial point of making such polymer/textile combinations usable is the adhesion between both materials. Investigations related to this adhesion, however, are still scarce. Similarly, the influence of 3D printed patterns on the geometries and the mechanical parameters of textile fabrics are only rarely examined. Continuing our previous research, recent tests evaluate the effect of different shapes 3D printed from diverse polymers on woven and knitted fabrics. These results will support other researchers as well as fashion designers in developing new 3D garment shapes by combining common textile fabrics with the relatively new possibility of 3D printing.

**Introduction**

3D printing is an innovative technology with applications in different areas of production. These applications include the fashion industry, where examples can be found in various case related to 3D printing geometries on textile fabrics, printing parts of the garments or whole garments. Even though combinations of 3D printed objects and textile fabrics are innovative for the fashion industry, they are still rare compared to the traditional fabrics. Applications for footwear products are more often found than garments. This is related to the polymers which are more often used in footwear products for sole production.

Applications of 3D printing on textile fabric strongly depend on a high adhesion of the 3D printed geometries on the textile fabrics. Investigations related to this adhesion, however, are still scarce [1-3]. Only few research groups have conducted investigations on the impact of textile and printing parameters on the adhesion between both materials. Similarly, the influence of 3D printed patterns on the geometries and the mechanical parameters of textile fabrics are only rarely examined [4]. This is why this paper depicts results of adhesion tests on different textile fabrics typically used for garments and shows some possibilities to create new 3D forms by adding 3D printed patterns to common textile fabrics.

**Methods and Materials**

Printing was performed using an FDM (fused deposition modelling) printer Orcabot XXL (Prodim International). As printing materials, PLA, soft PLA, and some other more or less flexible materials were used in order to depict the influence of the flexibility on the adhesion as well as the produced 3D

shapes of the textile/polymer composites. Similarly, different woven and knitted textile fabrics of varying thickness and areal weight were used as the base for printing.
Examinations were performed using a self-built drape tester according to Cusick to investigate fabric drape, a universal test machine to measure the adhesion force and different microscopes to investigate the interface between both materials.

**Results & discussion**
Both the 3D printing polymer as well as the textile fabric significantly influence the adhesion between both materials. Especially the comparison between woven and knitted fabrics, the latter being relaxed or stretched during 3D printing on them, shows large differences which can be attributed to a form-locking (physical) adhesion in the open pores of the fabric. Similarly, the viscosity of the 3D printing polymer in its hot state, i.e. during printing, was found to severely influence the adhesion.
The best combinations in terms of adhesion were afterwards used to print special geometrical and other forms which should create a 3D form from an originally flat (2D) textile fabric. Here, especially the bending stiffness of both materials were found to be relevant for the created shape – too hard polymers could not bend at all, while too soft polymers did not influence the textile fabric in the necessary way. Results also showed that not all textile fabrics were suited for the creation of such new shapes – too rigid or inelastic fabrics could not be draped sufficiently to produce the desired forms.

**Conclusions**
3D printing with different polymers on textile fabrics can be used to create composite garments in new 3D shapes. A crucial point is to ensure a sufficient adhesion between both materials, making previous tests with the materials in use necessary. The results of our study give an overview of the most important printing and material parameters and will thus help researchers and designers in producing their own composite garments.

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***Options indication***
*1.* ***Oral***
*2.* ***Topic 10 - Textile Engineering***

# Thermoelectric heat patch for clinical and self-management of post melanoma excision wound care.

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**Abstract.** Thermodynamics as a physical and healing therapy is considered to have potential beneficial effects when applied to soft tissue. Normothermia is the state of a body being at a normal temperature and is essential to healthy cell functioning and wound healing. This article presents the application of thermoelectric elements on a conductive textile; focusing on the heat transfer of five elements over varied areas. By setting the temperature of the thermoelectric elements relative to skin temperature, a thermal camera captured the heat transfer. An increase in heat transfer was created by lining the conductive textile with commercial polyester wadding forming a quilted patch. Thus, by adapting this patch, the maximum distance between the elements relative to a minimum heat loss was observed at 3 cm. Any distance less than 3 cm covers a small area, whilst an increase in heat loss occurs above 3 cm. Further research can be conducted by implementing a pulse width modulating (PWM) system to maintain a constant temperature between 32 and 34 °C. With the addition of a temperature sensing device, a preventative system can be developed for chronic wounds essential for diabetic patients.

# Study on the properties of natural fiber reinforced Poly (lactic acid) Composites

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**Abstract:**

This work aims to investigate the influence of sisal fiber content on the properties of sisal fiber reinforced PLA composites. Composite samples were extruded and then injection molded with different contents of sisal fibers (5%, 10%, 15%).The tensile properties of PLA composites reinforced with different content of sisal fiber (5%,10%,15%) show that the increase of the sisal fiber content in PLA composites improves the tensile strength and the tensile modulus of PLA composites, and also the improvement of flexural and impact properties of PLA composites is due to the increasing of the content of sisal fiber in PLA composites.The thermal properties of PLA composites reinforced with sisal fiber prove that The sisal fiber act the role of nucleating agent of the PLA polymer, also it allows the increase the degree of crystallinity in the PLA martrix.

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