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INTRODUCTION

Department of Textile Science and clothing design of the Technical Faculty "Mihajlo Pupin", University of Novi Sad, organizes in cooperation with the Faculty of Engeneering, Pamukkale University in Denizli, Turkey, the international conference "Textile Science and Economy VIII" - TNP2016.

These two high education institutions plan to work together to improve their project of international conference "Textile Science and Economy" that has been successfully developing for the past eight years. Many participants of this project indicated that the economic entities of the textile sector cannot develop successfully without textile science. This is confirmed by a large number of textile companies dominant in the market, that its dominance is based on constantly placing new and market-friendly products. However, the application of scientific research, through the development and commercialization of new products is a very complex process, which, often by corporate entities, especially those of them in less developed countries, is not appreciated and understood appropriately. Therefore, the international conference "Textile Science and Economy" is increasingly becoming a place of presenting examples of good practice in linking textile science and economy.

Many so far presented papers at the conference indicate that the connectivity of textile science and economy as well as for the successful development of companies is a key factor. Therefore this conference is increasing the focus of its work towards the goal of finding the best ways to attract and educate in this sector a large number of highly creative staff. Many studies show that only a highly creative staff can provide solutions to develop new technologies and products capable to cope with the strong competition on the world market.

International Conference "Textile Science and Economy" with its work so far has significantly contributed to improving the work of the Technical Faculty "Mihajlo Pupin". Using the knowledge and contacts made at this conference it has established cooperation with a number of universities and companies. It should be emphasized that with the Conference it was possible to establish a Cooperation Agreement with the greatest university in the world in this field, Donghua University in Shanghai. This Agreement in addition to the joint cooperation projects, enables the exchange of students. Last year two of our students had been participants of the Summer School of Design, organized by the University. Also the cooperation with the Faculty of Mechanical Engineering, University of Maribor, has enabled in the last few years, the participation of our students in the School of Design, which they organize. From business entities we need to mention excellent cooperation with the French company Lectra and the German company Pirin Tex. The contract with the French company Lectra has enabled the opening of the education center for training students in software and equipment of the world's largest company in the field of software and equipment for the fashion industry and soft materials. The contract with the German company Pirin Tex provides professional training of students in the company, which has 3.500 employees. Also it is worth mentioning that we have contracts with our companies and an established cooperation concerning vocational training and employment of our students through the project Fair for practices (internships).

This year the project international conference "Textile Science and Economy" continues with activities related to establishing stronger ties with industry. Specifically, the Conference will partly take place in Arilje - the region with more than 300 small and medium-sized textile enterprises. Students will offer these companies a conceptual design of new products which they will show at fashion shows and exhibitions that will be organized in the framework of the Conference.

For the first time at the conference their works through fashion show will show and students Faculty of Art and Design - West University of Timisoara. This is the result of partnership and cooperation between our two universities, in the framework of the international project, funded by the European Union through the CBC Romania - Serbia: "The analysis of innovation and cooperation ability and development opportunities of SMEs in the Serbian-Romanian cross border area inspired by the cultural heritage of the Serbian and Romanian people - BANAT FASHION "MIS-1427th

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Thanks for the partnership:

- **Faculty of Engineering, Pamukkale University, Denizli, Turkey.**
- **Faculty of Arts and Design, West University of Timisoara, Romania**

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CONTENT

PAPERS

DEVELOPMENT OF TEXTILE ELECTRODES USING NANO TECHNOLOGY

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ABSTRACT

Recently there is strong interest in lightweight, flexible, and wearable electronics to meet the technological demands of modern society. Wearable electronics represent a significant paradigm shift in consumer electronics since they have good flexibility, stretch-ability, and lightweight properties. High-performance sportswear, wearable displays, portable power, and embedded health monitoring devices are some examples of these novel applications. Textiles are inherent microstructures with fantastic properties of flexibility, comfort, light weight and mechanical stability. Our research group is working to develop highly functional textile electrodes using nanotechnology for wearable electronics and power sources.
In this work, highly functional activated charcoal doped multi walled carbon nanotube hybrid was prepared and printed on polyester woven fabric to make textile electrode. Variety of mesoporous hybrid carbon nanostructures were synthesized by mixing different types of charcoal with MWCNT. Morphological characterization revealed that the highly porous defect rich carbon structure consists of synchronized features of 3D carbon decorated with MWCNT network. The excessive oxygen surface groups can reduce large amount of polymer gel electrolyte and locates manifold catalytic sites for reduction of tri-iodide ions. These textile electrodes showed very high stability and conductivity and lower resistivity up to 8 Ω sq^{-1}. Electrochemical investigations confirmed higher electro catalytic activity (ECA) and exhibited very low charge transfer resistance of 1.38 Ω. Such facile assembly of these novel textile electrodes is quite promising for the mass production of next generation textile based wearable electronics and power generation devices.

Key words: Textile electrode, Nanotechnology, Nano hybrid, Highly conductive, Lower charge transfer resistance

INTRODUCTION

Textile based electrodes have received increased attention due to their potential application in super capacitor (Alhebshi, et al. 2013; Liu, et al. 2012), lithium ion batteries (Wang, et al. 2014; Zhu, et al. 2013), and electrochemical energy storage devices (Jost, et al. 2014; Pan, et al. 2014). These electronic textiles (e-textiles) offer the combined features of light weight, flexibility and charge storage capacity (Brown, et al. 2014; Jost, et al. 2011). Recently, fabrication of carbon nanocomposite based flexible electrodes have gained widespread attention due to their high conductivity, lower cost, and environmental sustainability. Design and fabrication of micro and nano-patterned carbon structures based on carbon nanotubes, carbon black, graphite, and graphene has been assembled on fabric substrate and used as electrodes in multiple applications (Arbab, et al. 2015a; Arbab, et al. 2015b; Sahito, et al. 2015a; Sahito, et al. 2015b).
Multi walled carbon nanotubes (MWCNTs) have a unique nano-scale structure, consisting of several coaxially arranged graphene sheets with distinct electronic features of high electrical conductivity, and chemical stability. MWCNTs are made up of nearly perfect atomically smooth basal planes which may not be suitable for efficient electro-catalytic application (Lee, et al. 2009). Amorphous activated charcoal has high surface area with porous structure, possesses multi-edges surface that can act as active centers for the charge storage reactions (Lu, et al. 2015). Induction of mesoporous activated carbon into the tubular graphitic framework without alter their electronic conductivity could yield electro catalytic active sites with minimum change of conjugation length. Synchronized structure of defect rich carbon with conductive MWCNT network supports to facilitate the charge transfer kinetics, and improve the electronic performance.

Textile fabrics are porous and stretchable made by weaving, knitting, or pressing fibers. Among the fabrics, polyester fabric is indeed the most commonly used because of its high strength, flexibility, and low production cost. In this paper, we report a novel textile fabric electrode employing a polyester fabric as substrate, and AC doped MWCNT as catalytic coating, which is synthesized by enzymatic dispersion route, reported in our previous work (Arbab, et al. 2015a). We fabricated different composite structures of AC doped MWCNT printed polyester fabric (carbon fabric composites) using coal, coconut shell and pine tree type activated carbon, designated as composite A, composite B and Composite C, respectively. Further, different amounts of AC (pine tree) were formulated to optimize hybrid structure. Electrochemical studies revealed the high electro catalytic activity and conductivity of our suggested textile electrode. These textile electrodes are expected to meet the various requirements of wearable electronics. In addition, the production of fabric based composites are very mature in textile industries, can provide benefit of roll-to roll production of flexible textile based electrodes.

EXPERIMENTAL

Materials

Plain weave 100 % polyester fabrics, with silicon hydrophobic surface finish were used as substrate. Three types of activated charcoal particles derived from coal, coconut shell and pine tree were purchased from Dy-carbon Co. MWCNT powder of carbon content > 95 %, 6-9 nm diameter, 5μm length (Sigma Aldrich Co.) was used. Lipase enzyme from candida rugosa, Type VII (Sigma Aldrich Co.) used as organic dispersant. Polymer carboxymethyl cellulose (sodium salt of MW 250,000g) was used as binding agent.

Fabrication of carbon fabric composite counter electrode

Different AC doped MWCNT nanostructures were synthesized in the following steps. First of all, 1mg/mL aqueous enzymatic solution of lipase enzyme was prepared in ethanol. 0.4 g of MWCNT was added in 100 mL enzymatic solution and stirred at room temperature for 8 hours. In the next step, different types of activated charcoal particles .i.e. coal, coconut shell, and Pine tree type were added into the individual MWCNT suspension and further dispersed for 8 hours. 50 mL ethanol was more added to dilute the suspension and ultra-sonicated for at least 3 hours. The suspension was vacuum filtered by using 0.5 μm pore size PTFE polymer membrane filter. After that, the carbon filtrate washed two times with D.I water to remove any excess of non-adsorbed enzyme impurities. Next, the filtered and washed AC doped MWCNT cake was mixed with 15mL solution of carboxymethyl cellulose polymeric binder and grind in agate mortar to get consistent conductive carbon paste. The carbon paste was stored over night at room temperature for aging. Cleaned polyester samples were cut into square and tape casted. AC doped MWCNT suspension was printed via doctor blade onto the polyester fabric under hot air drying. The electrodes were dried at 70 °C for 30 min., pressed at 130 °C for 20 min. in hot press machine.

RESULTS AND DISCUSSION

Morphology and Structural characterization

Morphology of three types of activated charcoal is shown in Figure 1 (A). All ACs have amorphous structure and showed mesoporous surface. It can be seen that, Pine tree based AC has sharp board structure and defect rich structure. Whereas, coconut shell based AC has polygonal structure and lesser defects, while coal type AC has a round shape structure with low porous surface.

Defect rich and porous morphology has advantage of fast tri-iodide reduction reaction and high diffusion of concentrated polymer electrolyte.
From Figure 1 (B), it is observed that MWCNT are well dispersed with the lipase enzyme without apparent aggregation. TEM image also revealed the flat fragmented collapse of charcoal sheets decorated with CNT tubular network. The presence of charcoal particles along with MWCNTs can promote electron transfer from defect rich carbon to the MWCNT walls, decreasing the surface work function of MWCNT, thereby improving the reaction of I_3^- in reduction mechanism.

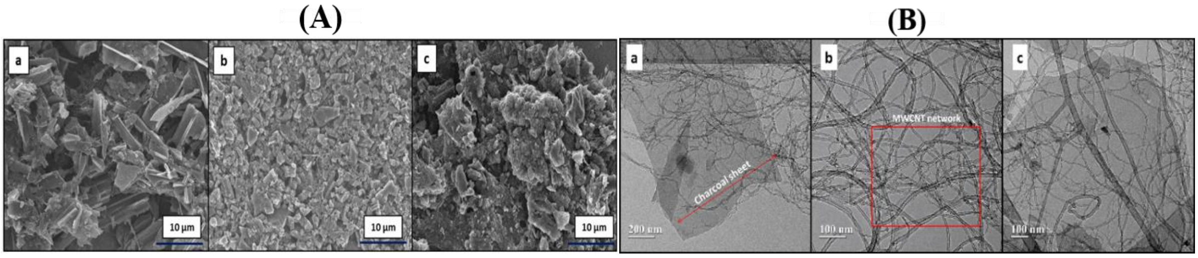

Figure 1. (A) FE-SEM images of (a) Pine tree (b) coconut shell and (C) coal derived activated charcoal. (B) TEM images of Ac doped MWCNT hybrid

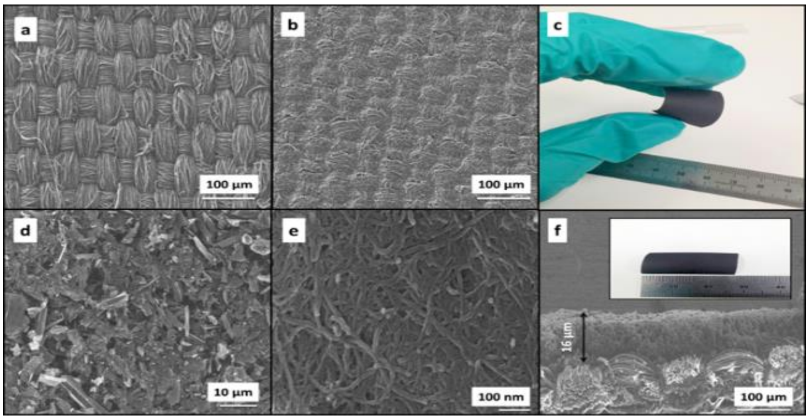

Figure 2. FE-SEM images of (a) uncoated polyester fabric. (b) Ac doped MWCNT coated fabric. (c) Digital image of flexible carbon fabric composite. (d) Low magnification FE-SEM image of AC doped MWCNT. (e) High magnification FE-SEM image of AC doped MWCNT. (f) Cross-sectional FE-SEM image of carbon fabric composite (digital image of carbon fabric composite given in inset).

Figure 2 shows the FE-SEM images of uncoated fabric and carbon coated fabric composite. It can be seen that, the surface of polyester fabric is relatively clean and smooth. After AC doped MWCNT printing, the surface of sample was fully covered with carbon sheet. There are no obvious cracks or flaws on the sheet were observed. Further high magnification image showed three dimensional fragmented amorphous carbon sheets decorated with conductive MWCNT network. Digital photograph showed the homogenous printing on textile substrate. Cross sectional view of AC doped MWCNT hybrid coated on polyester weaved fabric was also observed. A thick mesoporous layer was observed on weaved pattern. The measured average thickness of the layer is about 16 µm.

Surface area and porosity

To investigate the surface area and porosity of AC doped MWCNT hybrid, N_2 adsorption–desorption isotherm and the pore size was observed. The as-synthesized carbon layer exhibited typical N_2 hysteresis of adsorption-desorption curves indicating the characteristic of amorphous carbon.

As compare to AC free MWCNT, AC doped MWCNT showed higher amount of N_2 absorption at high relative pressure, signifying the presence of high mesoporous carbon in the substrate. AC doped MWCNT have higher specific surface area of 500.0965 m^2 g^{-1}, with 1.102288 cm^3 g^{-1} pore volume, whereas AC free MWCNT have low specific surface area of 337.1920 m^2 g^{-1} with 1.030778 cm^3 g^{-1} pore volume.

High specific surface area and pore volume structure will provide more accessibility to the I_3^- ions, and improved electro catalytic activity. Pine tree type activated carbon showed high pore size volume with high surface area, responsible for its efficient performance.

Electrical conductivity and stability

The sheet resistance of AC doped MWCNT coated fabric measured by four point probe showed excellent conductivity of 12 Ω sq^{-1} when prepared with pine tree based charcoal. Sheet resistance of different fabric composites listed in Table 1 and 2. AC doped MWCNT was selected as the conducting electro catalytic material on fabric, as it has significantly good catalytic reaction with iodide electrolytes and can easily be coated on fabrics at relatively low temperature. In order to test the conductivity of textile electrode against different bending positions, a custom-built two-probe device with slide clamps was build. Sample size of 1×3 cm was bent gradually in different positions and its electrical conductivity was measured. Fabric electrode showed negligible difference in the conductivity over different positions of bending. Conductivity of fabric electrode against bending cycles was also measured. The variation in the electrical resistance of the fabric was negligible over 10 bending cycles. After the bending test, no cracks were observed on the coated fabric.

Electro catalytic activity

The electro catalytic activity of the textile electrode is a significantly parameter for improving the performance of energy devices. Therefore, electro catalytic activities of the different carbon fabric composites were initially studied by the cyclic voltammetry (CV) technique. AC doped MWCNT hybrid printed on polyester fabric are expected to produce high conductivity and electro catalytic activity (ECA) towards the reduction of I_3^-. The CV curves of fabric electrodes using a three-electrode system are presented in Figure 3-a. Two distinctive oxidation and reduction peaks were observed for different fabric composites. The negative pair was assigned to the reduction reaction and the positive one was assigned to the oxidation reaction. The three important parameters which determine the catalytic activity of the electrodes are cathodic peak potential (E_{CP}), cathodic current density (I_{PC}), and the peak to peak separation (E_{pp}) of potential difference. It indicates that a higher I_{PC}, a more positive E_{CP} and a lower E_{PP} value demonstrate the greater electro catalytic activity of CE (Park, et al. 2015).
It was observed that, the variation of different carbon content around MWCNT, caused variance in electro catalytic activity (ECA) of the fabric electrode. It can be seen that, the carbon fabric composite synthesized with composite C has larger oxidation and reduction current densities as compare to composite A, and Composite B, respectively. These results ascribed to the high surface area and pore volume of pine tree type charcoal, which affect its electro catalytic activity (Yoon, et al. 2013). The cathodic peak potential (-2.43V) and larger cathodic current density (-7.945 mA $cm^{-2)}$ indicate its superior electrical conductivity and electro catalytic activity for I_3^- reduction. Figure 3-b shows the CVs of carbon fabric electrodes prepared with different charcoal content. It was interesting to find out that, by increasing the charcoal content high electro catalytic activity was observed. AC free CNT coated fabric possess low ECA with (1.95 mA cm^{-2}), whereas 0.8 wt% AC fabric electrode have large cathodic current density with (4.09 mA cm^{-2}) The profile and peak location of CV for the carbon fabric (0.8 wt%) electrode is similar to Pt coated FTO glass, demonstrating synchronized features of high catalytic activity and conductivity. Furthermore, by increasing the AC content from 1.6 wt% to 3.2 wt%, CV profile is changed to pure activated carbon. Low ECA with only one reduction peak was observed in high charcoal content (Yue, et al. 2013).

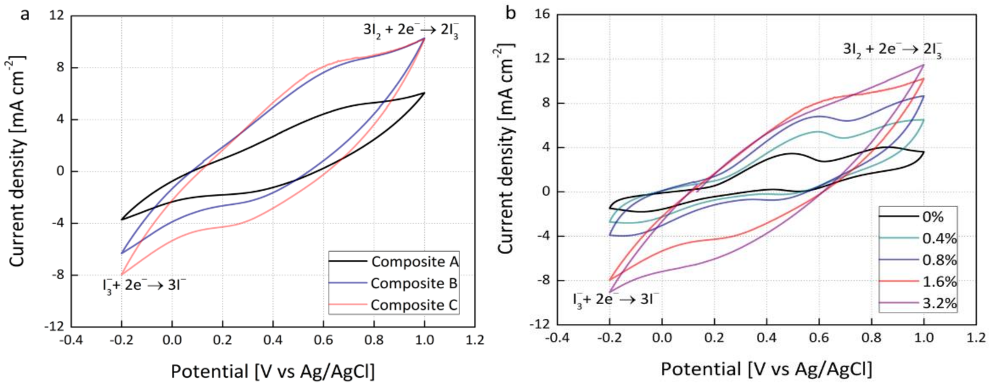

Fig. 3. Cyclic voltammograms of iodide species for (a) Different carbon fabric composites. (b) Effect of wt% of charcoal on ECA.

Electrochemical properties

To understand the electrochemical catalytic activity of three kinds of carbon fabric electrodes, electrochemical impedance spectroscopy (EIS) were carried out. In EIS characterization, electrochemical reaction rates of redox couple (I^-/I_3^-) were measured with electrochemical impedance spectroscopy (EIS) with symmetrical cells as reported in the previous literature (Bi, et al. 2015; Gong, et al. 2013). The symmetrical cell configuration consists of two identical carbon fabric electrodes, used to calculate the charge transfer reaction processes at the interface between electrode and polymer gel electrolyte. The sheet resistance (R_S) and (R_{CT}) parameters were obtained by fitting EIS plots using a Randles-type equivalent circuit. The typical Nyquist plots of symmetrical cells are shown in Figure 4-a. The plot shows a well-defined semicircle with one small semi-circle. The high frequency (around 100 kHz) intercept on the real axis represents the series resistance (R_S) of the electrode. The first semicircle at the medium frequency region is related to the charge transfer resistance (R_{CT}) and the corresponding constant phase element (CPE) of electrodes and electrolyte interface reaction, while the other small semicircle at low frequency region demonstrates the Nernst diffusion impedance (Z_W) of (I^-/I_3^-) in the electrolyte. since the Nernst diffusion impedance is negligible for our focus therefore, we manly emphasis on the R_S and R_{CT} of electrodes. The R_S and R_{CT} of different types of electrodes together with other parameters are tabulated in Table 1.

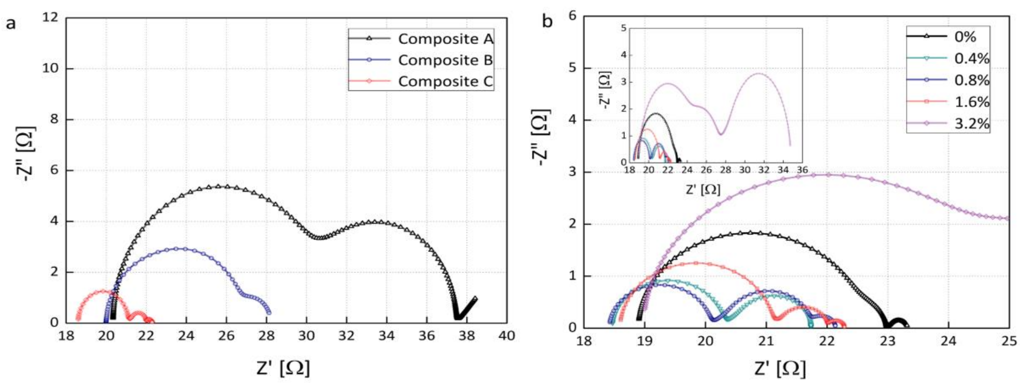

Fig. 4. Nyquist plot for (a) carbon fabric composite fabricated with coal, coconut shells, and pine tree charcoal (1.6 wt%). (b) Effect of wt% of charcoal on R_{CT}.

The R_S of three electrodes are negligibly varied, demonstrating good bonding strength of carbon sheet with textile fabric. According to the values obtained from the Nyquist plot, The R_{CT} of composite C (pine tree type) electrode was found to be 2.40 Ω, indicating a high electrochemical activity and conductivity than its counter parts.
The R_{CT} value of composite A and composite B has comparatively high R_{CT} of 6.50 and 2.55 Ω, respectively. This can be attributed to slow ionic diffusion in the porous structure of Ac doped MWCNT hybrid synthesized with coal and coconut shell type charcoal. The above results confirm the significance of defect rich pine tree type charcoal in the catalytic reduction mechanism.

Table 1. Electrochemical and photovoltaic performance of DSSCs fabricated with different carbon fabric composites.

Type of composite	Electrode Resistivity (Ω sq^{-1})	Symmetrical cell R_S (Ω)	R_{CT} (Ω)
Composite A	15.5	20.34	6.50
Composite B	13.1	19.95	3.94
Composite C	12.5	18.60	2.40

Table 2. Electrochemical and photovoltaic performance of DSSCs fabricated with carbon fabric composites of different wt % of activated carbon (pine type).

wt% of carbon	Electrode Resistivity (Ω sq^{-1})	Symmetrical cell R_S (Ω)	R_{CT} (Ω)
0	15.5	18.91	3.58
0.4	13.3	18.48	1.82
0.8	12.1	18.40	1.38
1.6	12.5	18.60	2.40
3.2	15.8	19.01	5.71

To further optimize the interfacial charge transfer process between polymer gel electrolyte and composite C electrodes, different composite C electrodes were fabricated by altering the charcoal content. The R_{CT} of composite C electrode decreases gradually with increasing charcoal content from 0 wt% to 0.8 wt%. This effect due to the high porosity embedded in MWCNT. In brief, carbon electrode of 0.8 wt% AC, highlighting a reduction in R_{CT} with 1.38 Ω (Figure 4-b). This proves that the synchronized effect of MWCNT with appropriate dosage of activated charcoal can enhance charge transfer mechanism of CEs when used with gel electrolyte. Further increment in charcoal content, high R_{CT} and low sheet to substrate adhesion was observed, which may be due to mismatch composite ratio. Theses result further confirms that carbon fabric composite consist of highly conductivity and porous structure, which enhance the charge transfer kinetics and entrap large amount of gel electrolyte for faster tri-iodide reduction. As the faster charge transfer mechanism improved by carbon fabric also helps to sustain maximum current attainable in the energy devices.

CONCLUSION

In summary, highly efficient and flexible fabric electrodes were successfully developed by a facile approach to fabricate different carbon based nanomaterials (AC doped MWCNT hybrid) on woven polyester fabric. Initially, three different types of charcoal nanomaterials (coal, coconut shell, and pine tree) were doped with MWCNT and printed on polyester fabric. It has been proven that the pine tree composite (composite C) is compatible for the fabrication of highly porous and defect rich hybrid structure and recommended for textile fabric coating. Optimization of doping with different dosage of charcoal in MWCNT, also improved the conductivity and electro catalytic activity of fabric electrodes. The whole design and fabrication is low cost and commercially feasible. Therefore, it can estimate that this novel textile fabric electrode will be promising for the roll to roll production of flexible textile structured energy and photovoltaic devices.

REFERENCES

Alhebshi, N.A., Rakhi, R.B., and Alshareef, H.N. (2013) Conformal coating of Ni(OH)2 nanoflakes on carbon fibers by chemical bath deposition for efficient supercapacitor electrodes, *Journal of Materials Chemistry A*, 1 (47), 14897-14903.
Arbab, A.A., et al. (2015a) Fabrication of highly electro catalytic active layer of multi walled carbon nanotube/enzyme for Pt-free dye sensitized solar cells, *Applied Surface Science*, 349, 174-183.
— (2015b) Multiwalled carbon nanotube coated polyester fabric as textile based flexible counter electrode for dye sensitized solar cell, *Physical Chemistry Chemical Physics*.
Bi, H., et al. (2015) Graphene wrapped copper–nickel nanospheres on highly conductive graphene film for use as counter electrodes of dye-sensitized solar cells, *Carbon*, 91, 153-160.
Brown, T., et al. (2014) Progress in flexible dye solar cell materials, processes and devices, *Journal of Materials Chemistry A*, 2 (28), 10788-10817.
Gong, F., et al. (2013) NiSe 2 as an efficient electrocatalyst for a Pt-free counter electrode of dye-sensitized solar cells, *Chemical Communications*, 49 (14), 1437-1439.
Jost, K., Dion, G., and Gogotsi, Y. (2014) Textile energy storage in perspective, *Journal of Materials Chemistry A*, 2 (28), 10776-10787.
Jost, K., et al. (2011) Carbon coated textiles for flexible energy storage, *Energy & Environmental Science*, 4 (12), 5060-5067.
Lee, W.J., et al. (2009) Efficient Dye-Sensitized Solar Cells with Catalytic Multiwall Carbon Nanotube Counter Electrodes, *ACS Applied Materials & Interfaces*, 1 (6), 1145-1149.
Liu, W.-w., et al. (2012) Flexible and conductive nanocomposite electrode based on graphene sheets and cotton cloth for supercapacitor, *Journal of Materials Chemistry*, 22 (33), 17245-17253.
Lu, B., et al. (2015) Enhanced capacitive properties of commercial activated carbon by re-activation in molten carbonates, *Journal of Power Sources*, 298, 74-82.
Pan, S., et al. (2014) Wearable Solar Cells by Stacking Textile Electrodes, *Angewandte Chemie*, 126 (24), 6224-6228.
Park, J.T., Lee, C.S., and Kim, J.H. (2015) High performance electrocatalyst consisting of CoS nanoparticles on an organized mesoporous SnO2 film: its use as a counter electrode for Pt-free, dye-sensitized solar cells, *Nanoscale*, 7 (2), 670-678.
Sahito, I.A., et al. (2015a) Graphene coated cotton fabric as textile structured counter electrode for DSSC, *Electrochimica Acta*, 173, 164-171.
Sahito, I.A., et al. (2015b) Integrating high electrical conductivity and photocatalytic activity in cotton fabric by cationizing for enriched coating of negatively charged graphene oxide, *Carbohydr Polym*, 130, 299-306.
Wang, X., et al. (2014) Flexible energy-storage devices: design consideration and recent progress, *Adv Mater*, 26 (28), 4763-82.
Yoon, C.H., et al. (2013) Enhanced Performance of Dye-Sensitized Solar Cells with Activated Carbons, *Journal of Nanoscience and Nanotechnology*, 13 (12), 7875-7879.
Yue, G., et al. (2013) High performance platinum-free counter electrode of molybdenum sulfide–carbon used in dye-sensitized solar cells, *Journal of Materials Chemistry A*, 1 (4), 1495-1501.
Zhu, Y., et al. (2013) Composite of a nonwoven fabric with poly(vinylidene fluoride) as a gel membrane of high safety for lithium ion battery, *Energy & Environmental Science*, 6 (2), 618-624.

A RESEARCH ON THE PHYSICAL CHARACTERISTICS OF PAN AND PVA NANOFIBERS OBTAINED WITH ELECTROSPINNING METHOD

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ABSTRACT

During the experiments conducted in this study, the experiment materials are the nanofibres obtained with electrospinning method with 8% solvent dissolved in polyvinyl alcohol-water for PVA nanofibre output, and 13% solvent dissolved in polyacrylonitrile dimehylacetamide, as well as the nonwoven fabrics created from these nanofibres. The study has been conducted by spinning nanofibres at a constant speed of 1 m/min. at 30 kV voltage value for PVA fibres and 35 kV for PAN fibres with 16 cm distance between the end of the pipette and the collector. Fibre spinning was conducted on PP meltblown surfaces with 30x150 cm dimensions. Among the obtained nonwoven fabrics, two surfaces have been covered on top of each other in a manner that PP meltblown surface remains outside, and a sandwich has been created; then elongation strength, abrasion resistance, air permeability and burst strength tests have been conducted on them. After coating with PVA nanofibre, a resistance increase has been identified on PP meltblown fabric, while a decrease in resistance has been identified on the coating surface after PAN nanofibre coating compared to the strength of PP meltblown fabric.

Key words: Electrospinning, PVA, PAN, Nanofibre, Physiological Tests

INTRODUCTION

Electrospinning is a process that creates nanofibres through an electrically charged jet of polymer solution or polymer melt (Ramakrishna et al., 2005). Owing to electrospinning, it is possible to manipulate fibres into three dimensional structures during their deposition. This gives possibility to forming non-woven fabrics with small pore sizes (Sajeev et al., 2008).
Poly vinyl alcohol (PVA) is a semi-crystalline, hydrophilic polymer with good chemical and thermal stability. It is highly biocompatible and non-toxic (Qin et al., 2008). It can be processed easily and readily react with different cross-linking agents to form a gel. These properties have led to the use of PVA in a wide range of applications in medical, cosmetic, food, pharmaceutical and packaging industries.

MATERIAL AND METHOD

The co-polymers PAN and PVA with 72,000 polymerization degree were respectively supplied from AKSA and Merck. PVA and PAN polymers were melted respectively in water and dimethylacetamide in 8% and 13% ratios with a magnetic agitator at 80-100 ºC, continuously for minimum 4 hours.
Electrospinning was conducted with an AU-40-0.75 model high voltage power supply bought from Matsusada company. The maximum voltage at high voltage source is 40 kV and the current is 0.75 A. Polymer solutions were filled in pipettes with 0.25 and 0.50 inner diameters.

Microscopic images of PVA and PAN nanofibres prepared on the slide were obtained with SEM-FEI Quanta 200 FEG and AFM-PSIA XE-100E without coating. Diameters of the nanofibres were measured with FEI Image and their 3D images were taken with XEI.
Tensile strengths have been tested at DEBA A. Ş. on James H. Heal Titan device with ISO 13934-1 strip method in single layer at MD and CD directions. In these tests, as the resistances of PAN nano-fibre spinned nonwoven surfaces appeared lower than the samples with only metblown nonwoven surfaces, the tests were repeated with the Zwick/Roell device at Ege University Physical Test Laboratory by increasing the number of samples.
Abrasion resistances were tested with Martindale method at DEBA A.Ş., by cutting eight 38 mm diameter samples in a manner that meltblown surfaces are exposed to wearing, because the abrasion resistances of nonwoven resistance surfaces are very low. The device was initially stopped at the end of 8 tours. Then at the end of every 3 tours abraded or blown surfaces were noted. Blowing resistances of filtration nonwoven surfaces were tried to be measured under 7 kPa/s pressure with the James H. Heal TruBurst device at Ege University-Physiological Test Laboratory.
Air permeability was measured with 5 measurements on each sample under 100 Pa pressure with Textest FX3300 device.

RESULTS

Figure 1 shows diameter measurements of nanofibers that PVA nanofibers have 252 micron average diameter while PAN nanofibers have 476 micron average diameter. Figure 2 shows SEM images of those nanofibers on different scales.
Nanofibers were sandwiched between two layers of 20 g/m^2 PP meltblown nonwoven surfaces for air permeability tests. Changing the feeding time of electrospinning, the amount of nanofibers were arranged in different weights per m^2. For example PVA-1 means 1 g of PVA nanofibers were deposited on 1 m^2 sublayer surface. Test results are given in Table 1.

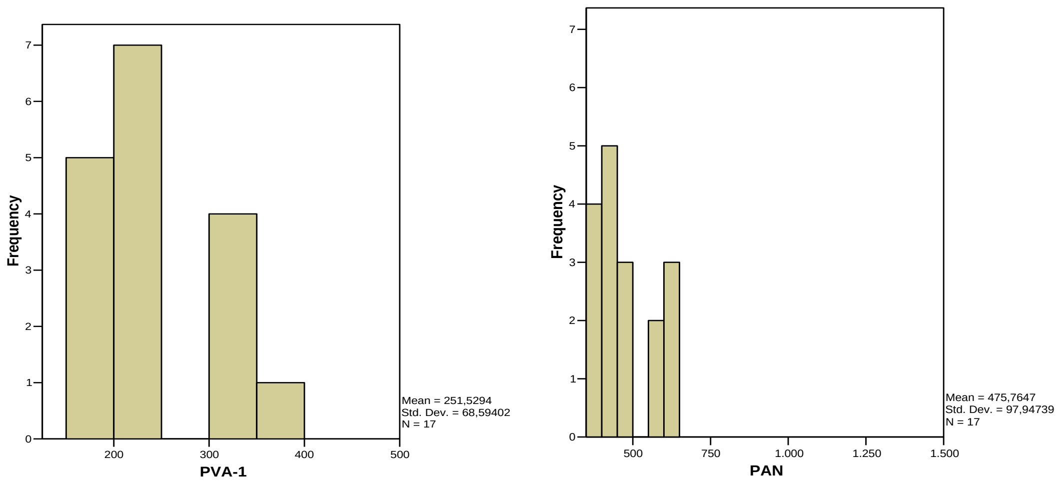

Figure 1: Diameter measurement results of the nanofibres

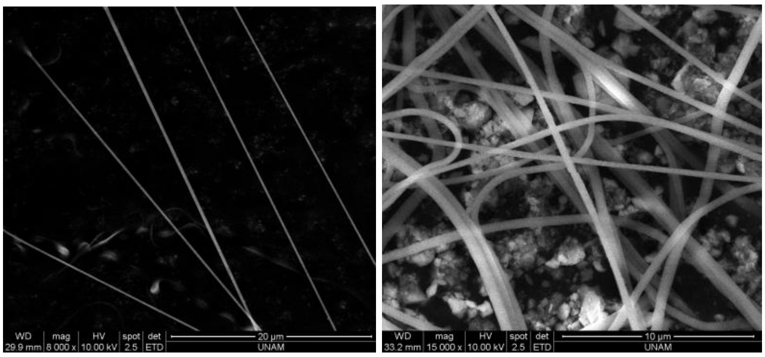

Figure 2: SEM images of (a) PVA-1 and (b) PAN nanofibers

Table 1: Air permeability of filtration nonwoven fabrics (cm³/cm²/s)

	Sublayer	PVA-0,21	PVA-0,3	PVA-0,6	PVA-1	PVA-2	PAN-0,5	PAN-1	PAN-2
	23,50	20,80	5,76	4,08	4,86	2,39	16,60	13,80	9,09
	27,80	18,40	5,44	3,11	3,15	1,89	15,90	14,80	9,11
	25,40	18,60	5,77	3,93	3,65	2,21	13,00	15,80	10,90
	25,80	18,70	5,75	4,25	4,55	2,40	14,30	14,10	9,63
	25,60	19,20	5,75	4,01	4,19	1,95	16,30	13,80	12,90
Mean	25,62	19,14	5,69	3,88	4,08	2,17	15,22	14,46	10,33
Standard deviation	1,53	0,97	0,14	0,44	0,69	0,24	1,53	0,85	1,62
%CV	5,96	5,09	2,50	11,46	16,85	11,05	10,02	5,90	15,65

Tensile strength and tensile elongation test results are given in Table 2. In the tests, tensile strength of PAN-1 nonwoven surface fabric appeared lower than that of meltblown nonwoven surface fabric once more. This result has been construed as that the dimethlyacetamide used for melting PAN polymer damaged PP meltblown fibres. On the other hand PVA nano fibres contribute to the tensile strength of nonwoven surfaces. The contribution of 1 g/m²-PVA nano fibres –with lower resistance value than the others- to meltblown nonwoven surface strength was measured as 0.53 N, that of 0,21 g/m²-PVA nano fibres as 0,86 N and that of 0,3 g/m² PVA nano fibres as 0,95 N. The elongation percentage obtained during breaking-off of the surfaces obtained from PVA fibres showed a slight change in ±2% range, while the elongation percentage of PAN-0.5 surfaces decreased by 2.54% and a more evident decrease of 8.41% was observed on PAN-1 surfaces.

Table 2: Breaking Strength Test Results of Filtration Nonwoven Fabrics

	Sublayer		PVA-0,21		PVA-0,3		PVA-1		PAN-0,5		PAN-1	
	Str. (N)	Ext. (%)	Str. (N)	Ext. (%)	Str. (N)	Ext. (%)	Str. (N)	Ext. (%)	Str. (N)	Ext. (%)	Str. (N)	Ext. (%)
	9,49	23,63	12,78	35,25	9,39	28,07	9,24	22,00	10,26	31,53	8,78	26,22
	10,12	36,95	12,34	31,21	10,77	37,64	9,85	32,62	11,67	33,86	8,79	18,38
	10,74	36,55	8,81	29,31	10,37	36,60	10,46	35,44	11,32	29,18	8,90	22,83
	9,76	39,88	11,26	37,45	11,45	32,49	9,85	27,07	8,96	20,13	8,60	17,10
	8,73	23,81	8,29	30,77	10,36	29,98	11,20	34,43	9,69	27,35	8,69	25,28
	8,97	31,62	10,49	23,02	11,33	42,56	9,74	29,90	10,29	40,44	8,44	17,94

	9,10 9,72	22,16 40,87	9,81 8,97	26,65 28,90	9,77 10,83	30,11 34,58	9,55 10,98	29,40 30,64	9,99 11,21	21,18 31,46	9,67 9,02	28,41 32,00
Mean	9,58	31,93	10,34	30,32	10,53	34,00	10,11	30,19	10,42	29,39	8,86	23,52
Standard deviation	0,66	7,75	1,67	4,57	0,71	4,82	0,70	4,30	0,92	6,64	0,37	5,42
%CV	6,86	24,26	16,15	15,06	6,78	14,16	6,90	14,23	8,80	22,58	4,20	23,03

The results of the abrasion strengths tested with Martindale method are provided in Table 3. Average abrasion strengths of meltblown surfaces were found as 38.375 without nanofibre addition, 31.5 with PVA nanofibre addition and 24.5 with PAN nano fibre addition. The negative impact of dimethylacetamide, which is used for melting PAN, on PP fibres was previously mentioned. This negative impact causes to an easier abrasion of the surface.

Table 3: The Abrasion Strength of Nonwoven Fabrics

	Sublayer	PVA-1	PAN-1
	32 35 35 41 41 41 41 41	24 27 30 30 33 36 36 36	17 20 20 23 23 26 32 35
mean	38,38	31,50	24,50

CONCLUSIONS

According to air permeability results, PVA-03 reduces air permeability compared to PAN-1 and PAN-2, because the average diameter of PVA fibres is almost half that of PAN fibres. As a result, because the total surface area of fibres covering the same size area increases as the fibre diameter decreases, the surface resistance of the material also increases and thus the air permeability reduces.
According to tensile strength test results, a statistically significant resistance increase is not observed on the surfaces covered with PVA fibres compared to meltblown surface, while a resistance decrease occurred with PAN-1 fibres, which connotes that a weakening of PP meltblown fabric occurs during the obtainment of PAN-1 fibres. Elongation percentage decreases parallel to the tensile strength with PAN-1 nonwoven fabric, while it does not represent a statistically significant difference with the others.

REFERENCES

-Ramakrishna,S., Fujihara,K., Teo,W.E., Lim, T.,C., and Ma, Z., "An Introduction To Electrospinning and Nanofibres", National University of Singapure, 2005, World Scientific Publishing Co.Pte. Ltd.
-Xiao-Hong Qin, Shan-Yuan Wang, "Electrospun Nanofibers from Crosslinked Polyvinyl alcohol and Its Filtration Efficiency", Journal of Applied Polymer Science, April 2008.
-Sajeev U. S., Anand K.A., Menon D., Nair S , Control of Nanostructures in PVA, PVA/Chitosan Blends And PCL Through Electrospinning, Bull. Mater. Sci., Vol. 31, No. 3, June 2008, pp. 343-351.

THE BALANCING OF SEWING PRODUCTION LINES IN GARMENT MANUFACTURE USING SIMULATION TECHNIQUE

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ABSTRACT

The need for high product variety, smaller batch size, shorter delivery time and higher quality has encouraged apparel companies to concentrate on the development of digitization and information management. This speeds the response to those rapid changes occurring in the apparel industry. However, on the shop floor, it is difficult to achieve line balancing due to the different pitch time of each workstation. Simultaneously, differences in operators' efficiency make this difficulty far greater. This paper will develop a simulation technique that can be applied to production lines, balancing the data derived and offering clear measurements of operators' efficiencies. The data collected by the researcher from a dress assembly line in factory in China is used to build a simulation using ProModel software. An optimization solution is suggested that may be one route to improving production line performance. Results derived from the simulation hypothesise that by considering the operators' efficiencies the production line could be changed generating higher productivity and lower work in process (WIP). Thus, simulation may also be effective in helping achieve better line balancing, even predicting problems before production starts.

Key Words: Apparel assembly line balancing (AALB), simulation, ProModel software

INTRODUCTION

With the rapid change of fashion trends and increasingly shortening of production cycle, the production mode of multi-product and small batch size has become an inevitable choice for the make-to-order (MTO) apparel manufacturer. Frequent changes to apparel styles have meant that manufacturers find they may be forced to reconfigure their sewing production lines at almost any moment to achieve the best production efficiency and generate the highest return on investment despite limited equipment and personnel resources. For businesses, such necessary reconfiguration resulting from trend-led product variation is both time-consuming and inconvenient if it is done by supervisors using their experience. In addition, line efficiency as well as production progress might be difficult to control in a measure due to such frequent changes.

In the past decade, simulation techniques have been widely used in many manufacturing industries. Many developed countries will conduct simulations before the reconfiguration or extension of a production line or before a new product is put into production. These provide a quantitative basis for making scheduling decisions, improving line efficiency, evaluating productivity and allocating equipment reasonably. Rotab (1999) in his research uses reports and demonstrates the methodology of structuring a spreadsheet simulation model of a garment production system. to suggest ways to minimise daily production costs. Such costs may be elevated by the wages of repairmen and the rent of backup machines resulting from different human-machine combinations. Senem and Fatma (2009) construct a simulation model to balance a sweatshirt sewing line and minimise the negative effects of labour-intensity of clothing production. The bottlenecks in the production line are analyzed and three solutions presented by means of what-if analyses to achieve a more balanced system. Tiacci (2012) proposes an event and object oriented simulator (EOOS) to identify the optimal solution of the assembly line balancing problem.

The EOOS can be effectively attached to algorithms used to simulate a wide variety of line configurations. Siti, Rohaizan and Tan (2012) develop a simulation model to analyze a modern clothing production line in Malaysia. Their study aims to reduce cycle time while increasing production quantity to meet order requirements. While Rotab (1999), Senem and
Fatma (2009), Tiacci (2012) and Siti, Rohaizan and Tan (2012) have proved simulation to be an effective tool in identifying potential problems such as bottlenecks and utilisation levels before production begins, all are under the assumption that operators in the line are at the same skill level with the same efficiency of 100 percent. This certainly cannot represent the real production process.
The apparel industry is a typical labour-intensive industry. Since human factors play an important part in the line scheduling, it is vital to arrange the production line bearing in mind the variance of operator efficiency: the aim is to achieve a balanced line with higher productivity, which means the pitch time of each station should be as similar as standard pitch time. Up to now, in most Chinese small and middle sized clothing companies, line balance control mainly relies on supervisors' experience and skills. However, when supervisors arrange a line, they may ignore operator efficiency, repair rate or other factors: this often fails to achieve a desirable scheduling result before the line is put into production. Many manufacturers have to make some adjustments when problems occur during production and this leads to low line efficiency. For a make-to-order garment manufacturer, simulation can be a time-saving, cost effective and low risk way to construct reasonable and practical production schedules and control them effectively. In addition, simulation can provide supervisors with quantitative data to help predict the production process.

The aim of this study is to construct a model using the data collected from a real assembly line for ladies' dresses, using *ProModel* simulation software to obtain an optimal scheduling solution. In this study, operator efficiency and repair rates are taken into consideration so that any solution may be more realistic. Section 2 describes the problem on which the study will focus; section 3 presents and analyses data coming from a real assembly line manufacturing ladies' dresses; section 4 describes the simulation model in detail and delivers model verification and validation; section 5 introduces an experimental design and simulation results while section 6 offers a level of research synthesis and suggests further areas for study.

PROBLEM STATEMENT

This research was carried out in a production company that produces women's clothing to high street retailers. The layout of the sewing line uses a Progressive Bundle System (PBS), where a specific number of pieces are tied and travel together throughout the process. The disadvantages of this production mode are generated primarily from high levels of WIP, a long production cycle and low working efficiency. Because of the high WIP, much of production space is occupied making the work environment disorganized as WIP piles up is what appears to be a highly disorganised fashion. Because of this disorganisation, there are contingent problems that make for high levels of rejection of finished items and thus significant delays in consignment delivery. Thirdly, operators have to spend a lot of unnecessary time on fastening and unfastening, checking and bundling.

Until now (2013), the production company's management remains based on supervisors' personal experience, making it difficult to achieve a balanced line before production begins. Supervisors are likely to make what they deem to be appropriate adjustments when problems occur during production. As a result, production is made less efficient and, in addition, the manufacturer may fail to finish a consignment on time because material handling, reworking had not been factored into the plan generated by shop floor managerial experience.

An added problem is that manufacturing companies are faced with increasing recruitment problems as the labour cost in China increases (http://px.zhongsou.net/...).

It becomes more important for companies to attach significance to the flow of WIP while factoring in limited resources of time, capital and labour to maximise efficiency. Operator allocation is a common issue in manufacturing industries, especially in labour-intensive industries such as clothing production. Despite this, the company in this study derives operator allocation based solely on a supervisors' manual experience– a process which cannot deliver desirable productivity. It is clearly necessary to achieve a balanced line based on considerations of operator efficiency.

To focus on the optimisation of the sewing production line using a simulation, one specific dress production line was chosen for this study. A production model based on *ProModel* simulation software was set up then the real production conditions were analyzed. Proposed optimal measures – specifically according to simulation results – can then be suggested. To improve production efficiency and accurately control production progress repair rates, transfer times and operator efficiencies are taken into consideration.

DATA COLLECTION AND ANALYSIS

The simulation model is based on the following data collected from the real production line of an apparel manufacturing company in Nantong, Jiangsu province, PR of China. Flow of a dress production sewing line is shown in figure 1.

1. Intervals of the entity arrivals. Usually time between two entities entering into the system follows a certain distribution ;
2. The task time for each operation is recorded in table 1. 20 measurements for each operation were obtained during production using time study techniques (Kanawaty, G, 1992) and they were all tested for distributional fit using *Stat::fit* statistical software attached to *ProModel*. For example, for task 3 –Pressing back side piece – 20 measurements were entered into *Stat: fit*. The results are shown in Figures 2 and 3.The distribution estimated for task 12 is obtained as *Normal (7.9, 0.7)* with a mean of 7.9 and standard deviation of 0.7.

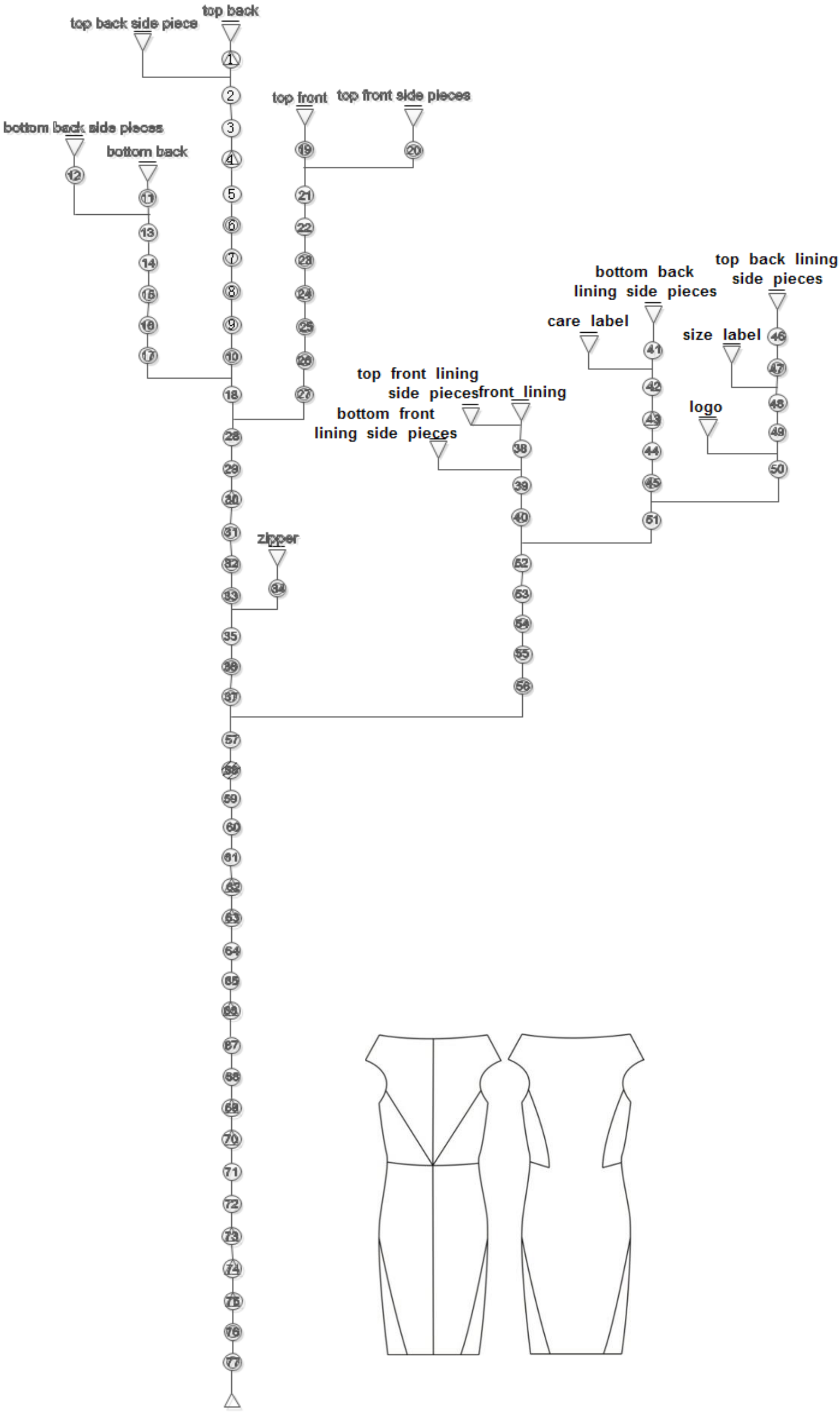

Figure 1 flow of a dress production sewing line

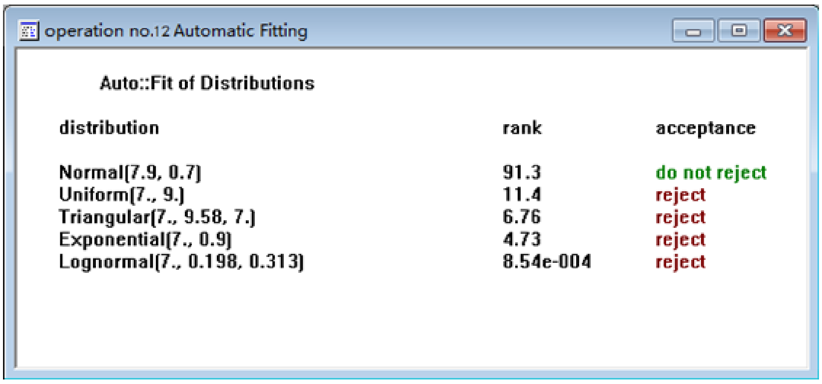

Figure 2 Typical distribution fitting results

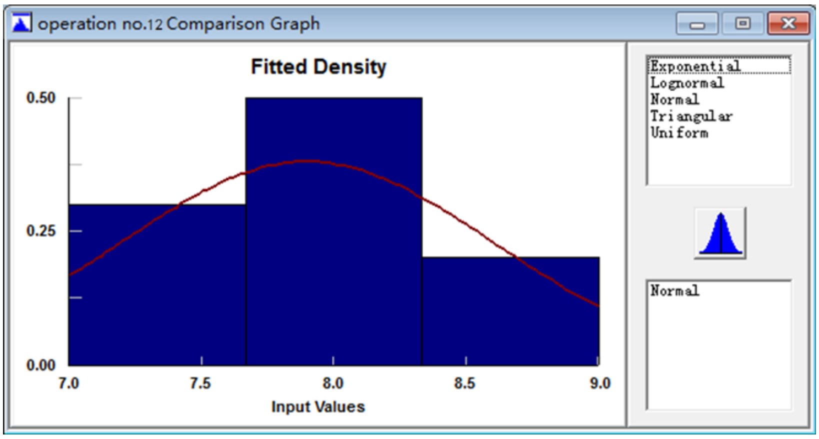

Figure 3 Normal fitting results

Table1. Task time of each operation

No.	Tasks name	Time/sec	Machine
1	Check pieces/ Bundling	Triangular(51.8, 60.8, 58, 1)	handwork
2	Attach bottom back side piece	Normal(28.9, 0.624, 9)	Lockstitch sewing machine
3	Sew top centre back seam	Normal(16.1, 1.02, 10)	Lockstitch sewing machine
4	Spot back darts	Lognormal(7.53, 1.26, 0.193, 11)	handwork
5	Sew back darts	Normal(15.9, 0.831, 12)	Lockstitch sewing machine
6	Pressing top centre back seam open	Exponential(5, 1.1, 16)	iron
7	Pressing back darts	Triangular(2.69, 5.39, 4, 17)	iron
8	Pressing back top side piece seam open	Normal(12.9, 1.04, 18)	iron
9	Pressing binding on back neckline	Triangular(9.5, 12.5, 11, 20)	iron
10	Pressing binding on back armhole	Normal(27.4, 1.06, 21)	iron
11	Pressing back bodice	Normal(7.9, 0.7, 2)	iron
12	Pressing back side piece	Normal(7.9, 0.7, 3)	iron
13	Attach top back side piece	Lognormal(31.6, 1.68, 0.206, 8)	Lockstitch sewing machine
14	Sew bottom centre back seam	Triangular(7.49, 10.6, 9, 13)	Lockstitch sewing machine
15	Pressing bottom centre back seam	Lognormal(2.41, 1.04, 0.285, 15)	iron

	open		
16	Pressing back bottom side piece seam open	Normal(7.95, 0.805, 19)	iron
17	Pressing binding on back waist line	Normal(11.9, 0.654, 22)	iron
18	Stitch bodice and skirt piece together	Triangular(30.5, 39.7, 35, 27)	Lockstitch sewing machine
19	Pressing front bodice	Normal(6.1, 0.943, 5)	iron
20	Pressing front side piece	Triangular(7.11, 9.81, 8.5, 4)	iron
21	Attach top front side piece	Lognormal(67.3, 2.07, 0.224, 6)	Lockstitch sewing machine
22	Attach bottom front side piece	Normal(48.3, 1, 7)	Lockstitch sewing machine
23	Pressing front bottom side piece seam open	Normal(19.3, 0.942, 14)	iron
24	Pressing front side piece seam open	Normal(29.1, 0.921, 23)	iron
25	Pressing binding on front armhole	Triangular(26.7, 29.3, 28, 24)	iron
26	Pressing binding on front waist line	Lognormal(8.7, 1.24, 0.232, 25)	iron
27	Pressing binding on front neckline and shoulder	Normal(22.7, 1, 33)	iron
28	Sew shoulder seam	Exponential(20, 1.15, 28)	Lockstitch sewing machine
29	Sew side seam	Normal(44.9, 1.41, 29)	Lockstitch sewing machine
30	Mark side seam	Lognormal(8.3, 1.95, 0.121, 65)	Handwork
31	Pressing back waist seam open	Lognormal(2.69, 0.911, 0.313, 30)	iron
32	Sleeve edge seam	Normal(11.8, 0.678, 31)	iron
33	Pressing side seam	Normal(41.2, 0.812, 34)	iron
34	Pressing zipper	Triangular(11.6, 14.3, 13, 26)	iron
35	Stitch invisible zipper	Normal(61.6, 1.39, 35)	Lockstitch sewing machine
36	Pressing front hem	Triangular(8.72, 12.4, 11, 43)	Iron
37	Pressing back hem	Lognormal(5.7, 1.24, 0.232, 44)	Iron
38	Attach top front lining side piece	Normal(108, 0.768, 36)	Lockstitch sewing machine
39	Attach bottom front lining side piece	Lognormal(46.9, 1.59, 0.199, 37)	Lockstitch sewing machine
40	Pressing top and bottom front lining side piece	Lognormal(35.5, 2, 0.181, 32)	Iron
41	Pressing shoulder seam	Lognormal(35.5, 2, 0.181, 32)	Lockstitch sewing machine
42	Attach washing label	Exponential(20, 1.15, 28)	Lockstitch sewing machine
43	Mark lining back dart	Normal(44.9, 1.41, 29)	Handwork
44	Sew lining back dart	Lognormal(2.69, 0.911, 0.313, 30)	Lockstitch sewing machine
45	Pressing lining back dart	Normal(11.8, 0.678, 31)	Iron
46	Sew top lining centre back seam	Triangular(30.5, 39.7, 35, 27)	Lockstitch sewing machine
47	Pressing top lining centre back seam	Normal(22.7, 1, 33)	Iron
48	Attach size label	Normal(41.2, 0.812, 34)	Lockstitch sewing machine
49	Mark brand	Normal(61.6, 1.39, 35)	Handwork

50	Attach brand	Normal(108, 0.768, 36)	Lockstitch sewing machine
51	Stitch lining bodice and skirt piece together	Lognormal(29.3, 2.14, 0.999, 38)	Lockstitch sewing machine
52	Sew lining shoulder line	Lognormal(46.9, 1.59, 0.199, 37)	Lockstitch sewing machine
53	Sew lining side line	Lognormal(6.96, 1.08, 0.288, 39)	Lockstitch sewing machine
54	Pressing lining bodice and skirt piece together	Normal(13.1, 1.02, 40)	Iron
55	Pressing lining side line	Normal(47.9, 1.41, 41)	Iron
56	Pressing lining side line	Lognormal(-0.669, 2.15, 0.115, 42)	Iron
57	Sew front and back collar together	Lognormal(9.74, 1.17, 0.221, 45)	Lockstitch sewing machine
58	Trim neckline	Lognormal(9.74, 1.17, 0.221, 46)	Overlocking serging machine
59	top stitch neckline	Normal(35.3, 1.22, 47)	Lockstitch sewing machine
60	Stitch zipper with lining	Lognormal(7.09, 1.33, 0.298, 48)	Lockstitch sewing machine
61	Top stitch zipper	Normal(42.7, 1.28, 49)	Lockstitch sewing machine
62	Mark armhole*4	Lognormal(11.7, 1.24, 0.232, 63)	Handwork
63	Snip armhole*4	Normal(136, 0.73, 64)	Handwork
64	Sew sleeve seam	Lognormal(72, 1.4, 0.172, 50)	Lockstitch sewing machine
65	Trim sleeve seam	Lognormal(1.7, 1.24, 0.232, 51)	Spincycle machine
66	Mark sleeve	Lognormal(-1.67, 2.15, 0.115, 52)	Handwork
67	Top stitch sleeve seam	Triangular(9.74, 13.4, 12, 53)	Lockstitch sewing machine
68	stitch shell fabric and lining together	Lognormal(7.28, 1.06, 0.297, 54)	Lockstitch sewing machine
69	Mark front panel*2	Lognormal(91.1, 2.27, 0.191, 61)	Handwork
70	Snip front hem	Normal(79.1, 1.45, 62)	Handwork
71	Sew hem	Normal(8.1, 1.04, 55)	Lockstitch sewing machine
72	Make tailor's tack on hem	Normal(130, 0.84, 56)	Lockstitch sewing machine
73	Inspection	Lognormal(5.31, 1.9, 0.141, 57)	Handwork
74	Turn over the clothes	Lognormal(123, 1.99, 0.266, 58)	Handwork
75	Shoulder line comparison	Lognormal(100, 2.21, 0.114, 66)	Handwork
76	Pressing neckline	Lognormal(89.8, 1.63, 1.38, 59)	Iron
77	Pressing armhole	Normal(48.9, 1.28, 60)	Iron

3. The rework rate of each operation;
4. The transfer time of the WIP – influenced by the distance between stations and the movement speed of the operator;
5. Operator efficiency – the efficiency of workers for each task is different because of the different skills involved and linked productivity (see table 2).

Table2. Operator efficiency under each operation (percentage)

No. of Operators	8															
	1	2	3	4	5	6	7		9	10	11	12	13	14	15	16
1	105	90	100	105	100	100	120	105	95	110	120	95	95	120	95	95
2	90	120	120	95	90	100	105	105	110	110	95	100	95	95	95	85
3	100	95	115	100	95	85	100	110	100	100	95	100	100	110	100	100
4	105	115	95	110	100	85	100	110	100	85	95	100	120	95	90	90
5	100	95	110	100	110	100	100	100	100	105	115	90	100	100	95	95
6	100	100	105	125	120	100	95	90	100	120	110	100	120	110	100	100
7	120	100	120	115	105	100	95	110	95	110	125	120	120	95	85	90
8	105	105	100	100	100	105	95	95	100	95	110	110	125	100	100	110
9	95	100	120	110	95	100	95	100	100	110	120	110	100	120	110	120
10	110	115	110	95	95	100	90	115	105	95	100	105	95	120	110	120
11	120	130	115	95	120	105	95	100	100	95	110	95	100	90	120	110
12	105	110	120	95	125	100	125	110	95	110	95	100	120	115	100	110
13	105	120	115	110	110	120	110	110	95	125	100	120	95	115	100	90
14	120	110	105	110	100	120	105	95	110	110	95	85	100	110	95	110
15	95	95	115	120	110	100	120	100	90	95	110	100	85	95	100	100
16	95	120	100	105	120	115	120	95	105	85	120	95	110	90	95	90
17	120	115	100	115	100	110	120	105	100	100	130	110	115	95	110	105
18	110	95	90	120	130	105	100	115	100	120	110	110	110	120	110	120
19	110	95	90	120	130	105	100	115	100	120	110	110	110	120	110	120
20	105	95	120	110	105	115	105	120	110	105	115	100	120	95	95	100

No. of Operators	No. of Operations															
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1	120	110	110	115	120	110	110	120	105	110	120	120	100	100	95	110
2	90	120	120	95	90	100	105	105	110	110	95	100	95	95	95	85
3	100	95	115	100	95	85	100	110	100	100	95	100	100	110	100	100
4	105	115	95	110	100	85	100	110	100	85	95	100	120	95	90	90
5	100	95	110	100	110	100	100	100	100	105	115	90	100	100	95	95
6	100	100	105	125	120	100	95	90	100	120	110	100	120	110	100	100
7	120	100	120	115	105	100	95	110	95	110	125	120	120	95	85	90
8	105	105	100	100	100	105	95	95	100	95	110	110	125	100	100	110
9	95	100	120	110	95	100	95	100	100	110	120	110	100	120	110	120
10	110	115	110	95	95	100	90	115	105	95	100	105	95	120	110	120
11	120	130	115	95	120	105	95	100	100	95	110	95	100	90	120	110
12	105	110	120	95	125	100	125	110	95	110	95	100	120	115	100	110
13	105	120	115	110	110	120	110	110	95	125	100	120	95	115	100	90
14	120	110	105	110	100	120	105	95	110	110	95	85	100	110	95	110
15	95	95	115	120	110	100	120	100	90	95	110	100	85	95	100	100
16	95	120	100	105	120	115	120	95	105	85	120	95	110	90	95	90
17	120	115	100	115	100	110	120	105	100	100	130	110	115	95	110	105
18	110	95	90	120	130	105	100	115	100	120	110	110	110	120	110	120
19	110	95	90	120	130	105	100	115	100	120	110	110	110	120	110	120
20	105	95	120	110	105	115	105	120	110	105	115	100	120	95	95	100

No. of Operators	No. of Operations															
	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
1	105	110	90	100	95	100	90	105	100	110	120	120	100	100	95	110
2	90	120	120	95	90	100	105	105	110	110	95	100	95	95	95	85
3	100	95	115	100	95	85	100	110	100	100	95	100	100	110	100	100
4	105	115	95	110	100	85	100	110	100	85	95	100	120	95	90	90
5	100	95	110	100	110	100	100	100	100	105	115	90	100	100	95	95
6	100	100	105	125	120	100	95	90	100	120	110	100	120	110	100	100
7	120	100	120	115	105	100	95	110	95	110	125	120	120	95	85	90
8	105	105	100	100	100	105	95	95	100	95	110	110	125	100	100	110
9	95	100	120	110	95	100	95	100	100	110	120	110	100	120	110	120
10	110	115	110	95	95	100	90	115	105	95	100	105	95	120	110	120
11	120	130	115	95	120	105	95	100	100	95	110	95	100	90	120	110
12	105	110	120	95	125	100	125	110	95	110	95	100	120	115	100	110

13	105	120	115	110	110	120	110	110	95	125	100	120	95	115	100	90
14	120	110	105	110	100	120	105	95	110	110	95	85	100	110	95	110
15	95	95	115	120	110	100	120	100	90	95	110	100	85	95	100	100
16	95	120	100	105	120	115	120	95	105	85	120	95	110	90	95	90
17	120	115	100	115	100	110	120	105	100	100	130	110	115	95	110	105
18	110	95	90	120	130	105	100	115	100	120	110	110	110	120	110	120
19	110	95	90	120	130	105	100	115	100	120	110	110	110	120	110	120
20	105	95	120	110	105	115	105	120	110	105	115	100	120	95	95	100

No. of Operators	No. of Operations															
	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
1	105	110	90	100	95	100	90	105	100	110	120	120	100	100	95	110
2	90	120	120	95	90	100	105	105	110	110	95	100	95	95	95	85
3	100	95	115	100	95	85	100	110	100	100	95	100	100	110	100	100
4	105	115	95	110	100	85	100	110	100	85	95	100	120	95	90	90
5	100	95	110	100	110	100	100	100	100	105	115	90	100	100	95	95
6	120	110	105	110	100	120	105	95	110	110	95	85	100	110	95	110
7	120	100	120	115	105	100	95	110	95	110	125	120	120	95	85	90
8	105	105	100	100	100	105	95	95	100	95	110	110	125	100	100	110
9	95	100	120	110	95	100	95	100	100	110	120	110	100	120	110	120
10	110	115	110	95	95	100	90	115	105	90	100	105	95	120	110	120
11	100	95	115	100	95	85	100	110	100	100	95	100	100	110	100	100
12	105	110	120	95	125	100	125	110	95	110	95	100	120	115	100	110
13	105	120	115	110	110	120	110	110	95	125	100	120	95	115	100	90
14	120	110	105	110	100	120	105	95	110	110	95	85	100	110	95	110
15	95	95	115	120	110	100	120	100	90	95	110	100	85	95	100	100
16	95	120	100	105	120	115	120	95	105	85	120	95	110	90	95	90
17	95	95	115	120	110	100	120	100	90	95	110	100	85	95	100	100
18	110	95	90	120	130	105	100	115	100	120	110	110	110	120	110	120
19	110	95	90	120	130	105	100	115	100	120	110	110	110	120	110	120
20	105	95	120	110	105	115	105	120	110	105	115	100	120	95	95	100

No. of Operators	No. of Operations												
	65	66	67	68	69	70	71	72	73	74	75	76	77
1	105	110	90	100	95	100	90	105	100	110	120	120	100
2	90	120	120	95	90	100	105	105	110	110	95	100	95
3	105	120	115	110	110	120	110	110	95	125	100	120	95
4	105	115	95	110	100	85	100	110	100	85	95	100	120
5	100	95	110	100	110	100	100	100	100	105	115	90	100
6	100	100	105	125	120	100	95	90	100	120	110	100	120
7	120	100	120	115	105	100	95	110	95	110	125	120	120
8	105	105	100	100	100	105	95	95	100	95	110	110	125
9	95	100	120	110	95	100	95	100	100	110	120	110	100
10	90	115	110	95	95	100	90	115	105	95	100	105	95
11	120	130	115	95	120	105	95	100	100	95	110	95	100
12	105	110	120	95	125	100	125	110	95	110	95	100	120
13	105	120	115	110	110	120	110	110	95	125	100	120	95
14	120	110	105	110	100	120	105	95	110	110	95	85	100
15	105	105	100	100	100	105	95	95	100	95	110	110	125
16	95	120	100	105	120	115	120	95	105	85	120	95	110
17	120	115	100	115	100	110	120	105	100	100	130	110	115
18	110	95	90	120	130	105	100	115	100	120	110	110	110
19	110	95	90	120	130	105	100	115	100	120	110	110	110
20	105	95	120	110	105	115	105	120	110	105	115	100	120

*Data sources: assembly line supervisors from a clothing manufacturing factory in Nantong.

Since the mental states of operators change during the working day, according to Zhao Ran(2012), efficiencies at different hours were recorded (see table 3).

Table 3: Efficiency of operators at different times(percentage)

No. of operators	Time of the day						
	8h	10h	12h	14h	16h	18h	20h
1	93	99	99	102	100	99	102
2	95	99	100	105	110	105	108
3	99	98	102	100	101	100	102
4	84	93	102	104	108	108	106
5	100	101	100	103	105	105	105
6	98	98	102	100	102	100	102
7	95	97	101	99	101	103	103
8	99	104	100	102	106	104	108
9	92	96	99	102	99	102	104
10	84	96	100	103	102	103	102
11	99	97	100	100	100	100	102
12	99	99	101	101	101	103	103
13	97	99	103	99	101	97	100
14	96	100	100	103	100	101	100
15	98	100	102	106	101	102	102
16	96	100	102	101	100	104	102
17	93	97	99	102	103	100	102
18	101	103	100	110	105	110	100
19	97	95	100	97	97	102	100
20	99	104	94	102	106	104	99

SETTING UP THE SIMULATION MODEL

CONSTRAINTS

Due to the complexity and variability of a real production system, it is almost impossible to simulate every aspect. It should be recognised that the model operates under the following constraints and assumptions.

1. Neither the processing time for each operation nor the quality obtained should be affected by any previous operation.
2. Allowances – such as thread changeover and recording – are taken into consideration. The allowance rate is 24.437%.
3. Machine breakdowns and maintenance are not taken into consideration, because of their nature of random occurrence.
4. The hour-long simulation is based on a 12-hour operational day, excluding the meal break.
5. There is no lack of raw materials feeding the assembly line during the production period.

SIMULATION ELEMENTS AND ATTRIBUTES

The simulation model was built using the *ProModel* student version 6.0 software. According to Harrell (et al, 2004) there are four basic elements to setting up a simulation using *ProModel*. These are entity, location, arrival and processing.

1. Entity

The entity is an object or production unit being processed in the model. This means products, materials, files, customers. In the model developed here, three entities are defined: piece, bundle and garment. The entity arrives at the first production line work station as a piece, a quantity of fabric; it is then grouped into a bundle of similar elements before being sent on to the following work stations. Ultimately, the pieces are assembled into a finished garment before leaving the production line.

2. Location

Locations are places on the production line where work is done on entities. In the model here, 20 locations are defined. Each stands for a station where work is done. Capacity – a key attribute of location – is made up of the number of units of entities the location can hold simultaneously Harrell (et al, 2004). Location 1 is used for receiving the entities and finishing some operations. In order to ensure that there is no lack of raw materials feeding the assembly line during the production period, the capacity of location 1 is set to be infinite. As for the other locations, capacity equals to the bundle size.

3. Resource

Resources are used to process entities in the system. In a garment sewing production line, an operator is the most important resource, responsible for the WIP. Sometimes the WIP is transported by an operator. The moving speed of the operator is determined by the bundle size they can transport at any one time. Operators can, for example, move at the rate of 50 metres per minute when carrying no load but can move at only 33 meters per minute with a load of 30 pieces.

4. Arrivals

Garment pieces arrive at station 1 to be allocated different baskets at the rate of exponential (2.5) minutes with a quantity of 30 (the bundle size is 30).

5. Variables

In this model, three variables are defined that influence the production progress at any one time. These are WIP, rework quantity and production quantity.

6. Paths

In a simulation, paths define the movements of entities and of resources. Paths may appear in two forms: as a single track or they can be combined to form a new path network (Harrell et al, 2004). In *ProModel*, simple paths can be automatically formed when a routing is defined. The default path between any two locations is the shortest connection.

7. Warm-up period

The warm-up period is the transition time from the beginning of the simulation to the steady state of the model. When the model reaches its steady state, the statistical distribution of the output of system variables will not change. In simulation study, only the outputs collected from the steady state are valid. That is because observations gathered in the warm-up phase may bias the observation estimates of time-averages. Therefore, it is necessary to discard the simulation output during the transition phase to obtain a more accurate estimate of the time-series output.

To estimate the amount of time the model needs to pass its warm-up period, a preliminary experiment is needed. First, a model variable call WIP is identified to track work in process quantities during the simulated production system. Then the simulation model will run for 250 hours to form a time-series plot of WIP (see figure 4-a).

As can be seen in figure 4-a, the warm-up period ends at around 90 hours. 100 hours is picked as the end of warm-up for avoiding any underestimation of the end of the transition phase Harrell (et al, 2004). The model was run for 250 hours, of which 100 hours is a warm-up period. The newly produced time-series plot is illustrated in figure4-b. It is found that observations during the 100 hours of warm-up period are eliminated. It is not difficult to predict that the average calculation turns out to be lower if the observations collected from the warm-up period are counted in the data analysis, resulting in inaccuracy.

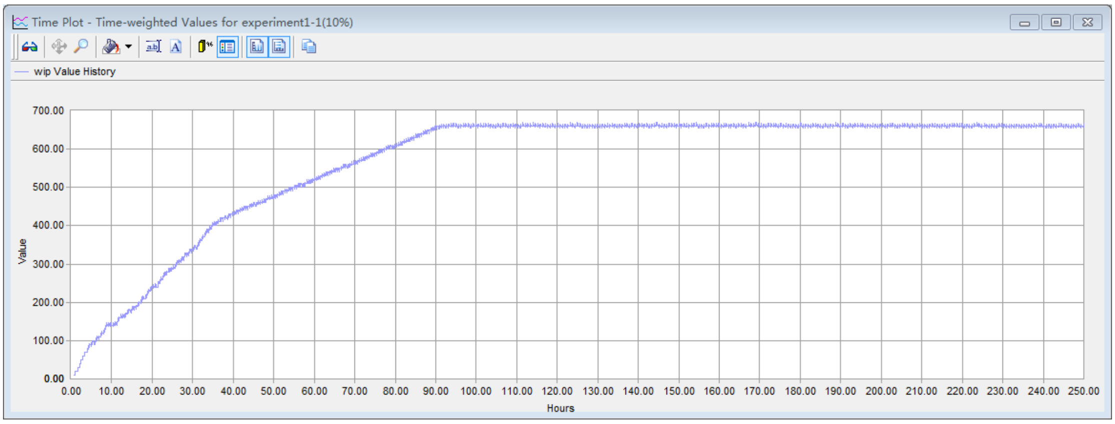

Figure 4-a: time-series plot of WIP inventory level with the warm-up time

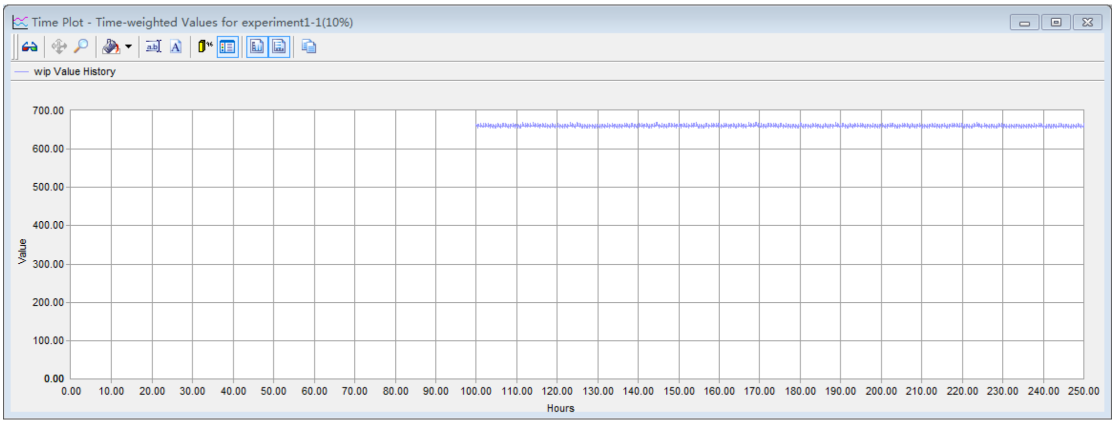

Figure 4-b time-series plot of WIP inventory level without the warm-up time

8. Replication

Interval estimation is a form of parameter estimation. Based on the need for accuracy, an appropriate interval range is constructed based on the sample population. The interval is the estimation of the range in which the parameter of the population distribution lies. Following the same confidence level, the smaller the width of the interval, the closer the approximate value comes to the real value. To reach a specific level of confidence interval, it is needed to determine sample size or replication.

Having run the model for 5 replications with a confidence level of 90% the results can be listed (see figure 5).

VARIABLES

Variable Name	Total Changes	Average Minutes Per Change	Minimum Value	Maximum Value	Current Value	Average Value	
WIP	249	2.68	510	570	570	554.27	(Rep 1)
WIP	278	2.43	510	570	540	550.41	(Rep 2)
WIP	279	2.56	510	570	570	543.28	(Rep 3)
WIP	278	2.52	510	570	510	545.40	(Rep 4)
WIP	249	2.88	510	570	570	541.37	(Rep 5)
WIP	266.6	2.61	510	570	552	546.94	(Average)
WIP	16.07	0.17	0	0	26.83	5.30	(Std. Dev.)
WIP	251.27	2.45	510	570	526.41	541.89	(90% C.I. Low)
WIP	281.92	2.78	510	570	577.58	552.00	(90% C.I. High)

Figure 5 Five replications of the model

There is a 90% level of confidence that the true but unknown mean of WIP is between 552.00 and 541.89. It would be ideal to reduce the half-width of 5.30 WIP to 3.00 WIP for the purposes of this study, so the number of observations needed to be conducted additionally is calculated by the following equation:

$$n' = \left[\frac{(z_{\alpha/2})s}{\varepsilon}\right]^2 = \left[\frac{(t_{\infty,\alpha/2})s}{\varepsilon}\right]^2 = \left[\frac{(1.645)5.30}{3.0}\right]^2 = 8.50 \text{ observations} \approx 9 \text{ observations}$$

Given: α=significance level=0.10 （confidence level equals to 0.90）

ε=error amount=hω=3.0 WIP / s=standard deviation=5.30 WIP

According to this equation, since we already have 5 observations the experiment needs to be replicated an additional 4 times to get the desired confidence interval.

9. Common random numbers

Common random numbers is a technique used for comparing two systems under more equal experimental conditions. This helps ensure that differences in performance of system designs are not generated by different experimental conditions Harrell (et al, 2004). CRN can produce random numbers from a same random number stream. *ProModel* can then provide users with 100 unique streams of random numbers. In this model, 77 different streams are used for generating 77 operation task times.

Verification and validation of the model

To verify the model, trace and debugging techniques provided with *ProModel* software were used to test that each statement of the model was correct. Animation was also used to check whether the model could run smoothly. To determine whether the simulation model is a meaningful and accurate representation of the real system, the simulation system is compared with the actual system based on production quantity. The model was run for 12 hours – the efficient working period in a single day. The result of total output was compared with the real system. Table 4 “output comparison” shows the output of the model after 12 hours of simulation was 249 – almost the same quantity as the real system. Hence, a conclusion may be drawn that the simulation model is valid and can accurately represent the real system.

Table 4: Output comparison

	Real system	Simulation system
Output (piece/12h)	230	249

EXPERIMENTAL DESIGN AND RESULTS ANALYSIS

Simulation experiment 1: influence of bundle size on line performance

This experiment was done to verify how bundle size influences the total output of a production line. In the experiment, bundle size was the only variable and four scenarios with different bundle sizes of 3, 10, 20 and 30 pieces were considered.

Table 5: Results of experiment 1

Experimental design	1	2	3	4
Bundle sizes per piece	3	10	20	30
Maximum WIP inventory per piece	55	182	380	570
Production quantity in articles	260	258	260	260
Time to finish an article in minutes	90.1	398.5	838.7	1279.0
Time to finish bundle in minutes	132.1	440.3	880.6	1320.9

Table 5 illustrates bundle size has a significant impact on the performance of the production line. The WIP inventory clearly increased with bundle size. In the meantime, the larger the bundle size, the longer the production cycle and the longer it takes to finish a single product. When setting up the bundle production system, it is essential to pay close attention to bundle size to take better control of the pace of production, the production cycle and the investment of capital in WIP.

Simulation experiment 2 – influence of operator efficiency on line performance and optimisation

In this experiment, a simulation technique was used to rebalance the dress assembly line and improve current production. Meanwhile, to evaluate the influence of operator efficiency on line performance, two operator efficiency scenarios were considered: in scenario 1 the efficiency of all operators on all operations is 100%; in scenario 2 there is a difference in the efficiency levels between different operators, also a difference in operators' efficiencies at different times of the day. A table functions facility can compare operator efficiency at a specific time of day with task time. 20 table functions were defined according to the number of workstations – 20 in this model. For example, task time of operator 1 was derived from the table function operator1 (HR):

Operator1（CLOCK(HR)-12*TRUNC(CLOCK(HR)/12)）SEC

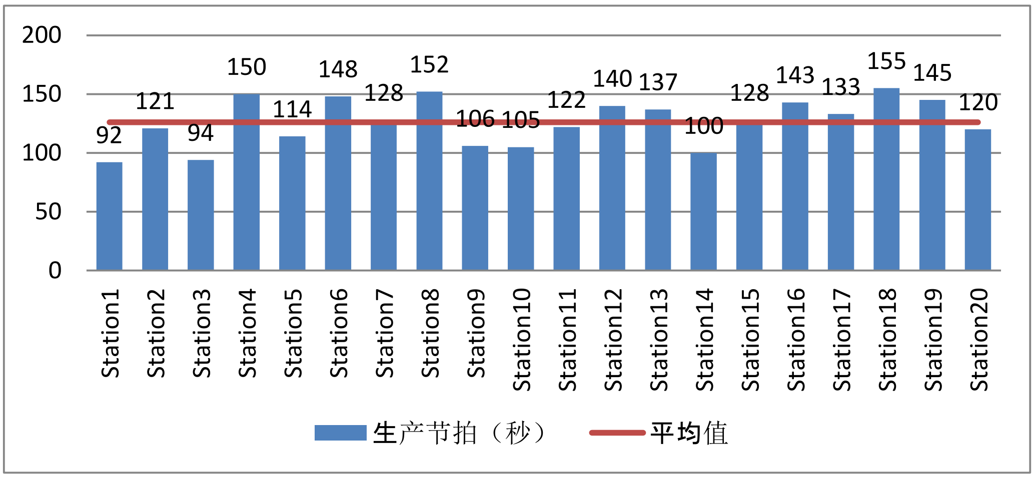

Figure 7: Pitch time of each station

Table 6: Location state of scenario 1

No. of workstation	Operation %	Idle %	Block %
1	100.00	0.00	0
2	80.42	0.00	19.58
3	63.54	0.00	36.46
4	98.61	0.00	1.39
5	76.04	0.00	23.96
6	97.29	0.00	2.71
7	84.79	0.00	15.21
8	100.00	0.00	0.00
9	71.04	27.15	1.81
10	69.86	2.43	27.71
11	79.38	0.00	20.62
12	90.63	0.00	9.37
13	88.75	0.00	11.25
14	65.35	0.00	34.65
15	83.13	0.00	16.82
16	92.50	0.00	7.50
17	86.25	0.00	13.75
18	100.00	0.00	0.00
19	93.75	6.25	0.00
20	78.13	21.88	0.00

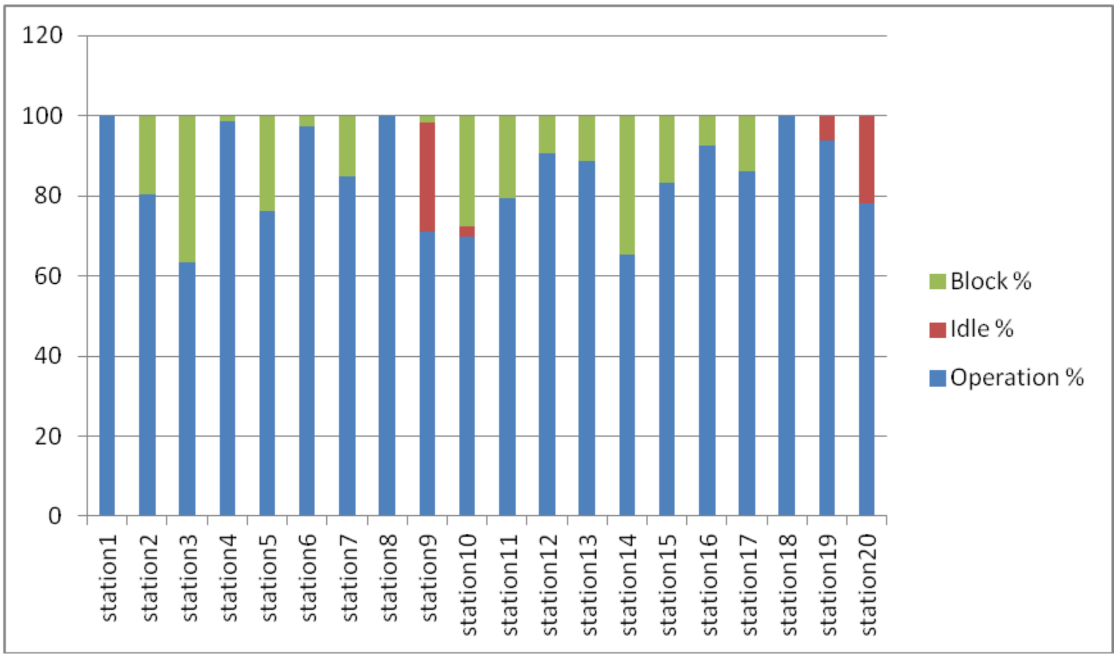

Figure 8: Single capacity location state in scenario 1

Figure 7 presents the pitch time of each workstation of scenario 1. It can be seen that the pitch time fluctuated across the production line and this results in an unbalanced line. The 18th workstation is the bottleneck in the line.

Table 6 shows the state of 20 locations in scenario 1. There are 3 kinds of state which are operation, idle and block. Operation means the station is in the state of processing products. Idle means the station is not working and waiting for the next entity. Block means the next entity is waiting to be processed in this station. Sum percentage of three states equals to 100%.
From table 6 as well as figure 8, it is clear that the 18th station's operation takes up a large part of the total production time. Stations before the 18th are blocked while later stations are sometimes idle. Certain solutions are commonly used in the company to deal with a bottleneck workstation:

1. Operation split – some operators are kept back while the rest are reallocated to other workstations to achieve a more balanced line;
2. If the work sequence at a workstation has operations that cannot be split, then the splitting can be done to the batch size and part can be given to idle workstations. Than the idle workstations can do the same work sequence to the split batch;
3. Increase the number of operators.

For example, at the 18th workstation where the 58th operation – top stitch neckline – and the 65th operation – stitch shell fabric and lining together – take place, operations can be split, for example by allocating the 65th task to other idle stations such as the 14th.

In scenario 2, tasks were reallocated with consideration of operator efficiency.

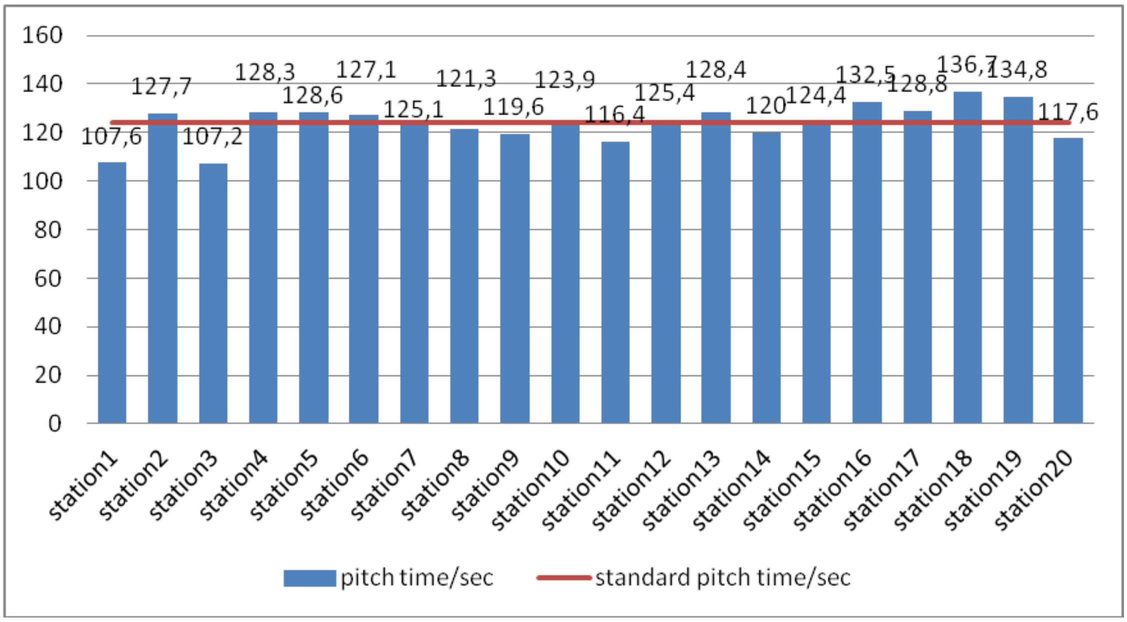

Figure 9: Optimized pitch time of each station

Figure 9 is the optimized pitch time for each workstation. It is clear that the production line turns out to be more balanced after optimization.

Table 7: Location state of scenario 2

No. of workstation	Operation %	Idle %	Block %
1	100.00	0.00	0
2	95.86	0.00	4.14
3	76.28	0.00	23.72
4	95.68	0.00	4.32
5	93.09	0.00	6.91
6	97.58	0.00	2.42
7	92.39	2.12	5.49
8	93.49	0.00	6.51
9	87.83	0.00	12.17
10	84.63	0.00	15.37
11	91.03	0.00	8.97
12	92.92	0.00	7.08
13	95.53	0.00	4.47
14	88.40	0.00	11.6
15	92.76	0.00	7.24
16	99.15	0.00	0.85
17	93.99	1.60	4.41
18	100.00	0.00	0.00
19	93.26	6.74	0.00
20	87.95	12.05	0.00

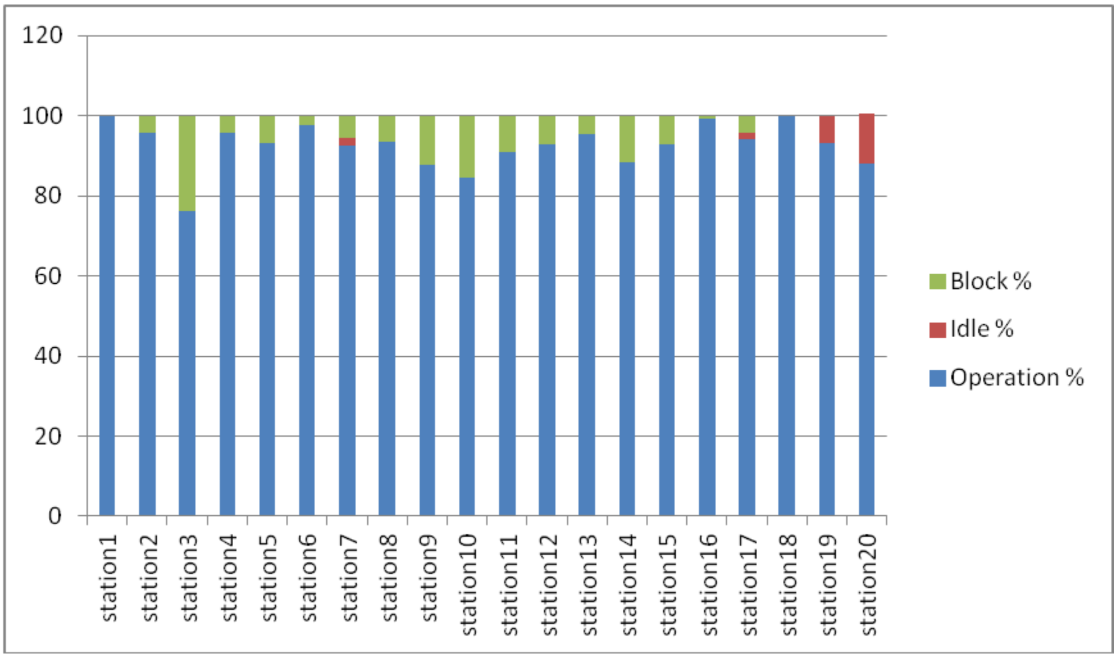

Figure 10: Single capacity location state in scenario 2

Table 7 and figure 10 suggest that the efficiency of all workstations were improved to some extent. The number of blocked workstations was reduced and the percentage of blocked time also decreased.

Table 8: Comparison of total output for experiment 2

	Scenario 1	Scenario 2
WIP/piece	552	570
Production Quantity/article	270	330

Table 8 shows that the daily output clearly increased by 60 articles between scenario 1 and 2. Optimization using a simulation technique and considering operator efficiency is an effective way to increase output and achieve a balanced line.

Scheduling production lines by considering operator skills can generate significant efficiencies. Because of the uneven capabilities and different productivity levels of operators, it is important to determine that operators should process those operations in which they are skilled. In this way bottlenecks may be eliminated and line balance improved.

CONCLUSION

A simulation technique such as *ProModel* provides a way of scheduling and optimising an apparel assembly line. In this study, an assembly line for dress production of a garment manufacturing company in Nantong, Jiangsu province, PR of China was studied as an example to test simulation as an effective technique over manual scheduling: it factored in rework, transportation and operator efficiency. The scheduling plan is also more close to the real production. The simulation method can help line supervisors locate inefficient line scheduling in advance; this allows the most appropriate actions for adjusting the assembly line even before the start of actual production. Simulation provides a convenient way to revise any arrangement constantly until an optimal plan is achieved. With the help of such simulation, manufacturers can adjust the line before production begins instead of during the production process: this may prove vital in extending profit margins, be helpful in improving production efficiency and effective in the control of production scheduling.

REFERENCES

Harrell, C.; Ghosh, B.K. and Bowden, R.O. (2004) *Simulation Using ProModel* (McGraw-Hill, New York)
Kanawaty, G. (1992) *Introduction to work study* (International Labour Organisation, Geneva)
Lorenzo, T. (2012) "Event and object oriented simulation to fast evaluate operational objectives of mixed model assembly lines problems" in *Simulation Modelling Practice and Theory* 24 (pages 35 – 48)
Rotab, K. (1999) "Simulation modelling of a garment production system using a spreadsheet to minimize production cost" in *International Journal of Clothing Science and Technology* 11 (5) (pages 287 – 299)
Senem, K. and Fatma, K. (2009) "Simulation of production line balancing in apparel manufacturing" in *Fibres & Textiles in Eastern Europe* 4 (75) (pages 68 – 71)
Siti, A.A.; Rohaizan. R. and Tan, G.F. (2012) "Cycle time reduction of a garment manufacturing company using simulation technique" in *Proceedings of the International Conference of Technology Management, Business and Entrepreneurship* (Melaka, Malaysia)
Zhao R. (2012) "The study of the standard working hours formulation of apparel production and assembly line optimization" Master's Degree Thesis of Donghua University (pages 35-37) http://px.zhongsou.net/zx/130605_7453559468170814270.html accessed on 5th June, 2013

DETECTION OF WARP TENSIN USING IMAGE PROCESSING IN DRAPE PLAIN FABRIC

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ABSTRACT

Every fabric contain warp and weft yarns. Warp and weft yarns make cross over each other systematically. Each yarn prolonged formation when make cross over connection for built fabric. It varies according to the type of fabric tension on yarn. This tension changes depends on the loom settings. We can found datas with using image processing, we could approach excellent results. Then the pixels were counted and converted into milimeter with image analysis. This is the first work finding the yarn tension inside the fabric. Ne 40/1 warp, Ne 80/2 weft cotton yarns with a density of 50 ends/cm and 20 weft/cm plain fabric. The distribution of elongation on the fabric samples after taking loom were tested and evaluated on the surfaces of the fabric samples. The results taken from image processing were given in pixels. According to the test results, the fabric samples showed greater elongation distribution at the left sides when compared with the right and the middle sides.

Key words: Warp elongation, image processing, weave, yarn breakage.

INTRODUCTION

The words fabric and cloth are used in textile assembly trades (such as tailoring and dressmaking) as synonyms for textile. However, there are subtle differences in these terms in specialized usage. Textile refers to any material made of interlacing fibres. Fabric refers to any material made through weaving, knitting, spreading, crocheting, or bonding that may be used in production of further goods (garments, etc.). Cloth may be used synonymously with fabric but often refers to a finished piece of fabric used for a specific purpose (e.g., table cloth).

A textile or cloth is a flexible material consisting of a network of natural or artificial fibres (yarn or thread) [1]. Yarn is produced by spinning raw fibres of wool, flax, cotton, or other material to produce long strands[2]. Textiles are formed by weaving, knitting, crocheting, knotting, or felting.

The word 'textile' is from Latin, from the adjective textilis, meaning 'woven', from textus, the past participle of the verb texere, 'to weave'.[3]
The word 'fabric' also derives from Latin, most recently from the Middle French fabrique, or 'building, thing made', and earlier as the Latin fabrica 'workshop; an art, trade; a skillful production, structure, fabric', which is from the Latin faber, or 'artisan who works in hard materials', from PIE dhabh-, meaning 'to fit together'.[4]
The word 'cloth' derives from the Old English clað, meaning a cloth, woven or felted material to wrap around one, from Proto-Germanic kalithaz (compare O.Frisian 'klath', Middle Dutch 'cleet', Dutch 'kleed', Middle High German 'kleit', and German 'kleid', all meaning "garment")[5].
Weaving is a textile production method which involves interlacing a set of longer threads (called the warp) with a set of crossing threads (called the weft). This is done on a frame or machine known as a loom, of which there are a number of types. Some weaving is still done by hand, but the vast majority is mechanised.

Computers can make easily fabric inspection but there are challenges: (a) some categories of fabrics, (b) distinct composition of various wallpaper groups of fabric texture, and (c) similarity in shape between defects and background texture. Computers fabric inspections are so expensive and it work correctly only for satin fabric that some weft density, which are known the ‘unpatterned’ fabrics. Several major methods were improved for “ unpatterned” fabric[6,7]. Dornier, Uster, Barco Vision, and Elebit Vision working on image processing for fabric control [8,9].

Loom carry different tensions different elongation in the warp yarns are seen width of the loom. Different mechanisms for the warp yarns make extensions varies. We research that varies elongations in the drape fabric.

In this study, the elongation of the warp yarns was measured using image processing on the drape fabric. Different warp elongations are seen on the fabric. Elongations of the warp yarns on left, middle and right sides are different on the drape fabric. These elongations of the fabric were photographed and were analyzed with MATLAB and then statistics analysis was were taken. Satin fabrics are woven in only one weft densities. In this study warp elongation values are occurred by image analysis.

MATERIAL AND METHOD

Material

Plain cotton fabric contain has Ne 40/1 warp yarns and Ne 80/2 weft yarns with a density of 50 ends/cm and 28 weft/cm respectively.

Modifying a normal camera body and lens structure, Charge Coupled Device (CCD) is obtained and its electronic film plates are used instead of normal film. 1 mm^2 CCD devices smaller than the detector consisted of thousands of extremely sensitive to light called pixels of the image to ensure that the smallest picture element, is composed of [10]. The detectors in proportion to the brightness of the signal photons hit manufactures electronic signal. Determines the numeric value of this signal size is recorded. Image processing, more saved, manipulate images, so the current image and graphics, change, alienate, or is used to improve [11].

Figure 1. Photo Shoot (CCD Camera)

In a program written in MATLAB, "L_f" values is calculated out of the images received from CCD. In this study a camera with a brand name Guppy PRO is attached to the computer. Fabric is fixed on a glass scaffolding system which is located across the camera. The camera gets visions of the fabric on the glass surface which is placed to the desired distance.
Four light sources are placed in front of and behind the glass surface with 45^0 angles. Images have been analyzed in MATLAB R2012. The measuring system is calibrated with constant distance “λ” calculating that milimeter distance divided by pixel distance.

Method

Warp beam drawn lines on the surface are showed in Fig1. "a" and "b" lines are drawn on the warp beam. Lines will be broken because of varied yarn elongations. This will get the format of the wave of later periods. We can see wave of fabrics as warp elongation varying. This represents a two-wave along the width which means the warp deformation changes are the natural graphics of varying yarn elongations.

We measure the distance after weaving distribution after the fabric is taken from the machine. Matlab separates the image as upper side and down side. First step Matlab calculates upper side and find upper weave statistics. Second step Matlab calculates down side find down weave statistics. End of Matlab work, mean distances are found between two weave. İt is showed as 'L_f'.

L_0 is firs the distance between the lines,
L_1 is lenght warp yarn in the fabric hence is the distance between the lines after weaving.
L_f is the mean distance between two dots on fabric.
C is warp crimp.
λ is unit converter between pixels and milimeter.
ε is warp elongation in a fabric.
σ is Yarn tenacity,
E is Stiffnes,

$$\varepsilon = \frac{\Delta L}{L_o} \quad (1)$$

$\Delta L = L_1 - L_0$

$$L_1 = L_f.(1 + C) \quad (2)$$

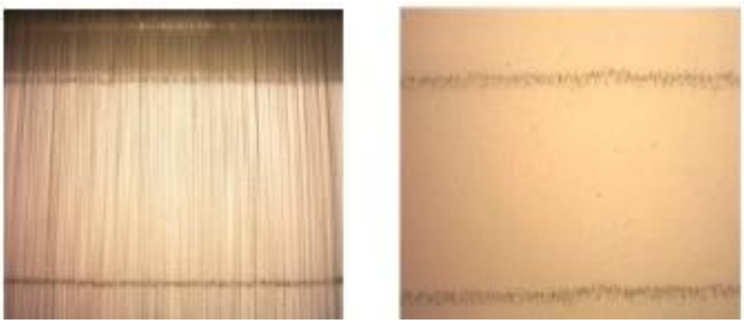
$\Delta L = L_1 - L_0$

$$\Delta L_1 = L_f.(1 + C) - L_o \quad (3)$$

$$\varepsilon = \frac{L_f.(1+C) - L_o}{L_o} \quad (4)$$

$$\sigma = E.\varepsilon \quad (5)$$

All features of fabric properties were remained constant during image processing and the distance between warp beam and fabric region were measured and the photographs were taken and given in Figure 2.



a) Plotted at warp beam. b) Dots at the fabric.

Figure 2. Photographs of Reference Grids on the Fabrics

(from left to right; a) on the warp beam, b) on the fabric)

L_f is the mean distance between two dots on fabric

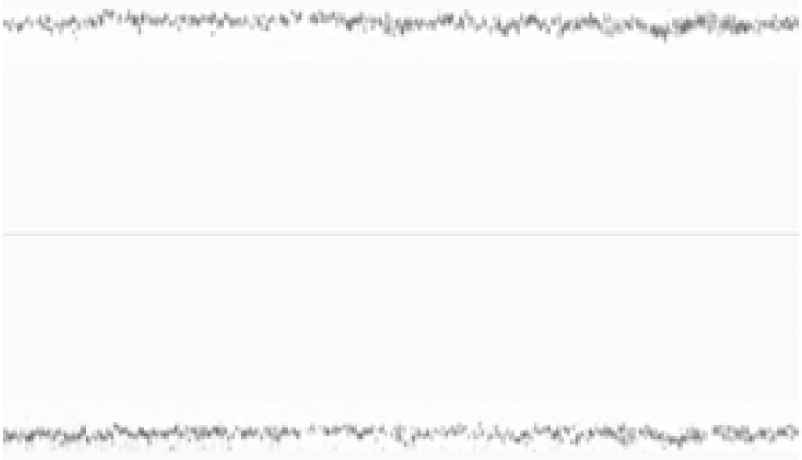


Figure 3. Two dots on a woven fabric

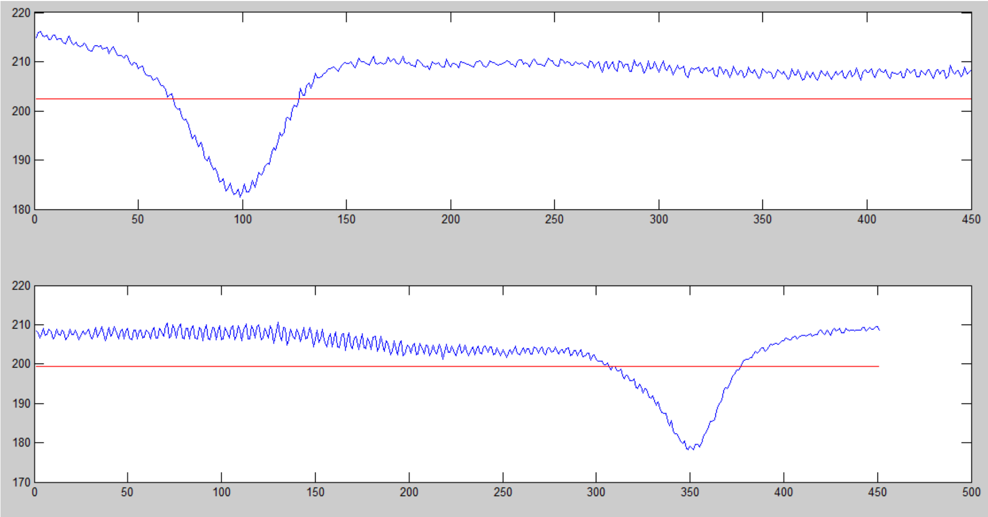


Figure 4. Color chancing among the pixels

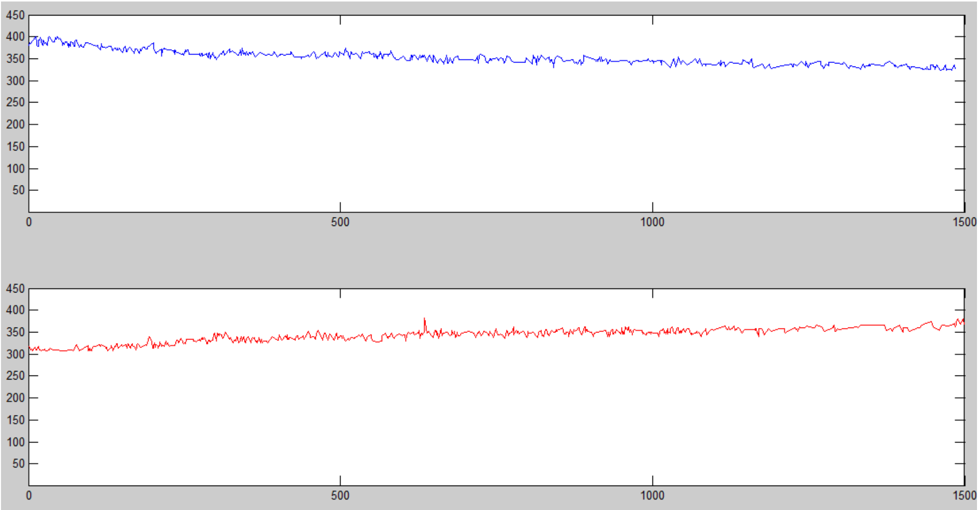


Figure 5. Upper and down sides measurement pixel lengths left sides on drape fabric

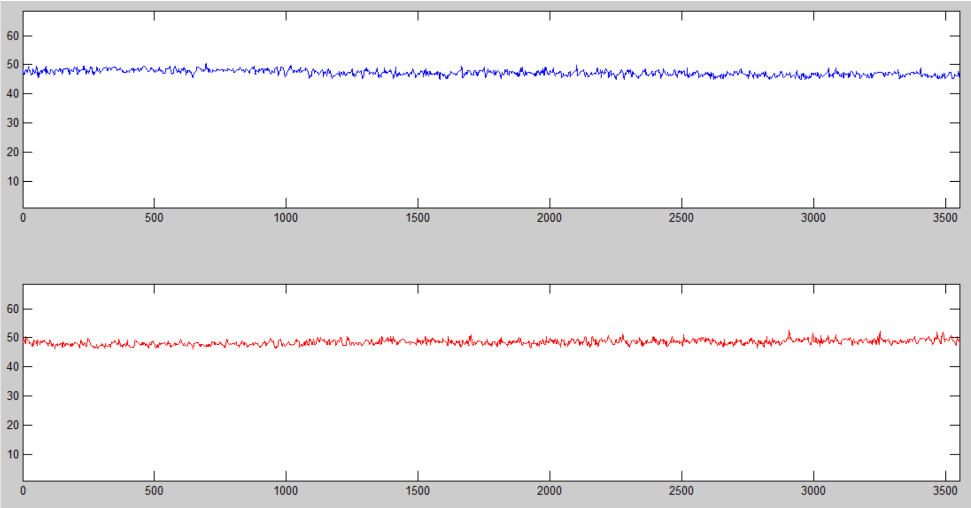


Figure 6. Upper and down sides measurement pixel lengths middile region on drape fabric

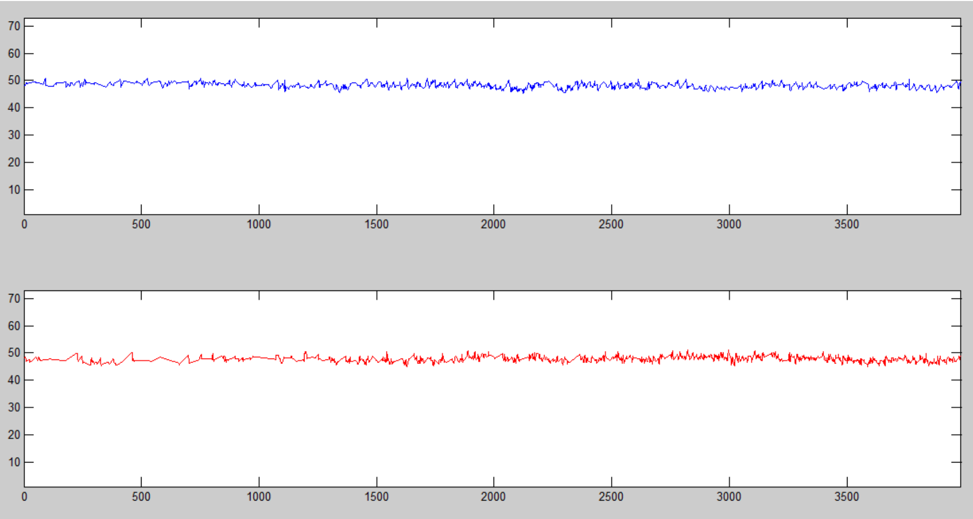


Figure 7. Upper and down sides measurement pixel lengths right sides on drape fabric

λ is unit converter between pixels and millimeter. λ was calculated,
λ= 0,0421 mm/px

We can convert the pixel datas to millimeter.

RESULTS AND DISCUSSION

The results taken from image processing were given in pixels. The test results can be seen in Table 1, and 2.

Table 1 İmage Proccessing summury.

L_f			
	Left	Middile	Right
L_f Upper region mean px	1152,05	1122,26	1146,58
L_f Down region mean px	1111,40	1151,44	1133,78
L_f Addiction mean px	2263,45	2273,70	2280,36
λ	0,0421	0,0421	0,0421
L_f Addiction mean mm	95,29	95,72	96,00
C	0,08	0,08	0,07
Ly	102,91	103,37	102,72
ε	0,0089	0,0134	0,0070
E	304,75	304,75	304,75
σ	2,71	4,08	2,13

$$L_1 = L_f.(1 + C) \quad (2)$$

E= 304,75
L_0 = 102 mm

Table 2 Warp Elongation aganist weft densityies

%ε	Left	Middile	Right
20 weft/cm	0,89	1,34	0,7

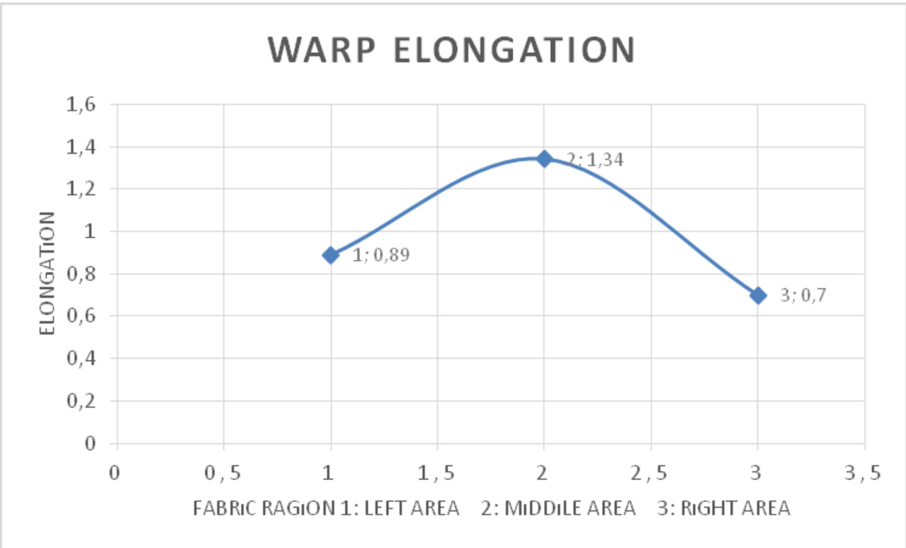


Figure 8. Elongation Percentage of the drape fabric with 20 weft per cm

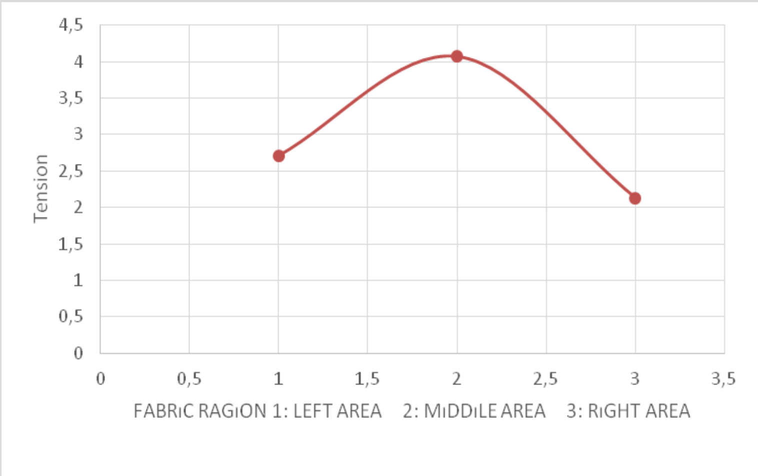


Figure 9 . Warp Tension in the drape fabric with 20 weft per cm

Warp elongations calculated in fabric. These elongations changed along the widh of loom. Other researchers founded chanced warp strain along widh the loom [8,9]. We can see vary of elongations at figure 8 and vary of warp tensions fig 9..

CONCLUSIONS

The distribution of elongation and tension on the drape fabric were tested and evaluated on the fabric surface. According to the test results, the middle side on the fabric samples were shown greater results than from the results taken from the left and right part of the fabric samples. It is attributed to calibration of the loom and the fabric structure. Warp elongation increases with warp density.

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REFERENCES

Merriam-Webster. Retrieved 2012-05-25.
"An Introduction to Textile Terms" *(PDF)*. Retrieved August 6, 2006.
"Textile". *The Free Dictionary By Farlex*. Retrieved 2012-05-25.
Harper, Douglas. "fabric". Online Etymology Dictionary. Retrieved 2012-12-11.
Harper, Douglas. "cloth". Online Etymology Dictionary. Retrieved 2012-12-11.
A. Bodnarova, M. Bennamoun, K.K. Kubik, Defect detection in textile materials based on aspects of HVS, Proceedings of the IEEE SMC' 98, Conference, San Diego, US, October 1998, pp. 4423–4428.
C.H. Chan, H. Liu, T. Kwan, G. Pang, Automation technology for fabric inspection system, Proceedings of Conference on Applications of Automation Science and Technology, City University of Hong Kong, November 1998, pp. 24–26.
Uster Fabriscan, (Mart 2010), http://www.fuster.com/pdf/uster/uster_fabriscan_eng.pdf.
Barco Vision, (Mart 2010), http://www.visionbms.com/vision/downloads/Cyclops AutomaticOn-LoomInspection_BRCH_EN_A00511.pdf.
Todd Jackson, A., Bell, C.A., (1991), "Megapixel resolution portable CCD electronic still camera" Proceedings of SPIE-The International Society for Optical Engineering, v 1448, pp2-12.
Yılmaz, A., "Kamera kullanılarak görüntü işleme yoluyla gerçek zamanlı güvenlik uygulaması," Yüksek Lisans Tezi, Haliç Üniversitesi Fen Bilimleri Enstitüsü Makine Mühendisliği Anabilim Dalı, 102, İstanbul, 2007.

Ludwig, H.W., Gries, T. (2003). "Measurements Carried Out To Minimise Warp Tension Variations in Weaving Machines", Melliand Textilberichte. June 02, pp. 55-58.

THE USE OF 3D PRINTERS IN SHOE TECHNOLOGY

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ABSTRACT

Creating models of rapid prototyping by using 3D printing techniques is based on the digitally cut layers of the model which are applied layer to layer in real physical space creating thus the final object. This mode allows you to create complex models with thin walls and complex internal structures which are almost impossible to make by applying traditional methods. Materials used for making model shoes are different: liquid, powder, powder or even metal material that is hardened by chemical reactions, UV light or some other methods. With 3D printing, techniques of making shoes use CAD technology, which is based on the development of a three-dimensional solid model - Solid Model in digital form.

INTRODUCTION

3D printing of footwear is a very interesting technology and its main idea is that what we want can be achieved in the short term, without the need for conventional means of processing, masters and machineries on which the production will be conducted. The technology of 3D printing is a method of making a three-dimensional object from .STL (Eng. Standard Tessellation Language) files created by some of CAD (Eng. Computer Aided Design) programs. This technology is one of the processes of rapid prototyping. Many different technologies are included into the processes of rapid prototyping, but they all work on a similar principle. The model is created layer by layer with the application of certain materials, depending on the technique of printing. That principle of fashion footwear production enables the process of making a very complicated geometry of fashion footwear which would be very difficult or impossible to make by applying other, conventional methods of production. Fashion footwear is produced directly on the equipment for 3D print processes based on 3D computer model of fashion footwear, without the need for additional tools.

The use of 3D printers includes many technical challenges, not only in design but also in the setting of production parameters in order to obtain good quality footwear and prevent warping (e.g. optimization of the rate of development, improving the properties of the material, setting the parameters of the development of new materials and the like.). The production of fashion footwear with 3D printer greatly simplifies and reduces the work of the constructor. An adjustment to the jointly developed products and distribution of products intended for sale on the Internet has become faster. This makes it easier to get an insight into the desires of consumers and to build better relations between the manufacturer and the customer.
At present, 3D printers can print fashion footwear by the dripping of a melted filament of all kinds of plastic, and in the near future stereolithographic printers will selectively solidify a liquid resin by photopolymerization. The new generation of 3D printers will produce fashion footwear of complicated geometry of different elasticity and conductivity of various substances.

3D PRINTER AND THE MANUFACTURE OF FOOTWEAR

What is 3D printing? It is known as a fast modeling – a quick creation of prototypes. Production of finalized products by adding materials where a 3D object is built layer by layer.

It can use more materials and more colors. One layer is about cca 100□m / 0.01mm. Printing is relatively slow, the speed is 50 to 100 mm / s. With 3D footwear printing most commonly used procedure is the following: at first a new idea for shoes is scanned, the cut and the material are selected, geometry, material and color are coordinated, and made in CAD program of 3D files. Programs create the profile based on 3D images and propose priority solutions according to their will. This results in a generic model in which the material and details are changed.
For the first time the technology of 3D printing was represented by the company 3-D Systems in 1987. The technology was based on stereolithography [2]. With this technology a three dimensional object was created layer by layer, using virtual computer-generated models. Shortly after the introduction of the new technology, the company 3-D Systems has sold its first commercial system based on stereolithography. In 1993, Massachusetts Institute of Technology (MIT) developed and patented a three-dimensional printing technology based on the principle of ink-jet technology. By using this technology, one material could be applied to other material by jets, and then they were joined in order to enable faster and more accurate making of a three-dimensional object. With the introduction of this technology, there were a number of companies such as Stratasys, and Z Corporation, which have recognized all the advantages of the development of this technology, which could be implemented in different areas of the industry [1].

Figure 1 shows the principle of making models of fashion footwear and cutting into thin layers where we get a stepped surface of the model. 3D model constructed by the computer is cut into two-dimensional layers of equal thickness, which are placed one on the other. This provides a three-dimensional shape, with a stepped surface appearance, because of the principle of stacking layer after layer.

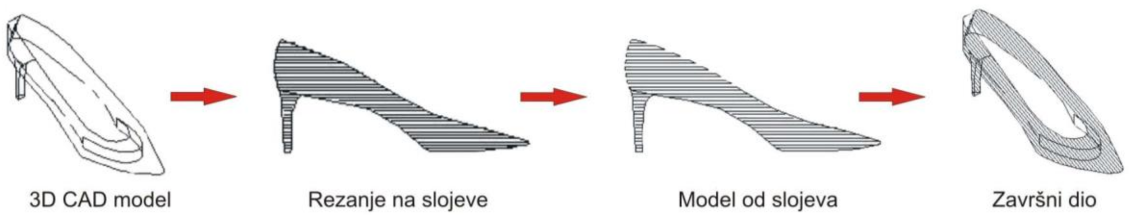


Figure 1. Development process layer by layer
3D CAD model; Cutting in layers; Model made of layers; Final part

A method of manufacturing fashion footwear by using 3D printers can be divided into the following phases of development:

1. The development of the first conceptual design and the development of solutions by engineers
2. Designing CAD models and 3D visualization. The first step of all 3D printer procedures is making the three-dimensional geometric model in some of CAD programs, Figure 2.

   The operating cycle of the future prototype begins with design, in particular with the concept. After adopting the concept, preliminary sketches, technical drawings, and finally the CAD files are made or digital three-dimensional model of the object. In the process of creating CAD files testing of model shoes by numerical methods can be conducted [17].

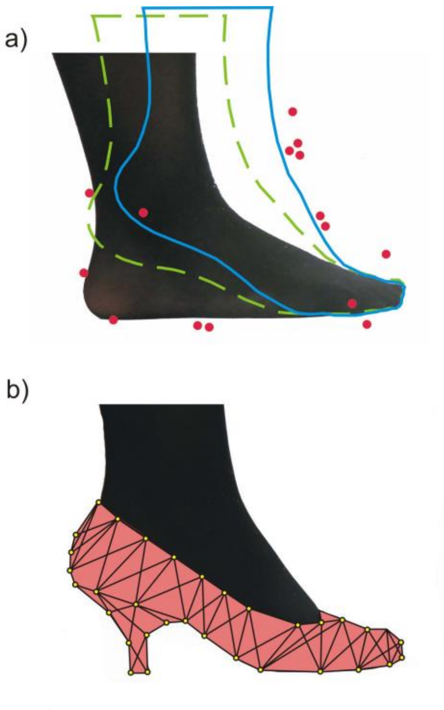
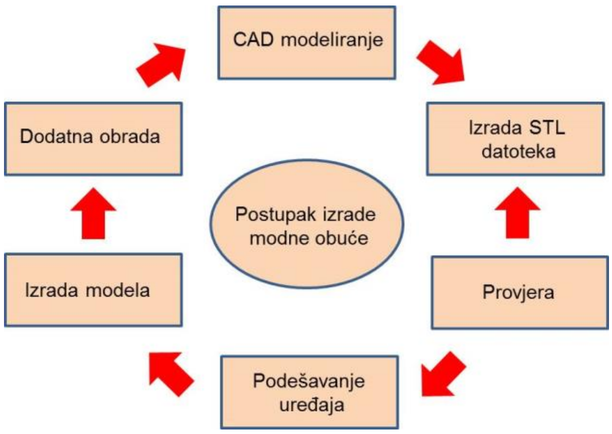


Figure 2. CAD model of fashion footwear

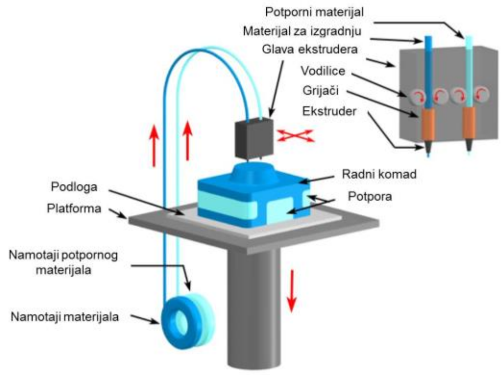
3. Turning CAD models into .STL file. STL file is a standardized format for transmitting data using devices for the rapid prototyping. That is a representation of the geometry of three-dimensional surfaces in the shape of a triangle. The surface of the model is logically broken up into a series of small triangles, the so-called faces. The direction and orientation of the face are described by three points in space. The file in that form is used for cutting the model into horizontal cross-sections or layers. The file is displayed in a web form - mesh, made up of so-called face, so that for a good image it must be optimal. The mesh, which forms the model must be thick in order to meet the desired surface quality, and in order to display smaller details properly. Otherwise, when the mesh is of a low density, a rough surface is obtained.
4. Turning STL file into the program for virtual cutting of the object into layers.
5. Selecting the parameters of 3D printers (thickness of the layer, strength, speed, temperature, generating support structures, etc.).
6. Setting up a 3D printer (replacement of materials, calibration, etc.).
7. Making the final product with 3D printer. The quality of 3D printed fashion footwear depends on the height of the layer, if you are working with thin layers, transitions between the layers are less visible, stepped structure is less evident and the items have a finer surface. The thickness of one layer usually ranges in value between 75 microns, which is slightly thinner than a sheet of paper.
8. The final procession of 3D object of fashion footwear (removal of excess material, subsequently, merging, removing the support structure, coating, sanding, gluing, painting, sandblasting, etc.).
9. Packing and delivery of the 3D object of fashion footwear.

Before the prototyping of fashion footwear it is necessary to define its purpose and intention, and choose the technique of rapid prototyping of fashion footwear accordingly. After the verification of shapes and sizes, the prototype is made. Possible disadvantages of the prototype are eliminated and corrected in the CAD file. The prototyping process is shown in Figure 3.



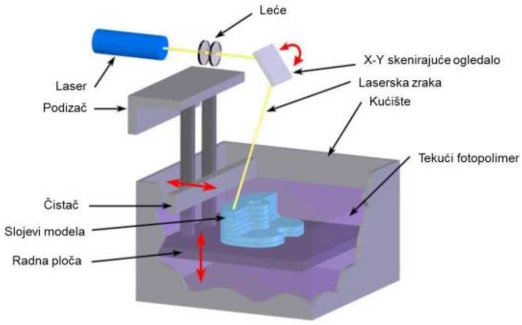
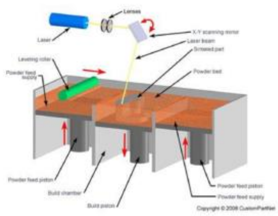
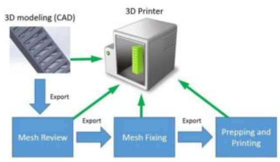
CAD modeling; Developing STL file; Check; Setting devices; Development of the model; Additional proccessing;
Figure 3. Cycle of a fast prototyping [2]

Today the process of 3D printing does not come in ready-to-use form. Before giving the command for printing there are many steps, and even more after fashion footwear comes out of the printer, which is often neglected. Besides the complexity of the design for 3D print, which can be demanding, preparation of the file and conversion can also be long and complex, particularly for fashion footwear designs which require complex technology during processing. However, constant updates and upgrades of the software for these functions are available so that the processing technology is improving as well. Furthermore, once it comes out of the printer, fashion wear needs finishing. Eliminating the need for supporting elements is an obvious development of processes that require supporting elements, but others include sandblasting, painting, staining, or other types of traditional finishing works, which are usually performed by hand and require skills and / or time and patience. Categorization and definition of 3D printers to (ISO / ASTM 52921: 2013 E), Figure 4.

<table>
<tr>
<td>

1. Fused Deposition Modeling - 3D FDM

Supportive material; Construction material; Head of the extruder; Sliding spindle; Heaters; Extruder;
Base; Platform; Desktop; Support; Coil of the supportive material</td>
<td>Polymer fiber passes continuously through the nozzle of a small diameter as shown in the figure. The nozzle is heated to a certain temperature, thus melting the supplied material and applying it layer by layer to form a three-dimensional object. During the coating process, the material is evenly pressed out of nozzle which is moving in the X-Y plane. After one layer is printed, a desktop offsets to the Z-axis for the thickness of one layer, and starts applying the next</td>
</tr>
</table>

	layer. This procedure is repeated until the final layer of the object is printed.
 2. Stereolithography - 3D SLA, SL *Lenses; Laser; Lifter; X-Y scanning mirror; Laser beam; Case; Liquid photopolymer; Cleaner; Layers of the model; Desktop.*	Computer loads the CAD model and creates layers. The most frequent layer thickness is approximately 0.1 mm, but may vary from 0.05 mm to 0.15 mm. The control computer then uses the laser unit and printer hardware to create a supporting layer. Due to the ultraviolet radiation, at lighted areas a poly-measuring liquid becomes solid. This process continues until the last layer of the object is printed.
 3. Selective Laser Sintering – 3D SLS	SLS method begins by converting 3D CAD model to standard STL format. In STL file dimensions and orientation of the 3D model can be changed, which the quality and accuracy of forms depend upon. After the conversion, the STL file is divided into layers. The powder of the material is transported by the rotating cylinder into the chamber for modeling. During the transportation of the material, a dissolution degree of the particles can be dosed, and thus homogenous structures of lower porosity can be obtained.
 4. 3D Printng - 3DP	3D printing method is used most often for the verification of forms, for the making of molds and cores for casting and for the production of tools and elastic parts. It is distinguished by the accuracy and quality, and can create models of medium to large size and the materials used are not harmful to health. Speed of the development depends on the required quality, that is, on the layer's thickness. Most devices are working at the speed of several layers in minutes. Faster selection of printing results in a poorer quality.

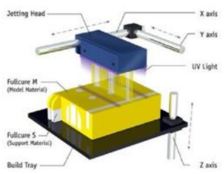
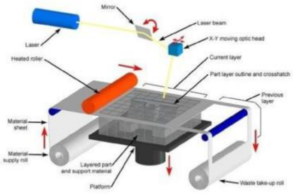
 5. PolyJet	By using 3DP PJ method dimensionally stable models are created, with the accuracy of 0.025 to 0.05 mm (ProJet) and 0.1-0.3 mm (PolyJet). Walls with the thickness of 0.6 mm can be produced. The surface of these models is among those with the top quality in the rapid prototyping industry, maximum dimensions of the model are 550 x 400 x 300 mm. This is the first technology, which enables the simultaneous application of a jet of various materials.
 6. Laminated Object Manufacturing - LOM	Laminated object manufacturing technology enables the production of models of different mass, while the thickness depends on the type of the film used. The surface's roughness also depends on the type of the film. This technology is used in the manufacture of functional models of high firmness, resistant to aggressive media and high temperatures. It is suitable for the verification of forms and the compliance of components within the set, with models that do not have small details.

Figure 4. Types of 3D printers [2], [3]

THE MATERIAL FOR 3D PRINTING

With a 3D printer material can have two roles, as the main material of which the subject is made or as an extra material for the supporting structure. Although by this process different objects can be created, it is necessary to take into account how the object is oriented for the making on the background because sometimes sharp angles or expelled elements can not be printed. If items are printed with auxiliary materials, they need to be removed after completion in the way as to break off or dissolve in the solution, depending on the material. Printable Material (Eng. Filament) is in the form of a plastic fiber, a wire and wound on the reel. In use the most common are thermoplastic or thermoplastic blended with organic materials, in Figure 5. The most common polymer materials are ABS and PLA, and behind them PC, PA, with some such as PVA and PS-HI. The materials for FDM (Eng. Fused Deposition Modeling) are pretty cheap compared to other additive processes, and many researches have been conducted and the development of new materials. For 3D printing of fashion footwear newer materials such as FilaFlex are used. Printing shoes with a double-screw extruder and a combination of PLA and FilaFlex produces shoes that provide good stability and comfort.

Materials for 3D printers		
	Process	
	Photopolymerisation	Modeling by melting
Liquid materials	Photopolimer materials and epoxy resin	Thermoplastic polymers, polymers, elastomers and wax
	Laser sintering	3D Ink-jet
Powdered materials	polymers, ceramics, plaster, sand with the binder, metals with the binder	polymer and metal powders
	Laminating	
Rigid materials	Polymers and paper	

Figure 5. Types of materials for 3D print [1]

DESKTOP

Desktop is the base on which material comes from jets during printing and the object is made on it. It defines the dimensions of the object that may be made by 3D printing. It is mostly heated to a certain temperature, which is lower than the heating temperature of the material. Sometimes it is used and not heated, but then it comes to special materials. Heated base is used because it significantly improves the quality of printing, so it prevents bending of the object until the material is being cooled down, in a way that it keeps it slightly heated even after leaving the nozzle. When the extruded material is being cooled down it shrinks a bit, but if it does not happen evenly throughout the object, it comes to bending. Bending is manifested through the raised edges which causes deformations of printed 3D objects. With the heated surface the temperature of the object is maintained until the completion of the process, which provides cooling and contraction of the entire object at the same time so there is no bending and lifting edges. The base consists of two parts: a heated plate of electrically conductive material and the surface material or surface plate that is placed on it. The heated plate is usually made of a metal material, because of the good thermal conductivity, the heat is spread evenly through the metal. Usually there is aluminum which is rapidly heated and cooled, as opposed to copper or steel which need substantially longer time. Polyamide strip is applied on the aluminum foil. A surface material of the base has a role to cover the hot plate and the extruded material is applied to it, which adheres much better to that surface.

Production and sales

The calculation of the total cost of 3D printing is calculated for each model separately. The first and most important parameter of the calculated price is the volume of the object which is being manufactured. The basic price is calculated per consumed or printed cubic centimeter of material (1cm3 of the material). The second parameter of the price depends on the material used in the production of the object and of the need for a supporting material. In the category of best 3D printing materials are objects formed by the materials ABS and PLA. In the medium price category are included materials of nylon and elastic polymers. In the most expensive price category are stone-like and wood- like polymers.

CONCLUSION

3D print technology is rapidly evolving and finds its application in the industry of fashion footwear. To make the most of this technology it is necessary to achieve a certain quality of the printed model, respecting certain rules. Newer printers work faster, more accurately with better software programs, more heads, all colors, different materials and a large selection of files with objects. The use of 3D printers and the sale involve making shoes by order. The final properties of the shoes made by 3D print technology depend primarily on the chosen technology, the chosen material and adjustable production parameters. For the optimum utilization of the advantages offered by 3D print technology we need to be informed about the advantages and disadvantages of the technology compared to other additional technologies, but also to conventional production methods.

LITERATURA

[1] Gebhardt, A.: Understanding Additive Manufacturing, Rapid Prototyping – Rapid Tooling – Rapid Manufacturing, Carl Hanser Verlag, Munich, 2012.
[2] Pilipović, A.: Aditivna proizvodnja, Polimeri 33, 3-4, 2012, 134-135.
[3] Matthews. J.: 3D Printing Breaks Out of Its Mold. Physics Today, 64, 10, 2011, 25-28.
[4] Pahl, G.; Beitz, W.: Engineering Design, Springer-Verlag, Berlin, 1984.
[5] Reinthaler, M.A.: 3D CAD - CAM Concepts for Multiaxis Milling of Lasts and Moulds, Schuh-Technik + abc, 2, 1988, 102-104.
[6] E. Canessa, Fonda C., Zennaro M.: Low-cost 3D printing for science, education & sustainable development, ICTP - The Abdus Salam International Centre for Theoretical Physics, Trieste, 2013.
[7] Cimtech Prototype, Operator's Guide, Version 2, Cimtech-Microdynamics Inc., Trenton, Canada, 1989.
[8] Mijović, B.: Biomehanička analiza stopala u cipeli s visokom potpeticom, Koža i obuća, 10-12, 2012, 28-31.
[9] Mijović, B.: Biomehanička analiza stopala u sportskoj obući, Koža i obuća, 7-9, 2014, 21-23.
[10] Mijović, B., Agić, A.: Foot structure in ergonomic design// Ergonomis Congress of Portuguese Speaking Countries/Anabela Simoes (ur.). Funchal, Portugal: APERGO, 2004. c7c5, 1-6.
[13] http://www.ijesrt.com/issues%20pdf%20file/Archives%202013/july-2013/25.pdf (posjećeno 10.7.2015.)
[14] https://www.printuridigital.ro/print-3d (posjećeno 10.7.2015.)
[15] https://www.additivefashion.com/3d-printing-2014/printing-without-a-3d-printer/ (posjećeno 10.7.2015.)
[16] https://3dprintingindustry.com/2014/12/30/gyrobot-3d-print-insole/ (posjećeno 10.7.2015.)

ENGINEERING DESIGN COMMUNICATION FOR THE FASHION INDUSTRY

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ABSTRACT

Communication issues turn into a fundamental matter for all the businesses, especially for the extra-frequented ones, such as fashion. Since it becomes global, we've been developing huge, multi-product collections in order to succeed. Administration of the supply chain became a challenge that seeks creative solutions and creative workflow management, along with the confident applying of the expanding range of available technology tools.
In today's multi-media society plentiful fashion literature encourages our work, to submerge ourselves within a lot of tasks. To embrace with a glance relationship between diverse roles of the industry, such as designing, fashion engineering, buying and merchandising is a must. There is very competitive literature available on topics such as fashion engineering, PR and fashion marketing, along with the promotion and fashion writing. On the other side, there is a pretty low number of writings – even can say none – for a topic of fashion design and engineering communication, along with its specific issues typical of the present-day company environment and within contemporary production conditions. However, the value of the fashion professional know-how and success of any business, are in straightforward relation to the way how the inputs will be accepted, as well as the quality of the visually and orally communicated outputs.
This discussion paper seeks to highlight the core elements and key issues of the fashion design and fashion engineering, communication, with an aim to draw attention to a possible program within the fashion educating system.

Keywords: Fashion Engineering, Engineering Design Communication (EDC), Product Development

INTRODUCTION

Similarly to the other industry from the design to the production there are numerous tasks to be synchronized during the design and engineering process of a garment. The fashion and apparel industry is a fast-growing and highly influential sector where the communication issues take a great part of success. However, it is not enough highlighted during the studies and practice – and not even in the professional routine – how important these issues are. Even the fashion design and fashion engineering courses use to focus separately on to one or another field. Many professionals will be confused about the limits of their duties, and about the impact, their work will have on the efforts of their colleagues depending on its visual quality. These issues often cause serious tensions between the participants of the chain, since fashion has become global, and over bigger collections, with multiple product types, and wide product range have to be developed in order to succeed. Improvement of original and dynamic ideas in great part depends on the quality of the communication during the workflow.

The range itself can be developed and produced in different company environment today; even produced inland or outland multiple tasks must be organized within the supply chain, and communicated well in order to have the collection ready for successful performance.

Browsing the available literature a significant deficiency can be detected on this issues. Even considering that there are numerous excellent publications on the topic of fashion as communication (1), fashion marketing communication issues (2) and several outstanding publishing on topic of engineering communication (3) (4), we must consider that nearly no one is interested in analyzing the problem of communication between fashion designers and fashion engineers. An even more due to nowadays very popular idea of sustainable garment chain management, in which communication issues are fundamental, if attempting to maintain the sustainability in genuine.

INFORMATION EXCHANGE ISSUES WITHIN THE GARMENT SUPPLY CHAIN

Since innovative technologies and The Internet have offered endless opportunities, designing a collection means more than "creating some nice products". Demand for diversity, immediacy, interactivity became higher than even a decade ago: manufacturing conditions changed, qualitative and qualitative expectations became tight. Therefore, management of the garment supply chain has become a key issue in our fast performance industry, and some publishing offers quality solutions for its supervision. (6) Analysis of problematic causes certifies, that the gaps largely stemmed from poor communication. Thus must point out that results achieved during the designing, sampling, pre-production process in great part depend on the communication issues. It is important to underline sustainable issues of these occurrences as well (see material waste, waste of time and energy, loss of market, etc.). Failure, dissatisfaction, and poor quality is often addressed to the skills and experience of the professionals, without considering that they all have a different experience. Even being skilled, misunderstandings caused by not enough precise designs and technical documentation can result in a non-quality product range, or product samples different than expected.

ENGINEERING DESIGN COMMUNICATION (EDC) IN THE FASHION INDUSTRY

The lack of communication between the design team members is a topic of some detailed empirical studies (5) which report on the shortcomings of communication in the knitting industry. Authors constitute that lack of communication often poses difficulties during the realization process of knitted garments. We can consider this symptom is gathered present in the garment- and apparel industry too.
Communication[1] can be classified in different the types depending on the type encoding of the message, depending on its function and proposal, etc. It can be categorized into three basic types in general, which all have their advantages, disadvantages, and even pitfalls. These are:
Verbal communication, in which you listen to a person to understand their meaning;
Written communication, in which you read their meaning;
Nonverbal communication, in which you observe a person and infer meaning.
Designers use all 3 types of communication, for different manner, but most common they communicate written, since Engineering Design Communication (EDC) is a type of visual communication, which is a form of written communication. Engineering design is fundamentally a socio-technical activity; not because technical products ultimately are designed for human needs and purposes, but primarily because design activities involve immense communication and interaction between individuals and groups in more or less complex social settings. (8)
Design – in its meaning of drawing and sketching – is of essential importance in the process of product development. During the design process, the aim of the designer is to plan the visual and tactile Appearance of the garments. If this process is shared by more designers (e.g. head designer, junior

[1] As a process of exchanging information, ideas, thoughts, feelings and emotions through speech, signals, writing, or behavior that is possible to communicate in a number of ways that depend on the message and its context in which it is being sent. Choice of communication channel and style of communicating also affects communication.

designer, accessory designer, graphic designer, etc.) than the way of a presentation by applying of identical style became fundamental.

Proposal of fashion design can vary, as the intention and performance of the designer may be different in stages of the creation process. The manner of design will result in a diverse type of sketches, manual- and vector drawings. Depending on their place and purpose within the product design and product development process, they may vary – more or less detailed – and according to these they aren't meant for to use for the same purpose.

The process of the product development, a key stage of the product lifecycle, is a difficult process. Even the product is rather addressed to its designer, work of many others are necessary to create it. Participants involved in phases of the product development will contact with the product design in the form of worksheets created. Their value and style are to maintain the quality of the prototyping. Professionals will communicate with each other through the product documentation, completing it in accordance of their specialism. The transparency, clarity, and preciosity of the documents are straight related to the quality of the sample, and the final product.

Figure 1. Design worksheets, detailed product outlook (Ego Sport AW 07/08 – Edit Csanák ©2007)

Every successful collection lays on a strong emotional concept of the designer. Implementation of ideas into brand valued physical products is a critical phase of the design process. Even more difficult it is when multidisciplinary of international projects are made, and when the team players come from different backgrounds, with different experience, different routine, and work habits.

Figure 2. Samples for detailed design worksheets (Ego Sport SS 2008 – Edit Csanák ©2007)

Style of the designs hold a great deal in the rationale evolution of the product and are essential for understanding ‘the future look and intention of it. Some references agree (6), that the need to support EDC is becoming more important in the fashion industry, due Product Development is becoming more complex, and re-use of past designs became common in this area too. Members of the multi-disciplinary international design teams have dissimilar backgrounds and diverse expertise. Their relation to the product is not necessarily objective, but rather a subjective explanation upon a previous experience. These practices – depending on the company environment, the regular product range of the particular company, market and target audience, style of the collection, etc. – may result in the various interpretation of the designs, resulting different final look/quality/features of the garment.

Engineering Design Communication (EDC) is essential to nearly all the activities within the supply chain since design in some aspects is present in its diverse phases, not just those which are directly related to the product development. EDC provides different types of visual information to be shared between engineers. The ability to read them and to understand them is in big percent related with the professional knowledge and the visual education. Engineering Design has been described as highly multidisciplinary and collaborative workout, during which significant information are shared within a highly contextualized environment. (6) Successful teamwork in geographically distributed teams is highly dependent on tools that support communication. Such informal communication is responsible for much of the information flow in an organization.

The interaction between designers and technicians is badly managed in many fields of industry. Fashion industry often faces with this problem of not having well managed the transfer of visual and oral information, between the designs of the clothes and people who make them.

Figure 3. Samples for garment worksheet - Figure from textbook ‘Designing of Seasonal Collection’

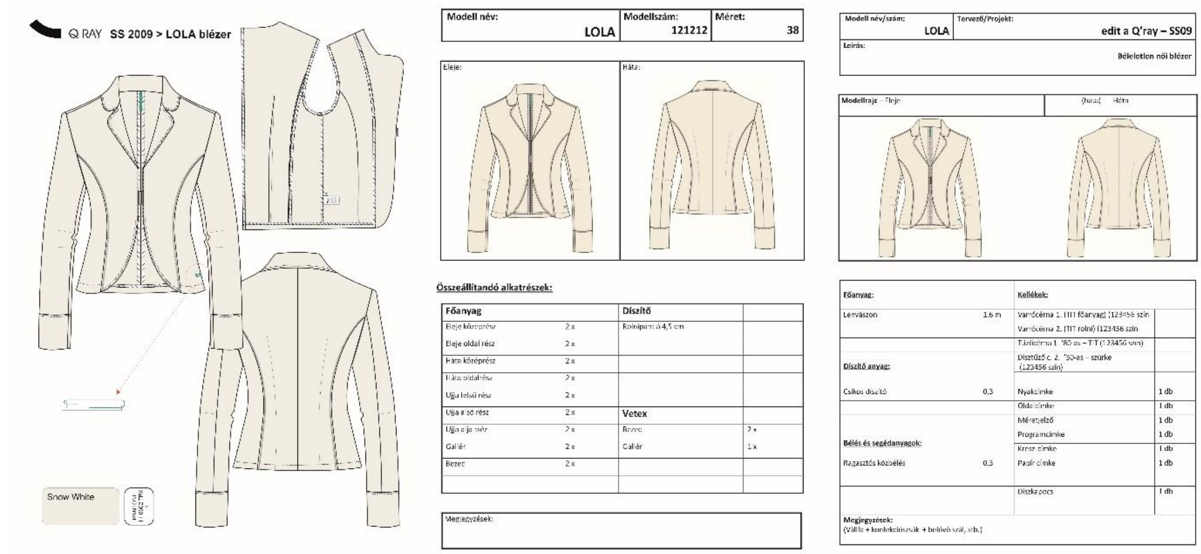

Figure 3. Samples for garment worksheet - Figure from textbook ‘Designing of Seasonal Collection’ by Edit Csanák, published for Fashion College students in 2015 (see the next figure)

Members of the design team have different backgrounds and diverse expertise. If the designs are specified imprecisely, incompletely, contradictorily an. They will read the design according to their previous experience, and will use technology similar apd inconsistently than technicians cannot understand and cannot interpret designer’s original intentionsplied at some alike design. These may result in garments very different from the original idea of the designer, and be the occasion on the dissatisfaction of designer and the management, in general.

Designers and technicians have different cognitive and perceptive attitudes. They aren't visually educated at the same level, and in fact: they aren't the same people. Designers trait their designs as a results of a complex mental process, which result are their designs – tangible manifestation of their talent. Visual appearance, structure and technical properties of the garment are clear and easy to understand for the creator. But it's not that easy for the technicians who are willing to understand the intentions of the designer in order to realize the garment; they have to make its pattern, to develop the garment construction, its technology, and to prepare the prototype/sample of entire product by applying different equipment and machines. All these have essential importance in the product development process. And each differently implemented sub-process can result in a product quite different than the expected. Consequently: it is essential for the participants to 'speak the same language'.

STUDY OF THE AVAILABLE LITERATURE AND FASHION METHODOLOGY

Classifying the fashion literature in general, two types of literature can be considered; references which are focus more theoretically onto fashion and design practice, and others with a more practical approach. Again others will analyze the relationship of the fashion design with economics, environmental factors of fashion industry, problems of resources and waste, safety and health considerations, and the impact of fashion in the future. Fashion as a field of design is also often discussed. On the popular page of a well-known publishing house[2] there are nearly 10 000 results on keyword 'engineering communication', and nearly 4000 articles which match search words 'fashion' and 'design'. Many works of literature attempt to analyze the role of fashion and clothing[3], demanding to explain what sort of meanings fashion and clothing may have, and how are communicated by clothing. (1) In term of planning theory these references study fashion from the aspect of the functions of the fashion products, highlighting their social, cultural, economic, documentary, etc. function.

[4]*Figure 4. Textbooks 'Designing of Seasonal Collection' (left) and 'Designing of Fashion Accessories' (right) by Edit Csanák, published for Fashion College students by the Hungarian National Labor Office, year 2015*

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[2] Esevier Ltd. Publishing House

[3] Clothing reproduces the society. Fashion, as a cultural phenomenon, can be analyzed in terms of a historical period, class, gender, and individuality.

[4] Analyzed from the same aspect, communicative aspect of the fashion products (or a collection) is giving continuous inspiration and topic to all the previous and contemporary fashion writings, from the fashion literature to magazines and fashion blogs.

A low number of contemporary literature is available which describes the process of designing, sampling, product development, and manufacturing. It constitutes a problem especially in the college level teaching since a great number of young people driven by the glamour of fashion industry start their studies each year in this type of education. Their aim is to get a job in the fashion market as fast as possible after a short-term training, willing' to improve their knowledge during the practice. Featured books (Figure 4.) provide essential information about the principles of fashion design, explaining the process of product development, by introducing the structural conditions and contemporary practice of the industry. Methods develop together with the industry requirements. Technical knowledge gained, doesn't match multiple conditions which the designers and fashion engineers will meet in routine. Individual techniques and methods, personal schemes, esthetical, professional, technological and practical knowledge will develop with the expertise. Successful oral and visual communication with colleagues, suppliers and consumers are especially necessary for success in a business today. (2)

PROPOSAL OF THE BOOK 'ENGINEERING DESIGN COMMUNICATION FOR THE FASHION INDUSTRY'

The goal of the book is to make the visual communication part of the problem-solving process more clear for designers and fashion engineers, based on the matter that efficacy of applying of the know-how is in straightforward relation with communication issues. Quality and success of the collective work in big percentage depend on how the entire tasks are managed, and how the complete process is communicated both visually and orally. Its aim is to encourage readers to embrace and submerge themselves within the diverse roles of designing, interpreting, and presenting fashion, which is so relevant in today's multi-media society, since results achieved during the design, sampling, pre-production and production process partly depend on communication quality of the chain actors.

A brief proposal of the book: 1. ABOUT COMMUNICATION IN GENERAL (Introduction; Concept, types, function, aspects; Visual communication). 2. ENGINEERING DESIGN COMMUNICATION (EDC): Engineering communication: theory, concept, functions; Importance of EDC in the fashion industry. 3. COMMUNICATION ISSUES DURING THE PRODUCT DEVELOPMENT. 3. PROCESS OF DESIGN (Design: meaning, aspects, theory; The role of the designer; Designer tools; Purposes of fashion design; Types of fashion drawing; Design documentation; Designer worksheets; garment worksheets and graphic worksheets: layout, image, technical characters, tools). 5. PROCESS OF FASHION ENGINEERING: Fashion engineering: meaning, aspects, theory; Fashion engineering tools; Purposes of fashion design; Types of fashion drawing; Documents of fashion engineering: layout, image, tools & trivia. 6. SYSTEMS OF INFORMATION EXCHANGE: Fashion information systems; Documentation: goals, types, methods. 8. ORAL COMMUNICATION. Etc.

CONCLUSION

This paper attempted to highlight lacking topics of communication between design and engineering. A challenge has been to point out the essential issues which will be detailed in further a publication. Its aim will be to fill in the gap between this two disciplines. Seek was to highlight the core elements of a program with an aim to develop awareness of the fashion education.

REFERENCES

1. **Barnard, Malcolm.** *Fashion as Communication.* Oxon and New York : Routledge, First edition 1996 (reprinted 2002 and 2008). ISBN 978-0-415-26017-6 (Hbk) 978-0-415-26018-3 (Pbk).
2. **Lea-Greenwood, Gaynor.** *Fashion Marketing Communications.* Chennai, India: Gill Sans std by MPS Limited, 2013. ISBN: 978-1-4051506-06.
3. **W. Knisely, Charles, I. Knisely, Karin.** *Engineering Communication.* Stamford, USA : Centrage Learning, 2015. ISBN-10: 1133114709 | ISBN-13: 9781133114703.
4. **Budapesti Műszaki Főiskola Rejtő Sándor Könnyűipari és Környezetmérnöki Kar.** *Mérnöki kommunikáció.* Budapest, 2009. Budapesti Műszaki Főiskola.
5. **Choi, Tsan-Ming Jason.** *Information Systems for the Fashion and Apparel Industry.* eBook : Elsevier Science, 2016. Series in Textiles, ISBN 9780081005804.
6. *Support for Informal Communication in Distributed Engineering Design Teams.* **P. Törlind, A. Larsson.** Annals of 2002 Int'l CIRP Design Seminar, Hong Kong, 2002.
7. *The Communication Bottleneck in Knitwear Design: Analysis and Computing Solutions.* **Eckert, Claudia.** Volume 10, Issue 1, Kluwer Academic Publishers, 2001-03., Computer Supported Cooperative Work (CSCW), pp 29-74. ISSN 0925-9724.
8. **Gopsill, James A. és Hamish C. McAlpine, Ben J. Hicks.** A Social Media framework to support Engineering Design Communication. [Online] 2013. [Accessed: 06. May 2016.] www.elsevier.com/locate/aei.
9. *Supporting communication between product designers and engineering designers in the design process of branded products: a comparison of three approaches.* **Rasoulifar, Golnoosh, Eckert, Claudia és Prudhomme, Guy.** Taylor & Francis Group Ltd, 2014., CoDesign: International Journal of CoCreation in Design and the Arts, 10., pp.: 135-152. ISSN 1571-0882.

GARMENT FOR CHILDREN AND ADOLESCENTS FROM TWO-DIMENSIONAL TO THREE-DIMENSIONAL

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ABSTRACT

In this article the author presents the technical transformation of the pattern of *construction and deconstruction* of the form, by elements of technique and execution that give a new dimension to clothing. A brief history of the evolution of the costume, from simple shapes to those exaggerated and return to smaller ones. The inspiration and concept of BI-TRI-BI collection in children and adolescents garments, is the story of plane material transformation in volume.

Keywords: garment, clothing, children, adolescents, two-dimensional, three-dimensional, shape, volume, pattern, origami.

INTRODUCTION

"In a world in constant transformation, creativity is a vital quality" [5] says Adina Nanu. The costume had always a narrative role, its creation basis being the change of the man's image of himself and had an important role in its individual and social identification.
The clothes were and remained a creative object, in its essence, defining for the man, its personality and its social status. The clothes define us and also lead us to a certain approach of life issues and a certain attitude and behavior.
They can be seen as a mask, as a camouflage with role of defense, consolidation and strengthening the sides and beautiful and harmonious aspects of the silhouette, but also of masking and hiding those less desirable and flattering aspects.
In the process of creation of clothes, the stage of the pattern construction is one of the most complex and it should be given special attention. A tailor designed and well done gives elegance and fluency to an outfit emphasizing the creation, the idea. The fashion design, says Antonela Curteza "requires a *visual, three-dimensional thinking*, comprissing ideas, developped elements and made in parallel, not separately"[6] associated with invention and innovation.

HISTORY

At its beginnings, the garment was a simple material in two-dimensional plan, which created volumes by draping, returning to its original shape. It followed the material geometrization, i.e. small cuttings which intensified the shape, without returning in two-dimensional plan. The costume began to receive highlighted and exaggerated shapes, disproportioned by occurrence of pattern, cutting lines of arching and sewing, geometrization of three-dimensional shape, so that the garment become an inoperative and discomfortable shell.
The patterns have become more sophisticated, with more details in the plan, and by transposition in material were created real three-dimensional geometric architectures with an emphasis on shape.
These issues regarding volumes included in the clothes require technical pattern knowledge and visual expression in discovering the infinite possibilities which could reach.

[5] Adina Nanu – ***Artă, stil, costum (Art, style, costume),*** Noi Media Print Publishing House, Bucharest, 2007, p. 292
[6] Antonela Curteza - ***Design, Design vestimentar noțiuni fundamentale (Design, Fashion Design, Fundamentals)***, Ankarom Publishing House, Iasi, 1998, p.26

The volumetric elements over time represented a real basis for increasing their knowledge by varying the components that form the clothes, especially the feminine clothes.
From the exaggerated shapes of the costume, it returns again to the simplicity of cut and reduced volumes. These oscillations of the shape, from two-dimensional to three-dimensional and back to two-dimensional, were a source of inspiration for designers who passionately seek to define their style, defying rules and trends and thus standing out.
Severe and voluminous silhouettes and the rigidity of historical costumes, created reluctance from the side of younger generations, reluctance to what is required and who have always wanted to decide their own destiny including how to dress. The evolution in clothing styles is also a result of the younger generation trend to overthrow the old canons, outdated, and imposed by society to parents.

INSPIRATION FOR THE COLLECTION

As Umberto Eco defines the architecture as “any type of design producing three-
dimensional constructions destined to permit the fulfilment of some function connected with life in society”, as well the fashion design is a form of culture and integration into society.

The design of clothes has its genesis in pattern technique. *Pattern Magic*, of the former teacher Tomoko Nakamichi from Tokyo’s Bunka Fashion College, it’s an example of skill in tailoring. Finding inspiration in nature and geometry, Tomoko Nakamichi managed to create beautiful clothing pieces with sculptural character. Their drapery is a game full of fantasy between light and shadow, and the pattern is a combination of two-dimensional and three-dimensional techniques.

il.1 

Figure1: Three-dimensional volumes

il.2 

Figure 2: Tomoko Nakamichi

The creations of the French designer Thierry Mugler, present a futuristic and geometric definition of the exaggerated femininity. Its linear silhouettes in rectangular shapes (triangle, square), are a source of inspiration for the transformation patterns through curves and straight lines into creations where the emphasis is on geometric volumes.

il.3 

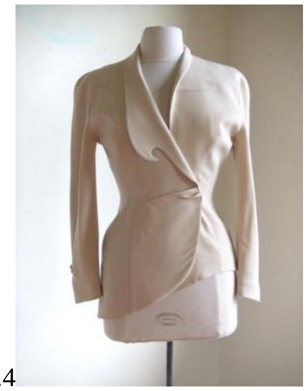
il.4 

Figure3: Thierry Mugler-designer 1980

Shingo Sato is the designer which impressed me most by his transformation techniques of pattern and spurred me to apply this work technique in my collection. Shingo Sato is a couture designer specialized in the technique called *Transformational Reconstruction*. For him each change of pattern, achieved by cutting the points that create volume, the tucks: bust, shoulder or arch, waist and hip, creates a new model, a new technical solution for volumetric reconstruction of the silhouette.

il.5 

Figure4: Shingo Sato

We found this attention to a volumetric reconstruction also to the artist Elena Minodora Tulcan who sees in this type of approach a new possibility of stylistic reconfiguration of the garment by the following way: „to deconstruct something that I previously built, with other reasons and means specific to art.”[7]

Fascinated by the volumetric game in the creation of clothing of great artists and technical solutions for obtaining these volumes through the design of the pattern, we gradually came to create our own patterns in which the emphasis is on new solutions to achieve some volumetric three-dimensional shapes.

[7] Elena Minodora Tulcan - ***Forme ale integrării stilistice prin veşmânt (Forms of stylistic integration by garments),*** Interart TRIADE Foundation Publishing House, Timişoara, 2009, p. 99

il.6 

Figure5: The first mold

il.7 

Figure 6:The second pattern of mold

il.8 

Figure7: Final product

Shingo Sato, constructs-deconstructs-reconstructs. His designs are in futuristic shapes with optical illusions, combined with the complexity of origami, with drapery, constructs flawless getting unexpected effects, creating an innovative fashion.

il.9  il.10 

Figure 8: Constructive technique of geometric shapes by cuttings in material

il.11 

Figure9: Wortex Technique

il.12 

Figure10: Origami Technique

Another artist that focuses on volume of the shape is Issey Miyake. The creation of the designer Issey Miyake expresses the freedom to create without restrictions or rules. His pieces are the result of a research, documentation and experiment process. From the beginning, the designer's creative process was based on the concept “a piece of cloth”, exploring the fundamental relationship between body and cloth that covers it. Thus, the artist created its own materials, combining traditional techniques with modern technologies. Issey Miyake creates ideas, doing things that have never been made so far, and through this process creates new clothing realities.

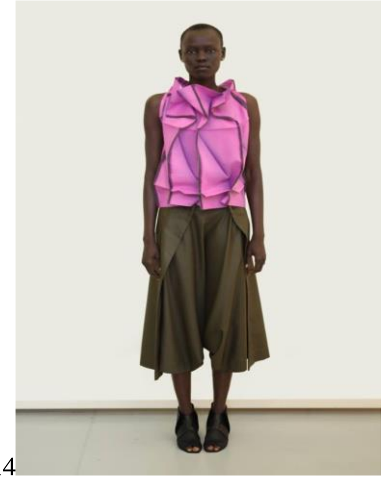
il.13  il.14 

Figure11: Issey Myake *Figure12: Issey Myak*

COLLECTION CONCEPT

BI-TRI-BI collection concept is the application in children and adolescents garments of a transformed pattern-mold, starting from the base pattern, to which we applied asymmetric volumes by *godets* or by applications of three-dimensional geometrical shapes, by *Transformational Reconstruction* technique of Shingo Sato, having a relation of morphological association and origami. BI–TRI-BI collection tells the story of the plane material transformation in volume. The clothes present an ethereal, innocent and complex world of the shape and volume exploration and also of the game with discrete shades of white and yellow.
The composition of collection has varied by alternating styles, from the simple, consisting of several elements, to complex. In making geometric shapes we used new cutting techniques and we created volumes in the material non-cut. Each piece of clothing has the name of the model which wears it and tries to capture its personality, specific to its age.
This transformation process is intuitive and we get to creative solutions unforeseen, discovered by chance, which gives freedom to the imagination in making garments, but without using knowledge of the tailoring, a working domain with exact calculations, you might not be able to produce a finite product. We can talk, in fact, about the technique of construction and deconstruction of shapes, by technique and performance elements that give a new dimension to clothing.
The idea from which we started was to create dresses for girls and adolescents, who have both the volume and shape, both on three-dimensional body and two-dimensional plan. Why we chose children as the target audience? Because nowadays the children's garments help to shape and develop their own personalities. Clothing creations can be understood as a way of plastic expression of the child.

Figure 13: BI-TRI-BI Collection

CONCLUSION

I consider necessary the awareness and respect for the individuality of children and adolescents, understanding the defining elements of their personality and in this context it is required a special attention to their specific clothing.

Interestingly, by the multitude of drawn lines through those tensioning points, you can create so many models by trial and error. What is fascinating about this work is the novelty of unexpected effects by construction-deconstruction-reconstruction, combined with the complexity of origami, the clothes being the result of a documentation and research process of the shape, combining traditional techniques with modern technologies, achieving true three-dimensional geometrical architectures with an emphasis on shape.

These models are to be transformed from molds into finished products, unique and wearable, because „ *The shape deconstruction* is a new way of life, a new *aesthetic*, which has many value and appreciation criteria.”[8] It is the idea from which I started in the execution of the collection, which is a result of the creative thinking, giving freedom to the imagination and improvisation, becoming a ”wearable experiment”.

Figure 14: BI-TRI-BI Collection

[8] Elena Minodora Tulcan - ***Forme ale integrării stilistice prin veşmânt (Forms of stylistic integration by garments)***, Interart TRIADE Foundation Publishing House, Timişoara, 2009, p. 186

REFERENCES

Books:
Adina Nanu – *Artă, stil, costum (Art, style, costume)*, Noi Media Print Publishing House, Bucharest, 2007
Antonela Curteza- *Design, design vestimentar noțiuni fundamentale (Design, Fashion Design, Fundamentals),* Ankarom Publishing House, Iași, 1998
Elena Minodora Tulcan - *Forme ale integrării stilistice prin veşmânt (Forms of stylistic integration by garments),* Interart TRIADE Foundation Publishing House, Timişoara, 2009
Umberto Eco – *Istoria frumuseţii,* traducere din limba italiană Oana Sălişteanu, Editura Enciclopedia RAO, Bucureşti, 2005
Ilustrations:
Illustration: 1 http://99que.blogspot.ro/2013/11/tomoko-nakamichi.html
Illustration: 2 https://www.pinterest.com/pin/296815431668402742/
Illustration: 3 https://www.pinterest.com/pin/328903579007578643
Illustration: 4 https://www.pinterest.com/pin/48765608441130650/
Illustration

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Illustration: 14 https://www.pinterest.com/pin/118782508894069721/

PARTICLE SWARM OPTIMIZATION FOR PORTFOLIO MANAGEMENT

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ABSTRACT

Portfolio management problem is a real valued variables optimization problem with quadratic objective function and linear constraints. Therefore, portfolio management is a multi-objective optimization task of two conflicting objectives: profit maximization and risk minimization. The problem is to determine an efficient frontier, a set of pareto optimal solutions, since both objectives cannot be simultaneously achieved. If a portfolio cannot provide a better profit for a given risk value by adjusting investment weights, then that portfolio is on the efficient frontier. In this paper, a particle swarm optimization based solution approach is applied to efficiently solve portfolio management problem.

Key words: portfolio management, particle swarm optimization

INTRODUCTION

Portfolio optimization problem can be easily solved with standard optimization solvers in its basic form. However, it is often difficult in practice to invest small amounts into many different assets. Therefore, it is necessary to consider cardinality constraints such as lower/upper limits to the weights of assets and enforcing the exact numbers of assets to be held in the portfolio for a realistic portfolio selection. Thus, the problem is hard to handle computationally. Markowitz mean-variance model (Markowitz, 1952, 1959) is extended to nonlinear programming model by Chang, Meade, Beasley, and Sharaiha (2000) and the mathematical formulation of cardinality constrained portfolio optimization problem is given as follows:

Parameters: N represents the number of assets available, μ_i represents expected return of asset i, σ_{ij} represents covariance value between asset i and asset j, R^* represents expected return, K is the desired number of assets, ε_i is the minimum weight of asset i. and δ_i is the maximum weight of asset i.

Decision variables: w_i is the weight of asset i that is held in the portfolio while z_i is a binary variable which is equal to 1 if the asset i is held in the portfolio, 0 otherwise.

$$min \quad \lambda\left[\sum_{i=1}^{N}\sum_{j=1}^{N} w_i w_j \sigma_{ij}\right] - (1-\lambda)\left[\sum_{i=1}^{N} w_i \mu_i\right] \tag{1}$$

$$\sum_{i=1}^{N} w_i = 1 \tag{2}$$

$$\sum_{i=1}^{N} z_i = K \tag{3}$$

$$\varepsilon_i z_i \le w_i \le \delta_i z_i \qquad i = 1, \dots, N \tag{4}$$

$$z_i \in (0,1) \qquad i = 1, \dots, N \tag{5}$$

$$0 \le w_i \le 1, \qquad i = 1, \dots, N \tag{6}$$

$$0 \le \varepsilon_i \le \delta_i \le 1, \qquad i = 1, \dots, N \tag{7}$$

Equation (1) minimizes risk while maximizing expected return for different values of λ parameter that is linearly increased from 0 to 1. Equation (2) ensures that the sum of asset weights is equal to 1 while Equation (3) guarantees that exactly K assets are held in the portfolio. Equation (4) imposes the lower and upper limit restrictions for weights of each asset. Equation (5), Equation (6) and Equation (7) defines variable domains.

METHOD

Particle swarm optimization (PSO) method, firstly introduced by Kennedy and Eberhart (1995), is a metaheuristic approach that is based on swarm intelligence concept. Scientists observed the social behaviors of birds and fishes during their hunt for food. Their findings show that birds/fishes adjust their speed and position considering both their own and others' experiences. In PSO technique, every bird or fish, called as a particle, tries to converge an optimal solution by moving from one position to another with a speed in the multi-dimensional solution space. The behavior of each particle is a compromise between the individual memory and group memory. PSO, is firstly applied to portfolio optimization problem by Cura (2009). Zhu, Wang, Wang, and Chen (2011) and Golmakani and Fazel (2011) proposed PSO based solution approaches and compared against genetic algorithm (GA) technique. Sun, Fang, Wu, Lai, and Xu (2011) proposed a discrete version of PSO and compared with continuous PSO, GA and classical optimization solvers such as LOQO and CPLEX. Deng, Lin, and Lo (2012) obtained better results with their proposed PSO approach compared to other PSO methods in the literature. Corazza, Fasano, and Gusso (2013) added a penalty function to PSO and improved the algorithm performance. In this paper, a PSO algorithm inspired by Deng, et al. (2012) is proposed as given in Figure 1.

Algorithm: Particle Swarm Optimization
Input: Data (R_i, VC_{ij}) and parameters $(R_i, VC_{ij}, K, \varepsilon, E, ps, c_1^{min}, c_1^{maks}, c_2^{min}, c_2^{maks}, Iw_{min}, Iw_{maks}, IT)$
Output: H
S: The set of assets
N: Number of assets available
ps: Population size
W: The set of portfolio weights
POP: Population matrix
VEL: Particle velocity matrix
E: number of λ
IT: number of iterations
H: Set of pareto optimal solutions
Start
$H = \emptyset$
$e = 1$
Repeat
  $\lambda = (e-1)/(E-1)$
  $W_i = \varepsilon + r(1-\varepsilon), \quad i = 1, \dots, ps \quad \forall W_i \in POP$
  $W_i^{rep} \leftarrow repair(N, K, S, W_i) \quad i = 1, \dots, ps \quad \forall W_i \in POP$
  $POP = \{W_1^{rep}, \dots, W_i^{rep} \dots, W_{ps}^{rep}\}$ /*randomly generate an initial population*/
  $PBEST \leftarrow POP$ /*save particle positions in the population*/
  $PBEST \leftarrow POP_{en\_iyi}$ /*save best position of the particles*/
  $iteration = 1$
  Repeat
    $c_1 = (c_1^{min} - c_1^{maks}) iteration/IT + c_1^{maks}$
    $c_2 = (c_2^{maks} - c_2^{min}) iteration/IT + c_2^{min}$
    $Iw_{iterasyon} = (Iw_{maks} - Iw_{min})(IT - iteration)/IT + Iw_{maks}$
    $VEL_{sj} = VEL_{sj} Iw_{iteration} + c_1 r(PBEST_{sj} - POP_{sj}) + c_2 r(GBEST_{sj} - POP_{sj}), \quad s = 1, \dots, ps \quad j = 1, \dots, N$
    $POP_{sj} = POP_{sj} + VEL_{sj} \quad s = 1, \dots, ps \quad j = 1, \dots, N$
    $POP_s \leftarrow Repair(N, K, S, POP_s)$
    $\{R^*, V^*, f_s\} \leftarrow \text{evaluate}(POP_s)$
    If $f_s < f_{PBEST_s}$

```
            PBEST ← POP_s
        If f_{POP_{sn_ty1}} < f_{GBEST}
            GBEST = f_{POP_{sn_ty1}}
        iteration = iteration + 1
    Until iteration = IT
    H_e ← GBEST,  e = 1, ..., E
    e = e + 1
Until e = E
Stop
```

Figure 1: Particle swarm optimization algorithm

EXPERIMENTAL RESULTS AND DISCUSSION

Five different capital market indices drawn from around the world (Chang, et al., 2000); namely, Hang Seng (Hong Kong), DAX 100 (Germany), FTSE 100 (UK), S&P 100 (USA) and Nikkei 225 (Japan) are used for testing the proposed solution approach. In the literature, three performance measures are widely performed (Cura, 2009; Sadigh, Mokhtari, Iranpoor, & Fatemi Ghomi, 2012)in order to calculate the errors between heuristic frontier and the standard efficient frontier: Mean Euclidian Distance (MED), Variance of Return Error (VRE) and Mean Return Error (MRE). The equations (9), (10) and (11) represent these performance measures, respectively. Let $(v_i^s, r_i^s, i = 1, \dots, 2000)$ represent the risk and return values on the standard efficient frontier and $(v_j^h, r_j^h \quad j = 1, \dots, E)$ represent the risk and return values on the heuristic efficient frontier obtained by the algoritm while $\left(v_{i_j}^s, r_{i_j}^s\right)$ represent the closest points on the standard efficient frontier to heuristic frontier $\left(v_j^h, r_j^h\right)$.

$$i_j = \underset{i = 1, \dots, 2000}{argmin} \left(\sqrt{\left(v_i^s - v_j^h\right)^2 - \left(r_i^s - r_j^h\right)^2}\right) \quad j = 1, \dots, E \tag{8}$$

$$\text{MED} = \left(\sum_{j=1}^{E} \sqrt{\left(v_{i_j}^s - v_j^h\right)^2 - \left(r_{i_j}^s - r_j^h\right)^2}\right) * \frac{1}{E} \tag{9}$$

$$\text{VRE} = \left(\sum_{j=1}^{E} 100 \left|v_{i_j}^s - v_j^h\right| / v_j^h\right) * \frac{1}{E} \tag{10}$$

$$\text{MRE} = \left(\sum_{j=1}^{E} 100 \left|r_{i_j}^s - r_j^h\right| / r_j^h\right) * \frac{1}{E} \tag{11}$$

Results obtained by PSO for all data sets with different K values is reported in Table 1. Efficient frontiers obtained by PSO on Hang Seng, DAX 100, FTSE 100, S&P 100 and NIKKEI 225 are demonstrated in Figures 1-5, respectively.

Table 1: Results obtained by PSO for all data sets with different K values

	MED	VRE	MRE
K	*Hang Seng (Hong Kong)*		
5	0.0000	0.8251	0.3983
10	0.0001	3.3796	0.8920
20	0.0005	27.1386	2.2392
	DAX 100 (Germany)		
5	0.0001	4.1655	0.6447
10	0.0001	14.8508	0.4709
20	0.0002	35.2857	0.3115

	FTSE 100 (UK)		
5	0.0000	2.7721	0.0867
10	0.0000	4.2943	0.3198
20	0.0001	16.1810	0.2937
	S&P 100 (USA)		
5	0.0000	6.6976	0.2270
10	0.0001	5.9751	0.6016
20	0.0002	22.2402	0.5836
	Nikkei 225 (Japan)		
5	0.0000	4.6771	0.3462
10	0.0000	2.1852	0.6590
20	0.0002	21.9461	0.8255

MED: Mean Euclidian Distance, VRE: Variance of Return Error, MRE: Mean Return Error

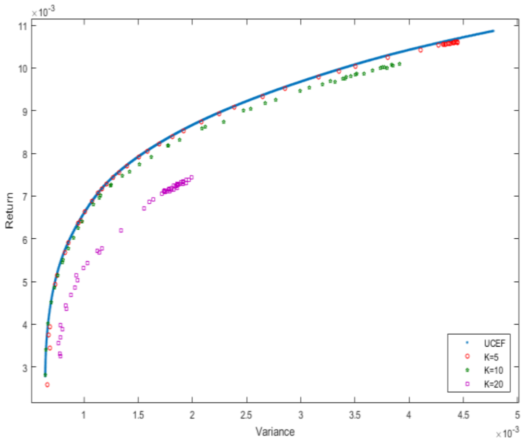

Figure 1: Efficient frontier obtained by PSO on Hang Seng data set for different K values

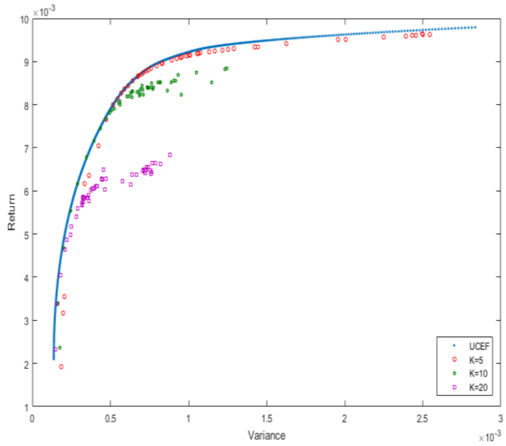

Figure 2: Efficient frontier obtained by PSO on DAX 100 data set for different K values

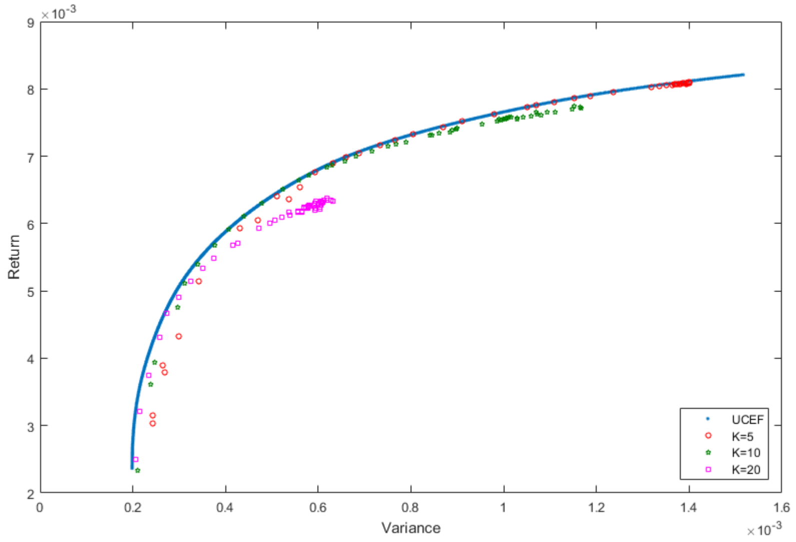

Figure 3: Efficient frontier obtained by PSO on FTSE 100 *data set for different* K *values*

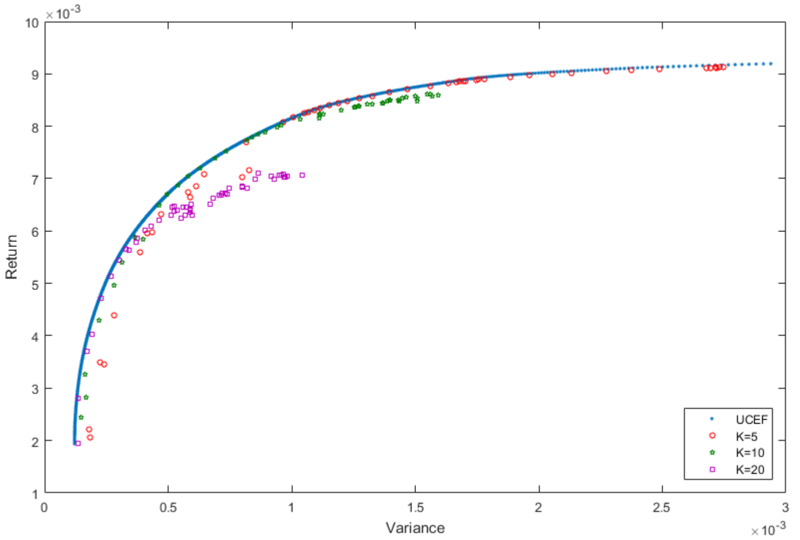

Figure 4: Efficient frontier obtained by PSO on S&P 100 *data set for different* K *values*

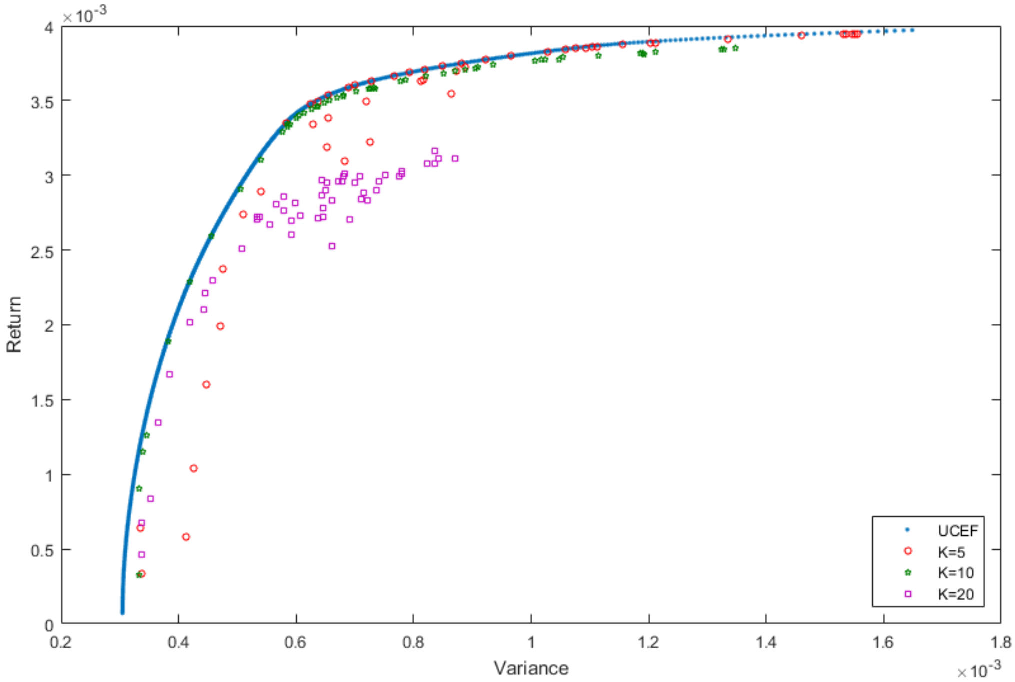

Figure 5: Efficient frontier obtained by PSO on NIKKEI 225 data set for different K values

CONCLUSIONS

In this paper, particle swarm optimization method is applied to solve portfolio management problem. Computational results confirm that this method is a useful tool for obtaining an efficient frontier with less error.

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REFERENCES

Chang, T. J., Meade, N., Beasley, J. E., & Sharaiha, Y. M. (2000). Heuristics for cardinality constrained portfolio optimisation. *Computers & Operations Research, 27*, 1271-1302.
Corazza, M., Fasano, G., & Gusso, R. (2013). Particle Swarm Optimization with non-smooth penalty reformulation, for a complex portfolio selection problem. *Applied Mathematics and Computation, 224*, 611-624.
Cura, T. (2009). Particle swarm optimization approach to portfolio optimization. *Nonlinear Analysis: Real World Applications, 10*, 2396-2406.

Deng, G.-F., Lin, W.-T., & Lo, C.-C. (2012). Markowitz-based portfolio selection with cardinality constraints using improved particle swarm optimization. *Expert Systems with Applications*, *39*, 4558-4566.

Golmakani, H. R., & Fazel, M. (2011). Constrained Portfolio Selection using Particle Swarm Optimization. *Expert Systems with Applications*, *38*, 8327-8335.

Kennedy, J., & Eberhart, R. (1995). Particle swarm optimization. In *Neural Networks, 1995. Proceedings., IEEE International Conference on* (Vol. 4, pp. 1942-1948 vol.1944).

Markowitz, H. (1952). Portfolio Selection. *The Journal of Finance*, *7*, 77-91.

Markowitz, H. (1959). *Portfolio Selection: Efficient Diversification of Investments*: Yale University Press.

Sadigh, A. N., Mokhtari, H., Iranpoor, M., & Fatemi Ghomi, S. M. T. (2012). Cardinality constrained portfolio optimization using a hybrid approach based on particle swarm optimization and hopfield neural network. *Advanced Science Letters*, *17*, 11-20.

Sun, J., Fang, W., Wu, X., Lai, C.-H., & Xu, W. (2011). Solving the multi-stage portfolio optimization problem with a novel particle swarm optimization. *Expert Systems with Applications*, *38*, 6727-6735.

Zhu, H., Wang, Y., Wang, K., & Chen, Y. (2011). Particle Swarm Optimization (PSO) for the constrained portfolio optimization problem. *Expert Systems with Applications*, *38*, 10161-10169.

GLOBALISATION OF FASHION, SOCIAL PATTERNS AND LOSS OF PERSONAL IDENTITY

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ABSTRACT

The aim of this paper is to research the relation between the individual identity and the way clothing expresses it into an existential space, dominated by the supremacy of image, in which the fast rhythm of events determines social interactions established, mostly, only at the visual level of appearances. Today, fashion is defined through the universality of the phenomenon, as it takes hold of more and more domains of the socio-cultural life (design, architecture, media, literature, travel, cinema). Therefore, clothing becomes one of the most relevant ways of expressing, in human interaction.

Keywords: fashion, globalization, personal identity, social pattern, communication.

INTRODUCTION

In an existential context defined by standardizing the masses under the influence of globalization, the trend of individualization of person is a theme of research in theoretical studies and visual arts. Series of contemporary concerns are being developed and their motivation derives from one's necessity to assert the unique identity and due to the desire to express it during social interactions.

After a long while of individual identity subordinated to the collective models, the democratization of society and, implicitly, the phenomenon of fashion, causes the appearance of some new research and creation topics. These topics are built around the process of identifying the means by which individuals develop their ability to communicate data about themselves, thus proclaiming the liberty and the statute of being unique, with a distinct personality.

The popularity of the trends towards individualization and originality ”by all means” has sometimes led to superficial approaches, by which any feature of a person acquires value only by its degree of uniqueness. An analysis of the main ways of expressing individual identity is required in the current socio-cultural context, that tends to put in use the universality at the expense of individuality.

GLOBALOSATION AND UNIFORMIZING OF FASHION

Although we live in democratic societies and talk about democratizing of fashion, free elections that individuals do without being constrained by the social patterns, dress codes or pressure of the means of promoting fashion, individuals are largely manipulated to choose for themselves standardized forms of expressing their identity and impersonal collective clothing.

Although fashion trends should be seen as a set of stylistic directions that individuals can voluntarily adopt or reject, sometimes they are understood as strict rules that one must comply, regardless the psihological specifics of each consumer, cultural local traditions or other social features.

This phenomenon of orientation and manipulation of masses in common directions determines homogenising individuals in terms of image, clothing and denying the individuality in favor of belonging to the global fashion directions. Contemporary society tends to promote certain ***social patterns*** as appropriate and to often marginalize attempts to dress, behave or think outside the imposed limits.

Figure 1: Thom Browne, Spring 2013 Menswear

Between what fashion phenomenon assumes through its function of communication of the identity of individuals and how quickly trends are changing certain contradictions arise. Although we claim that clothes, accessories and other consumer goods are symbols of personal identity, we come to change so often the objects that define us to the level of social interaction and in the relationship with ourselves, that there is no time to impregnate them with anything that could be considered a *personal touch*.

Globalization of fashion has several negative effects on the process of expressing the individual identity within social interactions. Globalization is suffocating traditions, homogenizes tastes and ideals of beauty and equalizes the individual aspects. It also emphasizes the development of international brands to the detriment of local ones, by adopting the same trends globally. Clothes end up confined to their value as objects of consumption and do not communicate any information about their bearers, but only about their manufacturers.

The rhythm of changing trends is so alert, that those who are true victims of this phenomenon do not have enough time to invest personal values or attachments in their goods, so that those become only superficial means of integrating the individuals in the general social spirit, or at most - symbols of collective identity; in any case –in a too small extent - real expressions of individual personality.

However, we can consider that personality, taste, personal value interfering the process of social communication that becomes almost robotic and impersonal, through the decisions that individuals take when they choose to follow certain fashion trends or certain items of clothing. Of the many trends generated in a season, individuals choose to follow only certain aesthetic directions, choices that actually combine the collective taste with the individual one in a social image that speaks about how quickly global fashion trends can produce the harmful effect of neutralizing one’s social identity, cancelling most of the aspects of personal identity related to local culture and tradition.

In the current social context, clothing is often incompatible with the wearer's physical and spiritual structure. The need to belong to a group is one of the features that define individuals, but often, due to the desire of gaining acceptance and a favorable image at a social level, they tend to suppress their own values and tastes in order to feel integrated. Although it is supposed that one’s clothes and image should be in harmony with his personal data (age, silhouette, social status, concerns) we are often witnesses of reconfiguration and disguising these authentic data under the shell of standardized appearances, that are, most of the time, inadequate to the wearer.

Clothing, along with accessories, makeup, hairdressing and attitude, can create illusions, false appearances, intentional or accidental distortion, can mislead the viewer in terms of age, social status or silhouette of the wearer. We want our clothes to make us look younger, more fit or richer and much of our clothing choices are concentrated around revealing the ideal ego, revealing what we want to be and not necessarily what we are.

At the level of social groups, fashion has the aim to establish rules, behaviors and values, and in relation to the process of homogenizing the individuals by clothing, these properties of the phenomenon are becoming increasingly obvious.

In the absence of regulatory character of fashion and aesthetic norms accepted in the communities, the phenomenon of fashion would be quite chaotic and would probably no longer be a concern of individuals in a society where every fashion image would be considered agreeable.

Figure 2: Thom Browne Menswear 2013

Although some contemporary analysts consider that in the past decade we witness the development of such a large number of trends that anything seems to be considered fashionable, social reality shows us different standards of assessment clothing and behavior. In a society where any clothing image would be appreciated, even if it is considered ”*into fashion*” trends or not, the social patterns, clothing codes and critical judgments over the individuals dressing and behaving choices, would be useless, would make no sense. We would no longer talk about *fashionable* or *unfashionable*, *beautiful* or *ugly*, *harmonious* or *discordant*, and the social phenomenon of fashion would no longer exist.

FASHION TRENDS OPPOSING GLOBALISATION

In order to reestablish the value of the individual’s authenticity it is not required the complete annihilation of patterns and social norms, but to change the way that individuals assume fashion trends that usually don’t fit to their personality.
What happens to the clothes ”*out of fashion*” but which contain, beyond style, shape, color or texture - considered outdated by fashion, memories, moods or interpersonal connections? Aiming to combat the negative effects of globalization and mass consumption, fashion designers have determined the rise of some niche social trends, stressing the importance of the relationship between the wearer and his clothing, considering that nonverbal messages communicated through fashion should speak about the authentic identity of the consumer.

A sub-cultural trend that tends to have a-temporal value is *retro/vintage fashion*, which has its place in the contemporary scene in different situations. Social stratification generated by different financial possibilities of individuals is still one of the main factors that determine clearly differentiation between the rich ones and those with a humble financial situation by their inability to keep up with fashion trends. Outmoded clothes in this context are primarily an expression of social reality beyond the apparent superficiality of fashion and clearly attests economic problems of certain backgrounds.
On the other hand, vintage or second hand products became fashionable in recent decades, by global promoting the integration of old clothing pieces in one’s wardrobe along with the ones that follows the latest trends. This phenomenon can be analyzed in street fashion and, possibly, in the stylistic proposals advertised in magazines and specialized websites.

Another social group that follow this trend is made of individuals who consciously choose to maintain a retro style and a classic wardrobe, being paradoxically considered, in today's society, either conservative, either eccentric.

This phenomenon is still a niche one, and it mainly applies to those with a genuine concern for their image, those who deliberate choose a visual identity in contrast with global trends. In this category can be integrated those who are still representing in the contemporary society subcultural movements originating from the 60s or the 70s (hippie, punk, goth, rave, etc.), or those who are developing a great appreciation for certain old styles from the history of costume and adopt clothes inspired from the fashion of the past.

Figure 3: Adrian Oianu - Carpathian Elves

Another trend that aims to combat the effects of globalization is *Slow Fashion* - as a social manifesto proposing slowing the process of consumption, recycling clothing items and customize clothing with personal visual symbols and immaterial values, against **uniformizing individuals in a mass of people.**

The *ethnic fashion trends* have a similar purpose, by introducing elements of traditional costumes in contemporary fashion in order to revalue local cultural symbols and fight against globalization.
Multiculturalism - a trend that combines aesthetic elements and symbols from various cultures, without removing their character by uniformising (as globalization tends), but rather enhances their individual value through unique combinations.

Figure 4: Lana Dumitru – Merry Cemetery 2013

As about stereotyping behavior and clothing identity, *The Theory of Collective Selection*, of the american sociologist Herbert Blumer, explains how fashion spread in terms of *Symbolic Interactionism*. The author considers that fashion creates social patterns not only in the sphere of clothing and adornment practices, but also in many other spheres of human existence that it seizes. Fashion has the ability to affect most areas of cultural and social life. Blumer also attest the normative character of fashion and believes it sets the limits of what is agreeable or disagreeable, is indifferent to criticism, involves absorbing of individuals and names ”non-conformists” those who do not obey and do not follow the course of fashion.

On the other hand, the author does not confirm the issue that fashion would be a chaotic phenomenon, where individuals are attracted by various forms of manipulation; but rather that it is a very calculated process. In his view, a person keen in fashion is usually very careful and aware of his own choices, taking care at all times to stay within the stylistic limits imposed by fashion. The effect of uniformization that fashion has on individuals is the most obvious negative aspect of the globalization phenomenon in Blumer’s opinion.

In other words, if fashion was "*a visible measure of unanimity*", it would prove to be an extremely disorganized and fragmented phenomenon. Fashion aims to order and hierarchy the dynamic aspects of society and that is why it becomes a social phenomenon that determines uniformity of individuals, directing them to certain limits and social patterns through the aesthetic and behavior directions that it is generating in social groups.

The implementation of an extremely broad set of aesthetic and social directions allows individuals to juggle into the process of *self-definition*. As fashion is a constant in social life just by its permanent change, individuals enslaved by its fluctuations get to reconfigure their visual identity and appearence permanently, trying to adapt to the newest fashion trends.

Beyond the aim to equalize individuals and to suppress individuality, assuming that the existence of so many fashion and behavior trends in the contemporary society allows individuals freedom of choice and helps them to overcome social patterns, the fact that people tend to join the general trends became in itself a fashion, a social pattern that evens personalities and issues of personal identity.

Figure 5: Thom Browne, Spring 2013 Menswear

The american designer Thom Browne is one of the fashion designers that tackles the issue of uniformity in its collections.

The performance made by Thom Browne to present its *Spring 2013 Menswear* collection can be seen as a metaphor for the handler and unifying phenomenon of contemporary fashion. Dozens of masked mannequins in oversized silver pipes were each positioned symmetrically on hotspots of shoes stacked neatly on the green lawn. The personal identity of each participant was hidden under identical makeup, silver face, goggles and helmet.
Then, the image of a uniform society, standardized under forms that fully camouflaged individual identity of each pawn was changed in an instant – revealing us the unseen side of individuals - the personal one.
Individual identity - as a saturated colored collection, playful through the associations of textiles and prints, full of story - like a social manifesto.

Figure 6: Thom Browne, Spring 2013 Menswear

UNIFORMS WORN VOLUNTARILY

Along with uniforms required in certain social institutions there are also uniforms worn willingly. Uniforms' influence in contemporary fashion trends is confirmed in the current urban streetscape and in the proposals of major fashion houses.At the same time, globalization and the effects of internationally spread of fashion creates uniformity in appearance through the implementation of the same fashion trends, and the *same ready to wear* collections internationally.

In this category stay the informal uniforms of collective social groups that develop common clothing images, emblematically for the group they belong to. In this context, the need to identify with others is satisfied.
Written or unwritten dress codes, rooted in the collective conception as true rules to follow, are, in the same time, a form of standardization of clothing across groups. In a democratic society, individuals tend to oppose the idea of wearing uniforms, but without realizing that, becoming victims of fashion and its trends, they end up by also creating a uniform form of clothing image.
Among the motivations that may underlie the opposition of individuals towards adopting the uniforms, we can determine the following: because the messages expressed by uniforms do not match with their beliefs, because they restrict freedom of expression, because they cancel the opportunity to be noticed by a custom clothing, because they do help them from a physical point of view, because they do not match with their tastes or because they are not practical enough.
Although the meanings transmitted by uniforms are considered by some authors as rigid and clear both for the viewers and the wearer, a clothing image does not always transmit the same messages, even in the case of a precise dress code.
Uniforms can be interpreted in different ways, during symbolic communication, by distinct receptors and can also be handled by wearers to express exactly what they want to communicate.Thus, regardless the message suggested by those who create uniforms in certain institutions, the wearers can reconfigure their image in a certain measure, according to their own ideas.

We can consider that regardless the rigidity with which certain dress codes are intended to be imposed on individuals, they have certainly freedom to communicate, in social interactions, only the messages that they wish to associate with their own image, and the ways of transforming the meanings of clothing are multiple.
Variability of uniform dress codes and the influence of the wearer and receptors on the carried messages by a visual image is also extremely relevant. Some authors believe that most of the symbolic visual codes of uniforms refer to what they represent in their idealized version and not necessarily what they really stand for their wearers. Deviation from these codes of uniforms is a reality that exists through a variety of reasons. Young people who needed or still need to wear uniforms are constantly trying to put their mark on these strict codes as a form of rebellion and nonconformity to any imposition.
By reinventing or minimal changing the uniforms they can express their personality in some way. The ways of acting on uniforms in different contexts are different, from shortening sleeves or skirts to narrowing jackets, rolling up shirt or pants, knotting atypical the ties or scarfs, accessorizing outfits with diverse jewelry, etc. The limits of these transformations is varied, from subtle, almost imperceptible changes, to real riots publicly expressed opposition to wearing uniforms.

CONCLUSION

As a way of expressing the individual identity - psychological and social one, clothes can be a transparent mean of communication of the inside reality of individuals, or can be a tool for reconfiguring it, by disguising inner universe and generating a false image, premeditated and sometimes lacking authenticity under the influence of fashion globalization.
Clothes are *the mask* or *the mirror* of one’s identity, in terms of phisical identity or in terms of social identity, because clothes have the ability to hide or to reveal parts, to advantage or disadvantage individuals, because clothing is a tool through which individuals can set up real or imaginary identities and can became someone else all the time.

REFERENCES:

BARTHES, Roland, *The Language of Fashion*, Bloomsbury Academic, London, 2013
BLUMER, Herbert, *Fashion: From Class Differentiation to Collective Selection* în *Sociological Quarterly*, University of California, Berkeley
BOVONE, Laura, *Fashion, identity and social actors - Identities through fashion: a multidisciplinary approach*, Berg Press, London, 2012
DAVIS, Fred, *Fashion, Culture and Identity*, The University of Chicago Press, London, 1994
HAȘEGAN, Miruna, *Modă și Manipulare: despre comunicarea prin costum*, Performantica, Iași, 2013
LE BON Gustave, *Psihologia mulţimilor*, Antet XX Press, București, 2004

RESEARCH OF ORGANIZATIONAL SETTINGS IN PRODUCTION OF TEXTILE AND FASHION CLOTHES – POSITIONING ON THE MARKET

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ABSTRACT

Today's fashion markets are such that one must respond to their challenges in a very short time, as shown by the analysis of the market as a decline in large and inflexible composition. On the other hand, small and medium enterprises that are more flexible and can quickly and efficiently respond to inquiries in a very demanding market are rising. The textile and clothing industry, fall into viable sectors that are specifically covered by the changes of the global market. Production must be appropriate to the market that can absorb it. The production time, trends, fashion reactions, market response are getting shorter lately. In order of getting a good position on the market, company must meet the requirements in terms of organizational settings. The vision of the textile and clothing industry is based on constant technological advancements, human resource and organizational restructuring, specialization and market competitive product manufacture with higher shares of added value, and it's concretized by the specific development goals. The strategy of development of the textile industry focuses more on the qualitative adjustment to the dynamic market, technology and technical and organizational changes, and less on quantitative growth of production. Therefore, the development strategy is based on development objectives of consistent market positioning, according to its abilities and skills, technology transfer and innovation, and unification of companies and their network connections in order to improve negotiating skills. The expected result of the development strategy in the area of organizational adjustments imply achieved partnership and internalized synergy effects of organized clustering. This paper analyzes and explains some of the prerequisites for good positioning on the market, such as organizational settings within production that increase productivity and competitiveness on the market. The results of the implementation of organizational settings with the 20 keys method on women's fashion clothing of varying complexity and design are given. Obtained results show that better organization of jobs achieves greater productivity, higher quality of work pieces, lower production costs, higher company profits and a better position on the market.

Keywords: textile, fashion wear, organization, production, market positioning.

INTRODUCTION

Production of textiles and clothing is one of the oldest and the world's largest industrial activities and has an important role in the total world production, employment potential and trade in many developing countries. The fundamental feature of the production of textiles and clothing is low capital intensity that refers to the fact that this industry is harder to adjust to the new global trends. Production of textiles and clothing is labor intensive industrial activities where labor costs are very important for growth and development. The major changes in the direction and scope of the global production of textiles and clothing experienced during the 1990s, when many companies relocated parts or entire production in areas with lower costs in order to maintain competitiveness. Most often are relocated in the countries with low labor costs (Asian countries), where are usually sutured imported textile materials and exported finished products.

The largest exporters of clothing in the world are China, the member states of the EU, Hong Kong, Bangladesh and India, while the biggest importers of clothing are the member states of the EU, the USA, Japan, Canada and Russia. The biggest world consumers of textiles are Asia, the USA and European countries although the most of these products are imported in these countries [1].
For inclusion in global value chains, textile production is suitable since most products can be exported at any stage of the chain, which makes it commercial intensive and sensitive to changes in trade regimes. In developed countries, a textile companies, as opposed to developing countries, mainly produce household and industrial textile products, which are technologically more advanced and less subject to design changes so they have higher added value production [2].
The largest low-cost clothing manufacturers among developing countries have successfully increased the share of export to the world market as a reflection of the replacement as a result of the economic crisis:

- expensive suppliers are replaced by cheaper,
- reduce the number of employees in industrial activity,
- the factories are closing,
- difficult access to capital,
- increased state aid,
- increased need to provide full services (including design, inventory management, etc.) [1,2].

The integration of the various stages of production may allow quicker adaption to market needs and reduce those activities that do not contribute to the creation of added value. The application of information and communication technology enables the improvement of procurement opportunities and creation of a virtual base for exchange via the Internet. The outcome of applied technology upgrade is expects the departure from the traditional way of buying clothes in stores and development of new ways of buying that allow interactive shopping from home [2].

Production of textiles and clothing is primary in many developing countries and the poor countries of the world in a way that is:

- one of the key sources of income,
- largest export industry,
- a source of jobs,
- allows integration into global production chains,
- the effects of agglomeration,
- method for reducing poverty.

Major world producers are increasingly opening their own retail stores. Manufacturers take the role of intermediaries and instead of developing their own production, they develop the network of global suppliers. At the same time number of private labels is growing and manufacturers of luxury brands associate with mass retailers. The importance of environmental sustainability and social responsibility is increasing and there is a need for quick responses to changes in markets. In the industrial activities of production of clothing is necessary regulatory policy to allow operation of the management system. Manufacturers and retailers must invest greater efforts to improve the business processes by adopting innovative technologies, cooperation and creating synergy effects [2].

TRENDS OF DEVELOPMENT TEXTILE AND CLOTHING INDUSTRY IN THE EUROPEAN UNION

For European companies are provided opportunities for new markets, reducing costs and gaining new knowledge due to changes in the global environment. European production of textiles and clothing is marked by strong competition from countries with lower labor costs, due to its labor intensity, high share of employment of poorly educated labor and relatively low investment costs.

The opening of European markets to import and the elimination of barriers to trade, together with the trends of globalization and liberalization, even more exposed European producers to the competition with lower costs countries [1,2].

Production of clothing in the EU is going through an intense process of restructuring and modernization with the effects of the closure of companies and the decline in the production of clothing in total processing industry.

In spite of slow demand growth, low productivity and strong international competition, companies that survive on the market generate profits comparable to other small trade activities. Consumer trends have a major impact on the production of clothing. Fashion trends are spreading globally with the help of the mass media and the Internet, which affects the demand. Import of mass products from countries with lower costs is increasing and prices of clothing are on the decline. Retail chains that offer cheaper products better position on the market which is affected by the purchasing power of consumers [2].

In the last decade the demand for textiles is stable and it's growing. Textile in Europe is characterized by fragmentation and is not competitive in the major markets, or markets that claim large amounts of products. In recent years, concentration of companies in the European textile production is higher as a result of rationalization of operations and the large increase in the number of mergers and acquisitions.

Modernization through the development of new products with higher added value, development and marketing of its products, the development of own brand and investment in research and development is the main factor in the success of development activities. European garment manufacturers respond to the latest developments and competition from China with the vertical differentiation, which means orientation to products with high added value.

Therefore, the potential for growth, particularly in the fashion sector, is in conquering the market of developing countries and is important to ensure access to these markets through the development strategy of entering the market [2]. EU countries that produce textiles, has in common the reduction in the number of employees with higher productivity. Companies that have survived, exploit their market niches where fast turnaround, quality and small batch production provides a competitive advantage.

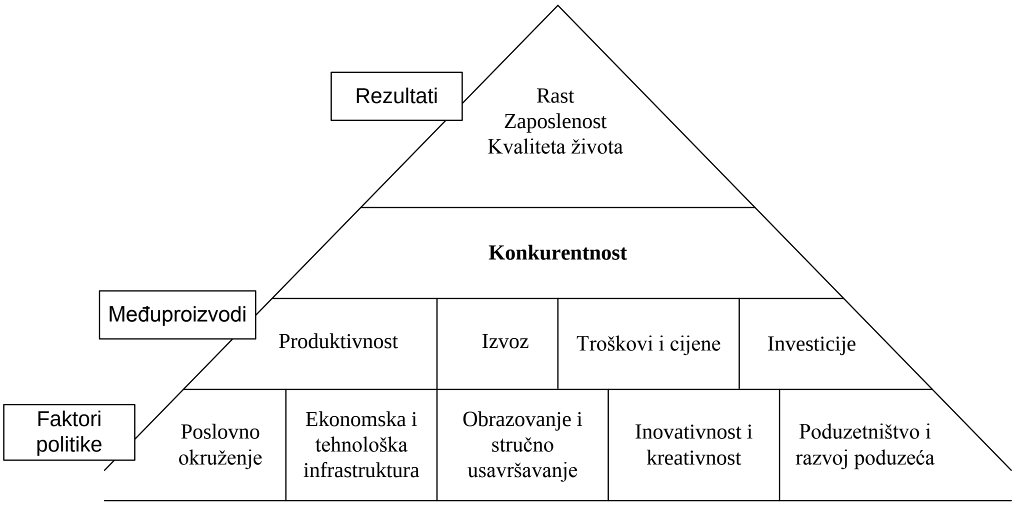
Therefore, three possible scenarios are predicted for development of European industrial activities of textile production by 2020:

The restriction of globalization – includes consideration of various effects of climate change,

Asian dominance – European excellence – assumes strengthening of the current trends in the future and

Advanced new member states describes the situation in which the EU and the member states with low costs are to defend the industrial base in Europe [2]

The development of the textile and clothing was determined by the needs of relocation and capabilities to respond rapidly to market needs. When it comes to fashion products focus on added value activities (research, development and design) is key factor. It is also important to emphasize the development of human resources. Figure 1 shows the structure of the pyramid of competitiveness [3].



Results Increase
Employment
Quality of life

Competitiveness

Intermediates Productivitie Export Costs and prises Investments

Political factors environment | Business | Economical and ecological infrastructure | Education and advanced training | and creativitie | Inovation and company development | Enterprenership

Figure 1: Structure of the pyramid of competitiveness [3]

The development of textile production is influenced by global competition, particularly by Asian countries, the creation of a knowledge base, ensuring rapid service markets (short time from production to marketing of products), and the cost of environmental protection [2].
Development of the textile and clothing is affected by many factors from the environment such as:

- saturation of the market of the European Union,
- a relative decline in spending on clothing,
- changes in consumer preferences,
- liberalization of the market,
- increased price competition,
- changes in the distribution,
- application of new technologies,
- human resources and industrial structures.

On the basis of the facts it could be said that the textile and clothing industry in Europe for the last 20 years is going through an intense process of modernization and restructuring [4]. The result of this intensive process is the modernization of production, increase productivity and closing of companies [1].
The textile and clothing industries are among the most globalized industries in the world, which is reflected in the freedom of the market, which leads to intense price competition and repositioning of these industries and increase imports. The problem of the textile and garment industry is related to the lack of competitiveness of cost, outdated technology, slow restructuring and insufficient presence of qualifies staff [5].

Fast fashion strategy is one to which the assortment quickly and effectively adapt to current and future trends. In order of following this trend, production must be well organized and flexible, condition of the warehouse optimized and supply chain extreemely fast.
Textile and clothing companies that followed those principles were growing much faster than those who observed the classic (seasonal) way of work [2].
In table 1 are given quantitative indicators for the textile and clothing based on the factors of development and impact analysis.

Table 1: Qualitative indicators for textile and clothing [2]

Development factors	Impact analysis (textiles)	Impact analysis (clothing)
The availability of quality of production factors	Limited access to capital. there is appropriate labor. Activity employs secondary education and unskilled labor. The trend is a slow increase in labor.	Limited access to capital. There is appropriate labor. Activity overwhelmingly employs women, low educational qualifications. Productivity varies, but shows the growth in the period. Insufficient availability of local raw materials for production.
Demand characteristics	These are mostly intermediate goods used in other industries.	The growing demand for a range of activities, but customer demands are growing and rapidly changing. The increase in the entry of foreign manufacturers on the market, with lower prices, mainly Asian.
Technological equipment	Labour intensive activity and poor technological equipment (old equipment).	Labor intensive activity and poor technological equipment (old equipment).
Expenditures for research and development	Expenditure for research and development are negligible and do not represent the level of investment required for the necessary changes in a positive direction.	Insufficient expenditure for research and development, and marketing activities.
Export potential	Export potential is low with the trend of reducing the share of experts in revenues. Indicator of relative comparative advantage is low, with the trend of reduction.	Export potential exists, but the export of higly concentrated, despite a slight trend of increase in the share of exports in total revenues. Insufficient development of domestic brands. Generates the relative comparative advantage.
The potential for growth and employment	The potential for growth and employment is low. It is noticeable reduction in the number of employees. Further growth requires additional investment, and activity is highly indebted.	The potential for growth and employment is low, except in the production of knitted and crocheted garment that has growth potential. At the level of activity is observed reduction in the number of employees. Focusing on finishing process. Insufficient development of the sales network. Further growth requires significant investments in

		marketing, technology, and create final products of higher added value. The activity is highly indebted.

Industrial engineering and operations management, combined with strategies for improvement have increased production efficiency and processes in the supply chain. Strategies for increasing the efficiency of production processes are: strategy of rapid response (Quick Response – QR), just in time (Just In Time – JIT), the ability to respond quickly (Time To Market – TTM), Total Quality Management – TQM), Lean (Lean) manufacturing and Six Sigma. Supply chains require that the cours of materials and delivery of products comply with the principles of lean management, and integrate with the capabilities of production, processes of information delivery about consumer demands, which is achieved by a holistic view of the entire business process throughout the life cycle of the product and by overcoming geographical barriers [6].

Figure 2. The production plant of tectile and leather [7]

Figure 2 displays a Croatian production facility for the manufacture of textiles and leather in Zagorje.

The main characteristics of the textile and clothing industry are:

- lack of permanent and favorable financing sources
- problems of distribution and collection of receivables
- structural problems with staff
- main production is significantly reduced
- owners are mostly involved in business management and development
- traditional business in the market structure

Textile and garment industry traditionally operates in a market structure with management that has experience, a very small number of companies is investing in the development, marketing and own brand. Most companies rely on a combination of lohn jobs and development their own products, so called mixed farming.

Companies should more intense focus on the development and sale of their own products to the short term lohn jobs. It is important to emphasize the merger of the role of owner and manager in one person, which is the basic starting point for commercial behavior, or concentration and centralization of business development and decision-making in one person. It would be necessary to separate ownership from management positions and remain on entrepreneurial behavior [4].

All companies where the owners managed to separate ownership from managerial functions have good business success. The problem is the lack of managers in the labor market for which the owners say it is one of the largest.

PRODUCTION POLICY IN THE TEXTILE AND FASHION CLOTHING

The production policy of the manufacturer of textile and clothing products, is as well as science and activity, a system of coordinated, planned, controlled and regulated knowledge, and skills and activities, functions, processes, measures, activities, operations, rules and laws that enable the creation, design, operating, servicing, management and control of all processes of production of textile and clothing products [8].

Companies can realize their competitive advantage over foreign suppliers by localized chains buyer – supplier – source (buyer – supplier – sourcing) that enable the production of small series of products manufactured and distributed in the short term and quick response to fast fashion cycles. Small companies will not be able to improve flexibility, efficiency, quality and awareness of the market if they do not have access to new knowledge, services and facilities [9].

The foundation of the modern mode of production is to find an organizational form to reduce the share of inactive operating state thus also reducing the cost of production, cost price, execution time of delivery, market competitiveness and increase profits of the company. Product of garment industry is seasonal and subject to fashion trends, therefore, the organization of production should be developed and maintained according to the strategies of QR, JIT and TTM [10].

The problem of the textile and garment economy as labor intensive brunch is exposure to strong competition of the countries with cheap labor. Due to lower labor costs compared to other manufacturing industries, constantly falling employment and there is a growing problem in recruiting qualified manpower. As the solution proposed by the structural changes in the textile and clothing economy of Europe, where there is a need to find new solutions in order to increase competitiveness in the saturated European market that the European Union encourages indirectly through horizontal and regional measures [11, 12].

Companies of textile and clothing industry recognized the need for quality and educated staff. But however, for these two industries there is a low level of motivation that comes from very low wages, work norms and to work for a limited time, so it is necessary to connect industry with educational and scientific institutions to produce qualified personnel [5, 13].

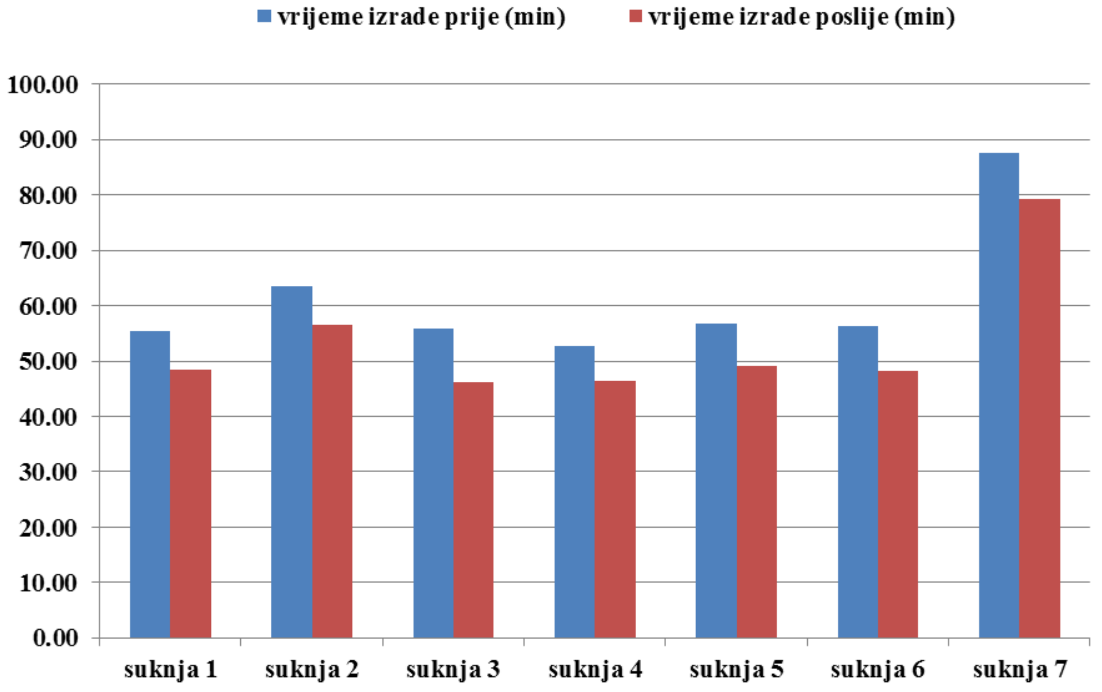
RESULTS OF ORGANIZATIONAL SETTINGS IN THE TEXTILE AND FASHION CLOTHING

The organization of work in the production depends on the choice of a technological process, the installation of jobs and inter phase transport where pleasantly designed workspace, meaning of personal work, correct relationships and rewarding of work have an impact on the psychophysical ability of workers [14].

In view of the existing competition on the market it is necessary to come out with an affordable price of the product for the target group of potential buyers for successful sale of the product is significant acceptable price and quality, therefore the focus of production should be in optimum product quality and reduce production costs, which allows to make profit. In order to increase productivity and hence competitiveness of market positioning in several textile and clothing companies is applied organizational method 20 keys, developed by Japanese professor Iwao Kobayashi, manager PPORF Institute for Development (Practical application of revolution in the factories and other organizations) and is based on the Toyota production system [15]

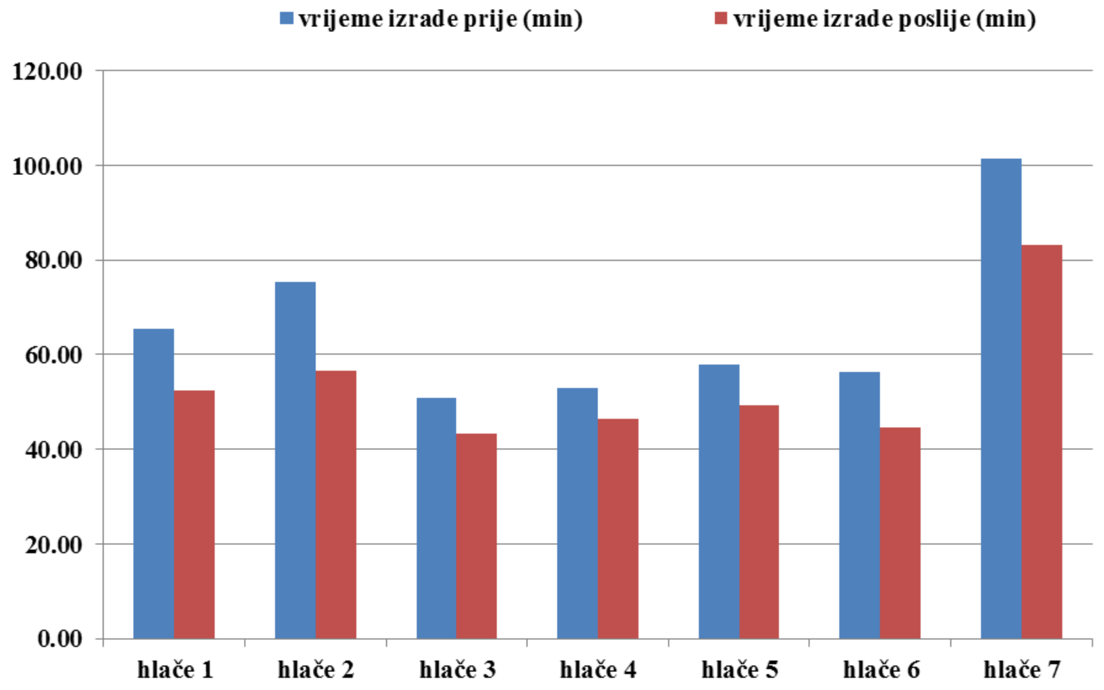
Supervision over the maintenance of working places and space has a significant impact in the organization of the technological manufacturing process. Technical staff of production facilities supervises the maintenance of order on production lines, and proper disposal of equipment and tools that are required to produce certain garment products.
The production process in the technological faze of sewing is performed on installed production lines to the existing deployment of machinery and equipment. The organization of production sewing lines depends on the type of fashion garment and clearly must be a specific location for the disposal of auxiliary materials, devices and supplies, and should be clearly marked transport routs [16].

With better organization of stabilized and designed jobs, significant results in reduced time norms are achieved and thus reduce losses and increase profits.
In company were recorded time norms on production lines of making seven models of women's skirts and seven models of women's trousers varying complexity and design where better organization of jobs achieves greater productivity, higher quality of work pieces, lower production costs, higher company profits and thus better position on the market.
Figure 3 shows an overview of the results of time norms seven models of skirts before and after the application of the system of organization 20 keys method, where it can be concluded that the time of manufacturing was significantly reduced when making all seven models. The average reduction in the processing time for all models is 12.66 minutes.
Figure 4 provides an overview of the results of time norms for seven models of women's trousers before and after applying the system of organization method 20 keys. Time norm of all models of women's trousers decreased after the introduction of the new organization method of 20 keys an average of 18.40 minutes.
The present results indicate successfully conducted organizational method (20 keys), which increases productivity and reduces costs of production, which are the basic prerequisites for successful market positioning.



manufacturing time before (min) manufacturing time after (min)
skirt 1 – 7

Figure 3. Shows the result of time norms of seven models skirt before and after the application of the system of organization method of 20 keys



manufacturing time before (min) manufacturing time after (min)
trousers 1 – 7

Figure 4. Shows the result of time norms of seven models of women's trousers before and after the application of the system of organization method of 20 keys

PROPOSALS FOR RESTRUCTURING TEXTILE AND CLOTHING INDUSTRY

The policy of restructuring the textile and clothing industry is focused on sustainable growth and development and the optimization of all subsystems together with all the elements and processes involved in the textile and clothing industry within a specific community of states. It can be defined as applicative, interdisciplinary and multidisciplinary science that studies and applies the legality of the actions, instruments and associated resources, potentials, capacities and possible directions of restructuring observed industry, technology, manufacturing capability, organization of production, ecology of production and legal frameworks [8].

To increase the competitiveness of the textile and clothing industry, it is necessary to make structural changes through the following activities: implementation of new technology, repositioning of production through training of personnel, the adoption of innovations in design, processes and materials in collaboration with the academic community for the development of the fashion industry, professional training and development of production system, focusing on creating innovative products and adopt new distribution channels, innovation in materials and design, increasing operational efficiency and improvement of products. This concept represents a system solution for the management of anti-recession policy. The textile and clothing industry should search the salvation in the development of high technology and building its own brands, increase of productivity, reduce production costs and increase the quality of manufacturing.

The basic mission of production policies of manufacturers of textile and clothing products is to provide full employment of productive capacity, potential and resources in production and quality, competitive, profitable and attractive design of the product [1].

Investments in marketing of their own products, development and brand management of its own products, as well as developing its own distribution channels, are key to achieving competitive advantage and to survive in the market [17].
Doing business with difficult access to money and disturbed liquidity makes finishing (lohn) operations, due to their rapid charge and little need for working capital, the only possible way of doing business in anticipation of better times and should not be viewed as a threat to the survival of the textile and clothing industry. It should focus on their strengths such as direct and free downloading of know-how and the fact that the additional works do not need working capital. Some companies, despite the adverse conditions, have managed to start production of added value products and successfully position themselves in the domestic and international markets [12].

CONCLUSION

From the main problems of the textile and clothing industry, what stands out is insufficient focus on the production of its own products, poor distribution and lack of strategy that would follow the company in an effort to increase competitiveness and production of products of higher quality.

Companies emphasize policies that guarantee their survival in the current market, and the possibility of investing in innovation and development of new/own products in the near future. Since the problem of the textile and garment industry is trying to solve and thus establish a better positioning in the market, there are some needs:

- new strategic directions such as:
- improving business processes,
- technological recovery and development,
- the development of brands,
- production of high-quality technical textiles,
- manufacturing garments with added value,
- innovation,
- patents,brands,
- distribution,
- increased efficiency,
- effectiveness and quality,
- positioning on domestic and international markets [18, 19].
- synergies textile and clothing industry with high educational scientific institution, in order to find a solutions and revitalization of the textile and clothing industry
- deal with the problems of the global market, disappearance of companies and adjustments to business conditions
- protect commercial production entities
- the creation of interdisciplinary teams of experts and associates (technologists, economists, lawyers, managers, entrepreneurs, journalists).

Achieving of these goals requires a favor of the state institutions, that will through various form serve the achievement of the goals [18].

REFERENCE

[1] Anić, I. D., i sur. (2007.), Strateške odrednice razvoja industrije tekstila i odjeće u Hrvatskoj za razdoblje od 2006. do 2015., Zagreb, Ekonomski Institut Zagreb
[2] Industrijska strategija Republike Hrvatske 2014. – 2020., Republika Hrvatska Ministarstvo gospodarstva, Zagreb, siječanj 2014.
[3] Godišnje izvješće o konkurentnosti Hrvatske, Nacionalno vijeće za konkurentnost, Zagreb, svibanj 2005., Svezak 2, str. 8
[4] Anić, I. D., i sur. (2008.), Ekonomski aspekti razvitka industrije tekstila i odjeće u Republici Hrvatskoj, Zagreb, Ekonomski Institut Zagreb, Hrvatsko društvo ekonomista, ISBN 978-953-6030-36-1
[5] Gavranović, A. (2011.), U raljama globalnog tržišta, *Suvremena trgovina* 5(36), str. 26-30
[6] Perkov D., Ćosić D. (2012.), Usporedba lanca vrijednosti i lanca opskrbe, Zbornik radova Visoke poslovne škole Libertas,. Andrijanić I. (ur.), Zagreb, 15. studenoga 2012., str. 137-150, ISSN 1846-9728
[7] Dostupno na: http://www.zagorje.com/clanak/vijesti/tekstilci-na-udaru-krize-mala-poduzeca-traze-pomoc, pristupljeno: 10. 04. 2016.
[8] Zelenika, R., Grilec Kaurić, A.,(2011.), Ocjena ekonomskog položaja tekstilne i odjevne industrije u Republici Hrvatskoj, Ekonomska misao i praksa DBK. (2011.) br. 2., str. 543-566
[9] Giuli, M., (1998.), The Competitiveness of the European Textile Industry, Centre for International Business Studies, Research Papers in International Business, South Bank University London Paper No. 2-97, 1998., ISSN 1366.-6290., dostupno na: http://bus.lsbu.ac.uk/cibs/research/working-papers, pristupljeno 10. rujna 2013.
[10] Rogale, D., i sur., (2011.), *Procesi proizvodnje odjeće*, Tekstilno-tehnološki fakultet Sveučilišta u Zagrebu, ISBN 978-953-7105-32-7
[11] Katović, D., Bischof Vukušić, S., (2008.), Vizija razvoja tekstilnog i odjevnog gospodarstva Europe, *Zbornik radova, 1. znanstveno-stručno savjetovanje, Tekstilna znanost i gospodarstvo*, Sveučilište u Zagrebu Tekstilno-tehnološki fakultet, str. 3-12, ISBN 978-953-7105-23-5
[12] Ujević, D.; Šaravanja, B.: Impact of Organizational Settings as a Precondition for Positioning on the Market , TRADE PERSPECTIVES 2013, Supply Chain Relationships, Proceedings of the International Scientific Conference, Knego, N.; Renko, S.; Knežević, B. (ed.), Zagreb, Sveučilišna tiskara d.o.o., 2013. 122-133
[13] Ujević, D., Knego, N., Lazibat, T., (2013.), Ekonomsko tehnološki aspekti modne industrije, Svečilišna knjiga, Ekonomski fakultet Sveučilišta u Zagrebu, Zagreb, Hrvatska
[14] Kirin, S., i sur.(2004.), Radno opterećenje i zamor u tehnološkom procesu šivanja, *Tekstil* 53, 5, str. 226-243
[15] Šaravanja, B., Dragčević, Z., (2010.), Introduction of the modular mode of the tehnological process using the 20 keys-sistem, Dragčevic, Z., Hursa Šajatović, A., Vujasinović, E. (ed.), Book of Proceedings of the 5th International Textile, Clothing & Design Conference Magic World of Textiles, Dubrovnik, Croatia, pp. 505-510, ISSN 1847-7275
[16] Šaravanja, B., (2011.), Organizacija proizvodnje i održavanje uređenosti proizvodnih pogona, Penava, Ž., Ujević, D. (ur.), *Zbornik radova, 4. međunarodno znanstveno-stručno savjetovanje, Tekstilna znanost i gospodarstvo*, Sveučilište u Zagrebu Tekstilno-tehnološki fakultet, 26. Siječnja 2011., Zagreb, Hrvatska, str. 173-176
[17] Gašović, M., Brdarić, M., (2012.), Integration of marketing and design strategy as an assumption for the success of fashion companies on the market, *Book of Proceedings, 5th International Scientific – Professional Symposium Textile Science and Economy*, Ujević, D

Penava, Ž. (ed.), 26th January 2012, Faculty of Textile Technology University of Zagreb, Zagreb, Croatia, pp. 231-234 ISSN 1847-2877
[18] Ujević, D., (2012.), Formula 5000, prezentacija 15.02.2012. Tekstilno-tehnološki fakultet Sveučilišta u Zagrebu
[19] Gavranović, A. (2012), Expectations in the Textile Industry after entry into the EU? *Book of Proceedings, 5th International Scientific – Professional Symposium Textile Science and Economy*, 26th January 2012, Zagreb, Croatia, pp. 235-240, ISSN 1847-2877

PHYSICAL PROPERTIES OF MULTI-LAYERED WOVEN FABRICS

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ABSTRACT

In this study, basic weaving techniques (plain, twill, satin) which are used to produce single-layer, double-layer, triple-layer and quadruple-layer fabric structures and selected performance and comfort characteristics of these fabrics were investigated. Picanol Gammax dobby weaving machines were used to produce 10 different samples. 10 of those samples were woven with 100% cotton Ne 40/1 yarn in both warp and weft direction. Fabrics produced with the same woven parameters and finishing processes including washing, leveling and sanforizing. Tensile strength, tear strength, pilling, crease recovery angle, bending strength tests were conducted on these fabrics.

Key words: Multi-layer, woven, fabric, performance

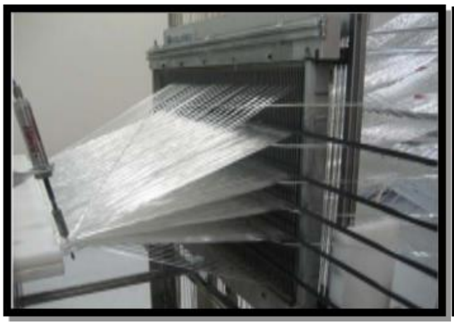
INTRODUCTION

Fabric structures can be designed as single-layer or multi-layer. Although multi-layer fabric structures bring some difficulties to meet technical specifications, they are often used in textile industry because of other advantages. The multi-layer fabric structures are more than one layer of fabric woven at the same time on a weaving machine and layers are combined with each other according to different methods. It improves not only heat retention and water permeability properties of the fabric but also provides high tensile and bending strength to industrial fabrics (Başer 2004). Compared to single-layer fabrics, multi-layer fabrics are heavy, voluminous and they have better heat retention properties. Weaving preparatory processes are more difficult and costly than single-layer fabrics. Weaving machines usually should have more than one warp let-off mechanism. Production rates are lower because of higher weft density (Türker 2010).

In the research which was conducted by Elnashar (2005) the properties of fabrics were analyzed by determining the efficiency of fabric porosity. The woven fabric multi-layer structure, the warp and weft densities, and the type of weave are factors of a woven fabric, which as porous material enables to transmit air, heat energy, and liquid perspiration. In the research which was conducted by Basal and the others (2009) provides comprehensive and informative data on the comfort related material properties of double layered knitted and woven fabrics, produced from engineered polyester, cotton and viscose yams, designed as cover sheets.

The term of multi-layer woven structures is generally used for the structures that occur by lacing perpendicular two yarn systems (weft and warp) with the help of an additional yarn system in the Z direction of 3rd dimension in the conventional 2D weaving process (Ünal 2012). This term is expressed in some literature as "two component multi-layered fabrics". Multi-layer woven’’ used in this study is an expression used for such fabrics. Fabrics formed with three groups yarns (ground warp, pile warp and pile weft) is expressed as 2.5D fabrics.

Multi-layer fabric structures can be produced with a single or multi shedding systems. Production rate of a single shedding system is low due to throwing of a weft in each time. Production rate of a multi shedding system are very high due to throwing of multiple weft at the same time and can also be used different weft yarns for different layers (Figure 1.1) (Shuakat 2011).



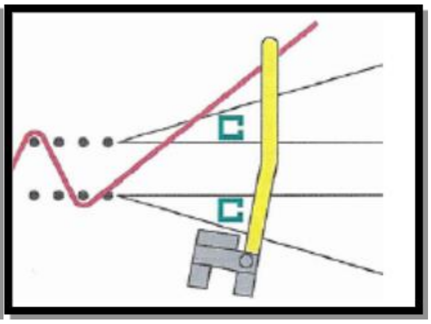


Figure 1.1: Multi-shedding multi-layer fabric production

Outer surface of multi-layer woven structures provide strength and increase abrasion resistance. Protection capabilities of fabrics can be increased by use of special yarn in the outer surface. The inner fabric surface provides more hygienic properties. In some cases, while the inner fabric surface provides strength, the outer surface provides a warmer touch.

MATERIAL AND METHODS

Picanol Gammax dobby weaving machines were used to produce 10 different samples. 10 of those samples were woven with 100% cotton Ne 40/1 yarn in both warp and weft direction. Connection is made in each cm. Uster values of raw cotton and white dyed cotton yarn are shown in Table 2.1 and Table 2.2.

Table 2.1: Uster values of 40/1 combed compact raw cotton yarn

Um (%)	CVm (%)	Thin -50 %/km	Thick +50 %/km	Neps +200 %/km	Neps +280 %/km	H	B-Force kgF	Elg. (%)	Rkm cN/tex
9.03	11.37	0.3	7.5	11.0	3.30	3.50	0.438	4.70	29.65

Table 2.2: Uster values of 40/1 combed compact white dyed cotton yarn

Um (%)	CVm (%)	Thin -50 %/km	Thick +50 %/km	Neps +200 %/km	Neps +280 %/km	H	B-Force kgF	Elg. (%)	Rkm cN/tex
9.03	11.36	0.1	5.0	6.3	1.5	3.57	0.416	6.69	27.63

Basic weaving techniques (plain, twill, satin) which are used to produce single-layer, double-layer, triple-layer and quadruple-layer fabric structures Fabrics produced with the same woven parameters and finishing processes including washing, leveling and sanforizing. Encoding and weaving parameters are shown in Table 2.3.

Table 2.3: Encoding and weaving parameters of samples

Samples	Encoding	Warp Density of Finished Fabric (warp/cm)	Weft Density of Finished Fabric (weft/cm)	The widht of reed	Reed number	Weight (gr/m^2)
Plain single layer	P1	56	50	172,97	18,50/3	166
Plain double layer	P2	64	50	172,97	18,50/3	165
Plain triple layer	P3	66	48	172,97	18,50/3	160
Plain quadruple layer	P4	72	52	172,97	18,50/3	173

Twill single layer	T1	52	54	172,97	18,50/3	180
Twill double layer	T2	64	50	172,97	18,50/3	179
Twill triple layer	T3	66	51	172,97	18,50/3	155
Satin single layer	S1	60	45	172,97	18,50/3	170
Satin double layer	S2	70	52	172,97	18,50/3	180
Satin triple layer	S3	72	48	172,97	18,50/3	163

RESULTS AND DISCUSSION

Tensile Strength Test Results

Based on standard TS EN ISO 13934-1, obtained values from the tensile strength test results are shown in the Figure 3.1. T1 has the highest tensile strength not only in warp direction but also in weft direction. There is no significant tensile strength difference of plain, twill and satin weaves. However, single layers tensile strength values of plain, twill and satin weaves are higher than multiple layers. It can be said that lower layers end up with better tensile strength values.

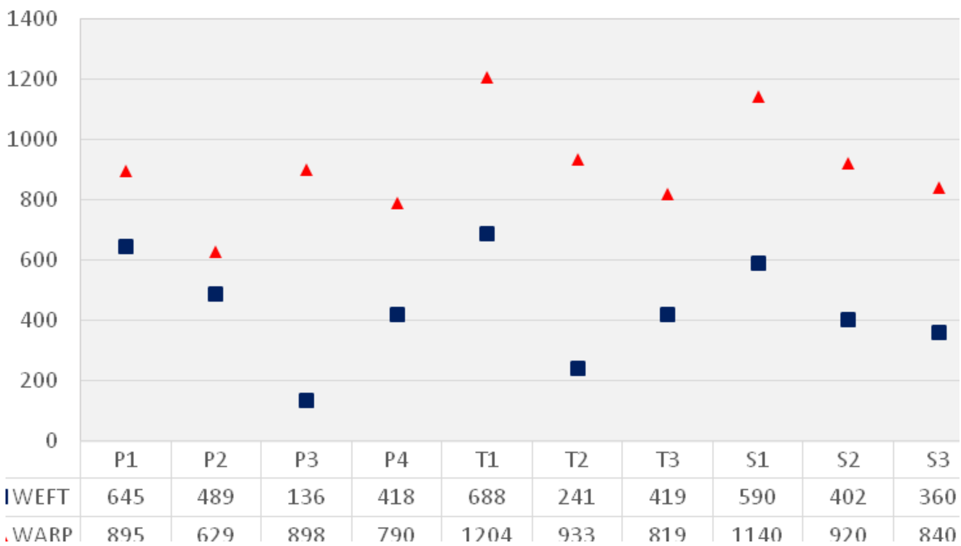
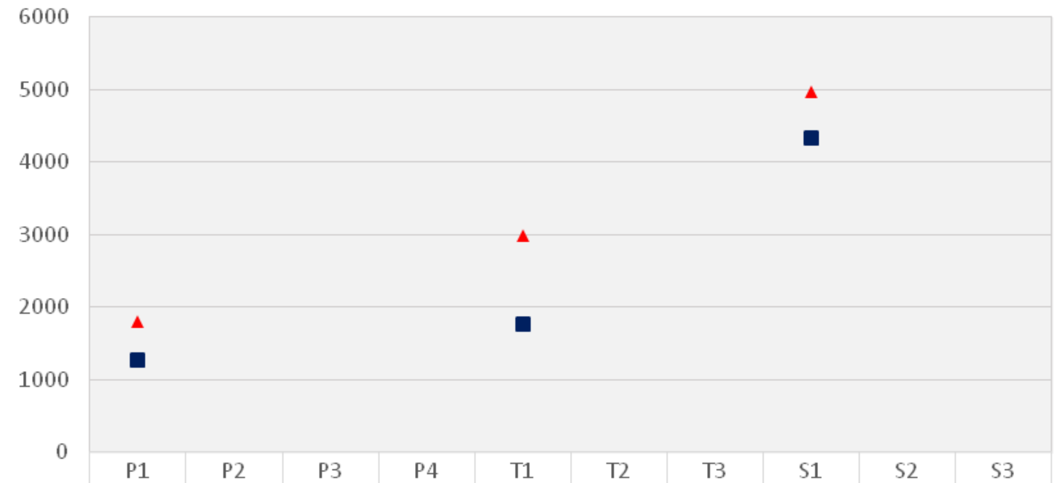


Figure 3.1: Tensile Strength Test Results of Samples (N)

Tear Strength Test Results

Tear strength test results with the standard TS EN ISO 13937-1 are shown in the Figure 3.2. Only single layer samples have laceration, multiple layer samples resisted to tear. While S1 has the highest tear strength, P1 has the lowest not only in warp direction but also in weft direction, as expected. It is difficult to tear the fabrics which have less number of interlacing because of loose yarns. During the laceration, loose yarns are overlapping over each other by sliding and gathering in laceration zone.



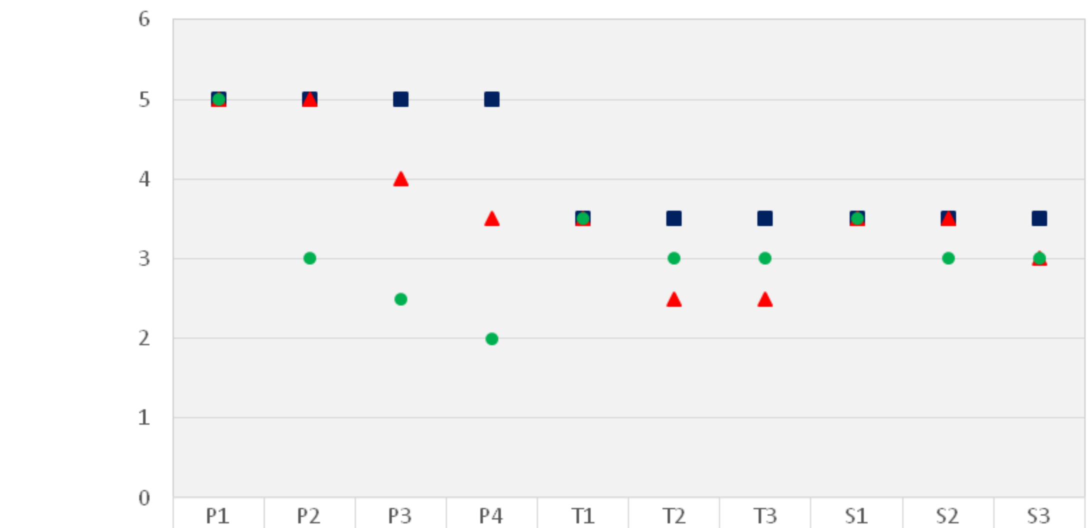
	P1	P2	P3	P4	T1	T2	T3	S1	S2	S3
WEFT	1267.2	-	-	-	1764.8	-	-	4336	--	-
WARP	1798	-	-	-	2986.6	-	-	4977.2	-	-

Figure 3.2: Tear Strength Test Results of Samples (gF)

- -

Pilling Test Results

Based on standard TS EN ISO 12945-2, obtained values from the pilling test results are shown in the Figure 3.3. Because of more interlacings plain samples pilling tendencies were lower than the others. It is also clear that single layers pilling tendencies were lower than multiple layers because of same reason.

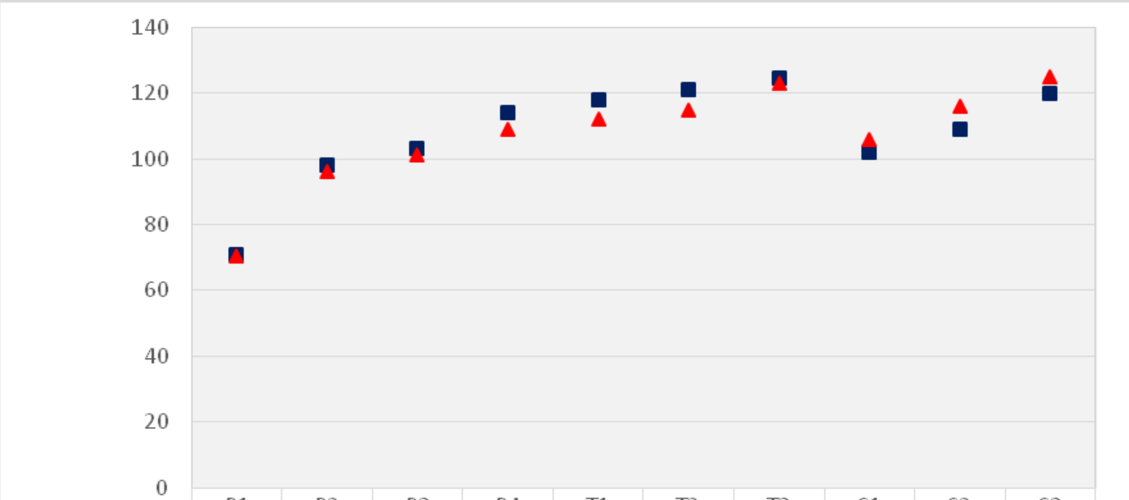


	P1	P2	P3	P4	T1	T2	T3	S1	S2	S3
125 SPEED	5	5	5	5	3.5	3.5	3.5	3.5	3.5	3.5
500 SPEED	5	5	4	3.5	3.5	2.5	2.5	3.5	3.5	3
500×4 SPEED	5	3	2.5	2	3.5	3	3	3.5	3	3

Figure 3.3: Pilling Test Results of Samples

Crease Recovery Angle Test Results

Crease recovery angle test results with the standard TS 390 EN 22313 are shown in the Figure 3.4. The lowest angles in both directions were found for single layer plain weaves, as expected.
While layers and jumping length of yarns are increasing, crease recovery angle are decreasing, or crease tendency is decreasing.

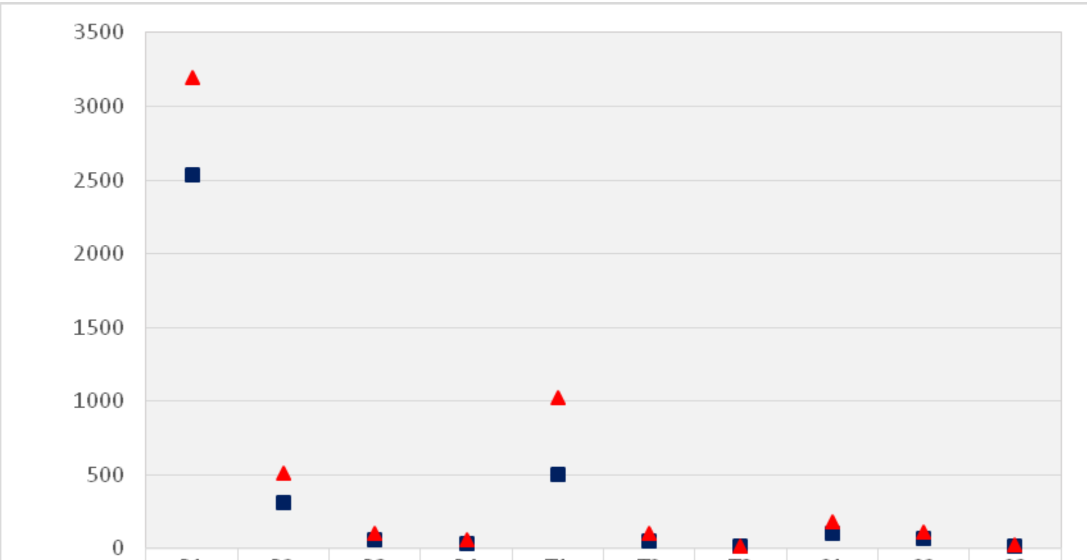


	P1	P2	P3	P4	T1	T2	T3	S1	S2	S3
WEFT	71	98	103	114	118	121	124.5	102	109	120
WARP	70.5	96	101	109	112	115	123	106	116	125

Figure 3.4: Crease Recovery Angle Test Results of Samples (°)

Bending Strength Test Results

Bending strength tests were done according to TS 1409 and results are shown in the Figure 3.5. While P1 has the highest value, S3 has the lowest not only in warp direction but also in weft direction, as expected. Higher amount of interlacing create more stiff surfaces.



	P1	P2	P3	P4	T1	T2	T3	S1	S2	S3
WEFT	2537	312	57	36	504	55	14	100	73	18
WARP	3191	511	105	59	1021	105	20	181	110	28

Figure 3.5: Bending Strength Test Results of Samples (N/m^2)

CONCLUSIONS

Tensile strength, pilling and bending test values are getting lower with the increasing amount of layer for the fabrics. However tearing strength and crease recovery angle values are getting higher as we expected. Same tendencies were observed for plain, twill and satin fabrics that number of interlacings per unit length directly effected the physical properties of the woven fabrics.

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REFERENCES

1. Basal, G., Mecit, D., Duran, D., and Ilgaz, S., ‘‘Comfort Properties of Double Layered Knitted and Woven Fabrics’’, Web of science, Vol 60(6), 299-307, (2009).
2. Başer, G. ‘‘Temel Dokuma Tekniği ve Kumaş Yapıları’’, Punto Yayıncılık, Cilt 1, 2. Basım, İzmir, 290, (2004).
3. Elnashar, E., A., ‘‘Volume Porosıty and Permeabılıty in Double-Layer Woven Fabrıcs’’, AUTEX Research Journal, Vol. 5, No 4, (December 2005).
4. Shuakat, M. N., and Wang, X., ‘‘Production and Applications of Multi-Layer 3D Fabrics’’, Centre for Material and Fibre Innovation, Deakin University, Geelong, VIC 3217, Australia, (2011).
5. Türker, E. Class notes, (2010)
6. Ünal, G. P., “3D Woven Fabrics’’, Namık Kemal University Department of Textile Engineering, (2012).

BRAND MANAGING AND DESIGN

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ABSTRACT:

Brand represents a collection of all touchable and untouchable product attributes, which make some company's supply unique, by the source of additional values. Design represents one of the most important brand components. Design is made by all characteristics of product that affect on how product looks like and functions, depending on the customer demands. In brand's context, design management is a process that includes: brand identity creating, brand reputation and brand value managing, including brand evaluation also. Effectively brand managing has an effectively design managing as the supposition.

Key words: Design, Brand, Additional value, Brand identity, Brand reputation, Brand value, Brand evaluation.

INTRODUCTION

According to AMI (8,.297), brand represents "name, period, sign or symbol or combination of both, so that one manufacturer's products and services could identify and differ from competition". In other words, brand represents a collection of all touchable and untouchable product attributes, which make some company's supply unique.
According to the listed brand definition, it unequivocally results that the design is an important brand component.
Brand, reviewed as a sign, is in fact a graphic design, which identifies product origins and prevents a possibility of appearance of identic products. As such, brand represents "an untouchable reality" which exists only if it is "implemented" in the product or service. Customer attaches himself with the brand both functionally and emotively, and that allows him feeling certitude during the product buying. (6.115)
Brand identity is created by all those elements that can identify the brand, such as name, symbol, color and so on. Brand name is graphically represented on the product, and it is a solution of graphic design. Brand symbol can be an illustration, image or draft, which is a designer's task. Case is the same with choosing of one or more brand colors. (7.109)

As an additional value, brand takes a high position in customer's consciousness and it represents a promise to the customers that product has an appropriate function for them. (7.111)

Brand is an interaction result and it represents a values source which differs in different cases, such as who is in interaction with brand: customers, manufacturers or distributors.
Brand values constructing represents a process which requires time and changes.
Relation between design and brand is not only graphic design, logo or sign. Design is present in all aspects of brand values: mission, promise, positioning, expression, quality, etc.
All of the stated brand elements, such as color, sound, appearance – can be designed.

Graphic design concerns about brand name and symbol. Product design concerns about its performances. Packing design concerns about wrapping material appearance. Interior design concerns about appearance of retail object.

In the modern business era, visual elements have much bigger influence on customers then the words itself, because customers memorize pictures easier than the words.
Brand value represents its material value, regarding of resources, apropos company property. Brand value keeps the level of brand popularity among the customers, and exists when the buyers are already familiarized with brand and are bonded with the brand by firm emotional and rational bonds. Customer's knowledge about the brand has a big influence on making decisions about buying. Relevant brand dimensions which have influence on customers responses on manufacturer's supply are: brand awareness, brand associations, brand loyalty.
Brand awareness means that the customers like to buy famous products and that they are prepared to credit the positive attitudes about known product.
Brand associations represents all that what connects the customers with some other brands (product attributes, use cases, brand identity, symbols).
Brand loyalty represents the core of the brand values and is fulfilled by loyal buyers that are attached for it.

Preferred brand values are those values for which the customers declare themselves about the most important attributes in the certain product category. In addition for a brand to be the leader, it's attributes or associations must be equal or bigger than those for which the customers have declared themselves to be the most wanted.
An effective brand managing means effective design managing, too.

BRAND AND DESIGN MANAGING

Design management has come through several different phases during its development, evolving into wide holistic phase. It's especially related to brand's design aspects, starting from the brand creation till brand values managing.
Brand creating begins with identifying market opportunities and creating of customers values, in addition to snatch the business opportunity. The point is in creating brands identity, during which a company designers get a tasks to design a basic idea, which would be later developed into a desired brand position in customer's awareness.
The brand represents a promise, which company makes towards existing and potential customers. Reviewed as an investment, not as a expense, design helps in brand "reviving" and values expanding. Brand and design investments must be controlled continuously, like an every other company resource. In legal point of view, brand value and all the other property values, must be protected and registered as an intellectual property.

Brand expression is related to activity of brand vision translation into something touchable. So that the customers could bond with the brand both physically and emotionally. Design's roll is to provide an experienced brand element. Basically, there are 4 ways in which the brands express their elementary idea: through product, through area, trough communications and through employed.
Delivery of values to the customers isn't possible without design, which is a unique sense which keeps the brand's spirit. (4.159)

Values delivery keeps various brand elements together, and that results with functional, emotional and self-expressional benefits for the customers.

Brand can be considered as a product in sense of: products coverage, products using, products user, country of origin, etc. Generally, brand coverage has two levels:

- Corporative brand (company develops brand which covers all of its products and services),
- Individual brand (company develops individual brands for each product).

Brand can be viewed as company in the way of an attributes of company (innovations, employed care, trust), such as their local or global characteristics.

Brand bonds itself for some individual in way of his personality and relation user-brand.
Brand expresses itself as a symbol in way of visual image, metaphor, brand inheritance, etc.
Design management, in brand managing context, represents process consisted from 3 phases:

- Creating of brand identity phase
- Managing of brand reputation phase
- Managing of brand values phase

BRAND IDENTITY CREATION

Brand identity creation is the first process phase in brand managing, which processes after customers, competition and companies analyses are done. Customer analysis covers trends, motives, unfinished needs and segments or customers groups. Competition analyses includes reputation of their brands, weakness and positioning in the market. Company analysis considers reviewing of the existing brand, its legacy, strength and company value.
Identity creation phase is consisted in defining customers values, names, identities and brand sign. Values proposal means brand essence for the customers. Identity designing is reviewed as strategy of making brand visible.
Brand identity is made by all those elements that can identify some brand. It can be name, symbol, color, etc. Basic advantage of brand products over generic products is a possibility of their easier identification.
Brand identity is a presupposition of its popularity and widespread fame over customers. Buyer's knowledge of brand has a big influence when it comes to making decision of buying.
In the eyes of the customers, brand means a "person" to them for which they bond themselves. Like people, brands own names, they belong to certain families, they raise certain style and reputation, and also a life time. In addition for brand personality to exist, brand identity must be adequately created.
Relevant brand dimensions which influence on buyer's answers on company supply are awareness of buyer about brand and associations of brand. (4.217)
Brand awareness, or ability of brand recognition and brand remembering, are reflections of achieved level of brand identity. Buyers like to buy famous and popular products, and they are prepared to credit the positive performances of those products.
Identity level evaluation includes measuring of:

- memories - correct brand identifications in the limit of same product category
- recognition – ability to distinct brands
- different types of brand associations
- brand favouring or preferring
- brand loyalty

Brand identity level evaluation includes exploring of relations between brand association in sense of:

- Uniqueness – comparing associations characters on the following brand with association characters on competitive company. That is what buyers consider to be unique at specific brand.
- Compatibilities – comparison of association structures among buyers, or asking buyers a questions about their expectations

- Uses – comparison of secondary brand associations with primary brand associations, or asking buyers a questions about which changes would they made, based on primary brand associations.

BRAND REPUTATION MANAGING

In general, reputation means show or picture to the public about some organization or person and their position in society. (5.119)
Reputation is multidimensional collection of psychological elements of some company, product or individual, which has dominant presence in the public.
Brand reputation can be defined as hearing show about some specific product, exposed by external characteristic view, by which it gains specific impression about product. (8.249)

Managing of brand reputation phase is second phase of brand managing. It is focused on the brand reputation. Band reputation refers to strength and uniqueness of brand associations in buyers memory.
From the customers point of view, there is nothing that can be only a product. One product doesn't come alone, brand name, status and personality stands by the product. (5.139)

Brand reputation management is a tactical phase of brand managing, which necessarily does:

- The creating of brand reputation and diversificating of various brand types on the market
- Concentrating on the limited number of brands, so that structure, that is focused on specified categories, can be accomplished
- Initiating of internal design dimensions and communications
- Developing of global branding dimensions

Some authors (1.127) claim that branding has 4 purposes:

- To represent the design, marketing, and communication instruments
- To have influence on each part of company and its auditorium
- To represent coordinating resource, because it makes company activities coherent
- To make company strategy visible for its surroundings.

Brand reputation is tightly related with the design when it comes to brand "reviving", by using hearing experiences. Very often, the ways this can be achieved, are defined by so called design directives, apropos documents that describe rules of using brand elements in different circumstances.

Directives design (4.212) represent visual specifications and formal rules of brand usage in different situations. Duty of taking care about brand, usually belong to brand manager, although it can be done by some external design agency with which contract should be made and signed about supervising brand implementation process. These directives ensure consistent brand usage and design on all points where brand engages with customers. These points include:

- Using sign or logo in printed and digital media
- Rules that define co-branding
- Sponsorship situations or arrangement franchise
- Merchandising rules in branded retail objects

BRAND VALUE MANAGING

Managing brand values is the third, strategic phase of brand managing, which is focused on brand values. Considering that the design is an important component of brand values, designing decisions are made in cooperation with top management and they have long-term character.

During that, design is reviewed as integrated component of product/brand supply. It is expected from the design to help in creating vision about future of the company
Brand value is in fact brand property, which can be base for achieving competition success and long-term profit. Aim of accomplishing the lidership, when it is about some brand is creating of greater brand values. Thereby, design roll is to identify brand value elements which make differences and initiate long-term brand vision and employed-customers relations, and company mythology which is the center of story making which discovers a brand value.
Design instruments (2.115), which assist in measuring the brand values, are covering:

- Interactive support system in making decisions in brand managing – knowledge managing system
- Comparative identity directions
- Brand usage directions
- Online training
- Orderly innovations checking
- Brand success stories
- “Design’s moment” celebrating
- Promotional efforts news
- Comprehensive training programs
- Rewarding programs or ladling out the honors in brand success celebrations

Strategic brand managing leads towards creating of new design instruments, such as visionary and relationary
.

BRAND VISION DEFINING

Companies with the firm attitudes and convictions have something in common, as for its employed, such for customers, too. It is so called big idea, which gets deeper than any other vision sr statement which bond with the brand. According to De Mozoti (4.117), for given ideas, it is said:

- Big ideas are radical – companies with the big ideas want to change the world
- Big ideas are social – they are a property of all employed, not only of the top managers
- Big ideas are touchable – They are made of actions, not of words
- Big ideas magnify desires – they are creating a consumers society

Benefits that companies get from a design todays, are usually an ideas, even if design still has a central role, from at least two reasons:

- Big idea isn’t complete until it’s touchable, apropos until it’s visible or touchable in any way
- Big idea includes a mix of skills and knowledge, and requires syntheses. It looks for people that are capable to recognize an important idea among large number of ideas. Big ideas requires people which aren’t afraid to be radical. It’s a way of thinking that designers use. Designers responsibility is to care about true ideas. Their eyes are pointed into difference that they can offer to the society. So, not only a difference which values delivery means to the customers, but a difference that it offers to whole society.

Basic attributes of every successful brand are (8.297):

- Clear understanding of brand purpose in long time period
- Clear vision of how the company want to be precipated by the side of its surroundings
- Strong brand topic, which supports all companies activity
- Strong and clear visual identity

INTERN BRAND MANAGING

Brand value management is tightly bond with intern branding in companies too. Intern braning models are stories programs, happenings and people which perfectly represent brand value. When brand managing reaches "the best praxis" level in certain company, then everybody in the company understand how the every individual's behavior can contribute to brand.
Branding isn't activity which is carried out by only one section. Besides the design, advertisement and sell promotions, each contact point with the customers must be in brand function. Also, every individual in company should be aware of responsibility for creating and maintaining brand values.

Brand is an every companies soul, so understanding of it's basic values becomes a responsibility of all employed, starting from human resources manager (which hires new talented people), exploring and development engineers (evaluate new working technologies), till users service representatives, which are directly bonded with customers.
So, on which way the brand can be "pressed" into culture? By keeping companies culture and employed behavior, with brand promise to the customers, it's easier to tell it than to do it. That's why the decisions makers, related for the design, should:

- Create pratnerships and generate inclusion of the other business functions, such as human resources
- Again and again brand articulating in the sense of intern beliefs and corporative mission and vision
- Balance the budget execution between external activities and internal demands
- Create messages pointed towards to intern company politics, apropos employed

BRAND VALUE EVALUATION

Brand value evaluation is very important aspect of brand value managing. Brand evaluation systems must be based on statistic. Evaluations itself, that are based on measurable pointers, must be valid. There are two main focus points of design management, and that are:

- Including variables into reputation measuring systems and brand values
- Understanding and participating in evaluatuion system choosing

DESIGN EVALUATION AS PART OF BRAND REPUTATION AND BRAND VALUES

Most of the companies do reputation testing of their brands ordinarily, but sometimes it is hard to isolate an influence of the design itself, because it is integrated into advertisement plans. However, there are projects which don't include promotions, so the design's influence can be easily measured.
Instruments, such as brand evaluation and perceptual maps are, allows consistency control over graphic design with brand positioning on the market and understanding of the customers interpretations, related to brand reputation.
When person thinks about certain brand, he has a visual show of that brand. However, the most of the advertising studios is based on verbal explanation of brand values> From the previous contradictions, it outcomes that it is useful to pay more attention to images, so that visual brand profile is evoked.
When some company changes logotype, it can be a risking decision. That's why most of the companies makes decisions to explore quality of offered design solutions, so It could be helpful to the top management to make right decisions about company visual identity changes.
Developing brand values is a systematic, so when it's about design influence on that value, it's necessary to check how many changes of designs signs (visual identity) influences on perceptions of that company by the customers point of view.
When it's about measuring of design influence over the brand value, design should reflect dimensons such as: awareness, loyalty, precipated value and assotiations.

BRAND VALUE SYSTEM SELECTION

Creating of the strong brands is a very profitable investment for the companies. Consultant agency "Interbrand" has researched brand values comparing with total actions value of companies, apropos it has calculated the brand values as percent of total actions value. Researching showed that in 9 of 60 top brands have value that overcomes 50% the value of the companies that they belong to. Biggest brands, like BMW, Nike, Apple and Ikea have a 75% of brand value of total company value.

Brands have a different values when different systems are used for their evaluation:

- Evaluation based on market prices – difference between netto property price and price made through transactions is defined, and that indirectly presents a brand value.
- Evaluation based on expenses – evaluation of brand value is made according to investments during the last period, apropos it is evaluated how big expenses of brand creating are, with wanted level of knowledge and loyalty, comparing to expenses of creating of existing brand.
- Evaluation based on potential benefits – brand evaluation is realized based on incomes which are directly credited to the brand. Bonus that brand brings, or brand capital property which allows for brand to sell on a higher price then competition's equivalent product price.
- Evaluation with several criterion

Most of the evaluation models ranks the brands, considering the benefits such as customers loyalty and brand internationalization potential. For example, " Interbrand " model classifies brand value according to incomes which are credited to brand, using criterion like:

- Brand market perspective
- Dominance of brand market participation and competition brands
- Reputation and fame of brand
- Legal protection of brand
- Potential internationalizations

Listed model is criticized because of the following reasons:

- Brand value is a variable and it is a result of subjective thoughts of experts. This instability is the opposite to brand consistency
- They don't offer methods with which is possible to manage brand in future

It is essentially important that design managers understand which brand evaluation system is preferred by the side of their company, so that design effect would be better estimated in branding.

CONCLUSION

Brand represent a dynamic category and is always related to imagination and creativity. Successful brands are those that manage to continuously innovate their design and reputation. Design is used in brand's identity creating, expanding the wideness of brand influence, such as in optimization of brand values during communication with the customers. Design is also used to anticipate more difficult consummation patterns and intense brand competitiveness. Also, design participates in brand valorization, making it actual through packaging, product, advertising, etc.
Brand resources are made of creditability, justification and influence. For the design, it means consistency in esthetic and shape, permanency of graphic symbols and building of new emotions.

Design management, in the context of brand management represents a process which has 3 phases: brand identity creation, brand reputation management and brand values management.
First phase, or brand identity creation phase comes after market analysis and consists in determining of names, brand signs, as in defining values for the buyers. Proposition of value for buyers expresses brands essence. Identity designing is watched as a way of making the brand strategy visible.
Phase two, or reputation managing phase is tactical phase, which is conduced to: build brand reputation and diversify various brand types on the market; concentrate on certain brand numbers; initiate intern dimensions of brand communications and develop global branding dimension.
Phase three, or brand value management is strategic phase of brand management. Design's decisions are made in cooperation with top management and it has a long-term perspective. Brand value is a strategic variable and represents a property that can be base for overtaking the competition's advantage.
Basic purpose of brand managing is creation of greater brand value. Design's roll is to identify elements of brand value that difference the brand and secure their long-term vision and fortify companies philosophy about that value. This phase is made of few sub-phases: defining of brand vision, managing of intern brand and brand value evaluation.
Defining of brand vision must come from the fact that the big ideas are radical, that thy change the world, and that they are made by actions, not by word and they belong to all employed in the company.
Intern brand managing is, also one of activities of brand values building. Branding isn't activity which carries out only one department in the company. Not only design advertisement and PR, but every other spot contact with buyers, and every individual in the company must be subaltern to the brand.
Brand value evaluation is a very important part of brand managing phase. Evaluation must be done by means of quantitative pointers, and it is necessary to single out design influence over brand value. Thereby, that influence should reflect values dimensions such as: awareness, precipated value and associations. Evaluation systems are based on market price, expenses, potential benefits and several other criteria.

REFERENCES

Best ,K.,The Fundamentals of Design Management(2010),AVA Publishing Sa Lausanne, Switzerland

Bloch,H.P.,Product Design and Marketing: Reflections after Fifteen Years"(2011),Journal of Product Innovation Management 28,str,378-380.

Beverland,B.M.,Managing the Design Innovation-Brand Marketing Interface: Resolving the Tension between Artistic Creation and Commercial Imperatives(2005)Journal of Product Innovation Management 22,New York

De Mozota,B.,Design Management: Using Design to build Brand Value and Corporate Innovation"(2003), Allworth Press New York

Gašović,M.,Fashin advertisement(1998),Institute of Economic Sciences, Belgrade

Gašović,M.,),Products management (2011),Faculty of Economics Subotica, University of Novi Sad

Petrović,V.,Gašović,M.,Fashion collection-advertisement ,technologic and management aspects of the fashion design (2016),Technical faculty, Zrenjanin

Kotler,P.,Vong,V.,Sonders,Dž.,Armstrong,G.,Advertisement principals(2007),MATE d.o.o. Belgrade
Vasiljević,M., Design – modern views(2005),Faculty of Design, Belgrade

DETERMINATION OF SEPARATION FORCE FOR COMPOSITE MATERIALS

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ABSTRACT

The ubiquitous application of composite materials are possible because of their unique combination of characteristics. The composite is artificially made, that gives the possibility to improve this combination of properties. In the present study separation force was tested of a three layered composite material which were thermally bonded with three different process speeds (30, 34 and 39 m/min) and the two PU thickness (2 mm and 4 mm). The results show that lesser speed of thermal bonding resulted in stronger bond of components, which has contributed to greater PU melt and its penetration into woven fabric and knitted fabric.

Key words: car cushion, polyurethane foam, thermal bonding, bonding speed, woven and knitted fabric

INTRODUCTION

The quality and appearance of car seat cover is important, because it is the part of the vehicles interior that making the first contact with the traveller. Single-layer car seat covers was produced before the appearrance of the multi-layer composite material and had poor resistance to abrasion and tearing, especially on the folded areas, were uncomfortable during prolonged sitting and had an extreme anisotropy. Deterioration resulted in pad shaped seat, especially when woven fabrics were used, and their life span was shorter than the life span of a car. It is worth noting that among the first composite materials that have appeared on the market were car seat covers and nowadays these materials are the most manufactured type of fabric in a group of technical fabrics (Mogahzy, 2009, Rowe, 2009).

In the last few decades, intensive development of new materials has resulted in composites that meet all the requirements of car manufacturers. Life span of basic car seat covers should be, on average, at least the lifetime of car. It is important to choose materials that will have the necessary properties in the final composite. The value of composites (woven fabric + polyurethane foam (PU) + knitted fabric) depends on the force of the separation of the individual components (Fung, Hardcastle, 2001, Kovačević, Ujević, 2013, Mukhopadhyay, Patridge, 1999, Ujević et al., 2005).

The usage and qualitative values of textile materials and composites are commonly evaluated by its physical and mechanical properties, wear resistance, resistance to UV radiation, resistance to high and low temperatures, good physiological properties, design and comfort (Kovačević et al., 2009, Ujević et al., 2002, Mcloughlin, Hayes, 2013).

The usage of composite materials for car seat covers improved their physical and physiological mechanical properties and resistance to abrasion, UV radiation as well as resistance to variations in temperature. Composite materials with PU inside allow better longevity, greater comfort and less deformations on the folded areas. This composite longer retains the look and shape of the car seat cover without folds, especially if the components in the composite are thermally well bonded.

The properties of materials used in the composite covers for car seat covers affect the properties of the final composite.
This means that the properties of composites are inherited from its components and can be changed by selecting components until a composite of the best properties for given car seat covers is made (Fung, Hardcastle, 2001, Bruins, 1969, Dombrow, 1965).

Nowadays, the properties of materials and composites often change, in order to improve the quality and produce a more durable car seat cover (Horvat-Varga, 2009, Pačavar, 2015).

EXPERIMENTAL PART

Separation forces of a newly developed composite fabric with two PU thickness (semi-composite: knitted fabric + PU and composites: woven fabric + PU + knitted fabric) was conducted with dynamometer Pellizzato/Tinius Olsen type H5KS, according to DIN 53 357 standard. The testing was conducted by using particular methods under strictly defined temperature and humidity of the material being tested. The moisture conditions were defined as 65 ± 2% and temperature of 20 ± 20C, as the standard atmosphere conditions for testing.

Materials

Woven fabric: 100% polyester (PES) multifilament, dobby weave, the density of warp / weft: 29 / 20.5 (yarn / 10 cm), the fineness of warp / weft: 620 dtex f 144 / f 167 48 × 3 dtex
Knitted fabric: 100% polyester (PES) multifilament, Locknit (Charmeuse), density arrays / rows: 13 / 11 (cm), the fineness of the yarn: 75 - 84 f 36 dtex.
Polyurethane foam (PU): two thicknesses: 2 mm and 4 mm were used to make the composites.

RESULTS

Testing results are shown in Table 1 and Figures 1 and 2.

Table 1: Sample thickness

Samples	**Thickness (mm)**		
	The measured values	Sum of components	The difference (reduction, %)
(PU) 2 mm	0.70		
(PU) 4 mm	1.40		
KF	0.22		
PU 2 mm + KF	0.88	0.92	4.55
PU 4 mm + KF	1.60	1.62	1.25
WF	0.70		
WF + PU 2 mm + KF	1.44	1.62	12.50
WF + PU 4 mm + KF	2.18	2.32	6.42

WF: woven fabric; KF: knitted fabric; PU: polyurethane foam

According to the results presented in Table 1 and Figures 1 and 2 the following can be determined: Thickness of each sample with different bonding process speeds was measured and the values are shown in Table 1.
By thermally bonding components into composite, the thickness of the composite were reduced, in comparison to the sum of the components in the composite before the thermal bonding.

Separation force of knitted fabric in the composite and PU of 2 mm is 6.45 N (speed at 39 m / min) to 8.69 N (speed at 30 m / min) in the longitudinal direction, and 6.21 N (at a speed of 39 m/min) to 8.59 N (at a speed of 30 m / min) in the transversal direction. Forces of separating knitted fabric from PU of 2 mm and woven fabric in the longitudinal direction was 6.48 N (speed at 39 m / min) to 7.94 N (speed at 30 m / min), while in the transversal direction it was 6.70 N (at the speed of 39 m / min) to 8.37 N (at a speed of 30 m / min).

Composites with thicker PU do not show any significant difference in the forces of separation, it varies from 6.03 N (speed at 34 m / min) to 8.11 N (speed at 30 m / min) in the longitudinal direction and from 6.24 N (speed at 39 m min) to 8.62 N (speed at 30 m / min) in transversal direction. Force of separating knitted fabric from 4 mm PU and woven fabric in the longitudinal direction is 5.83 N (speed at 39 m / min) to 8.5 N (at speed 30 m / min), and in the transversal direction is 5.94 N (in speed of 39 m / min) to 8.67 N (at a speed of 30 m / min).

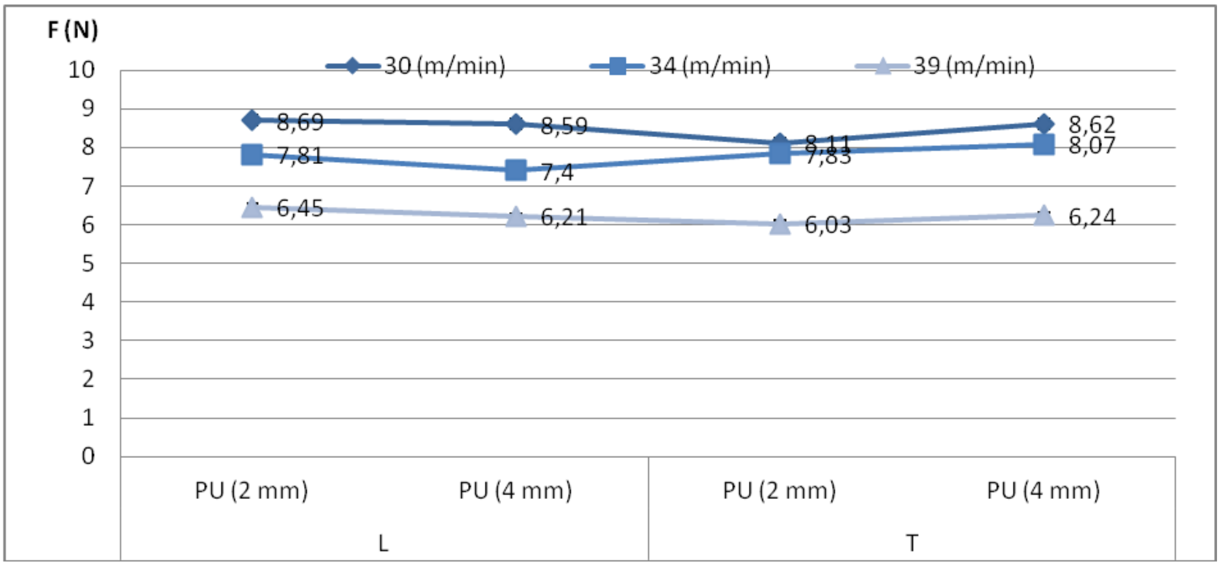

Figure 1: Separation forces of woven fabric from PU and knitted fabric (F: separation force (N))

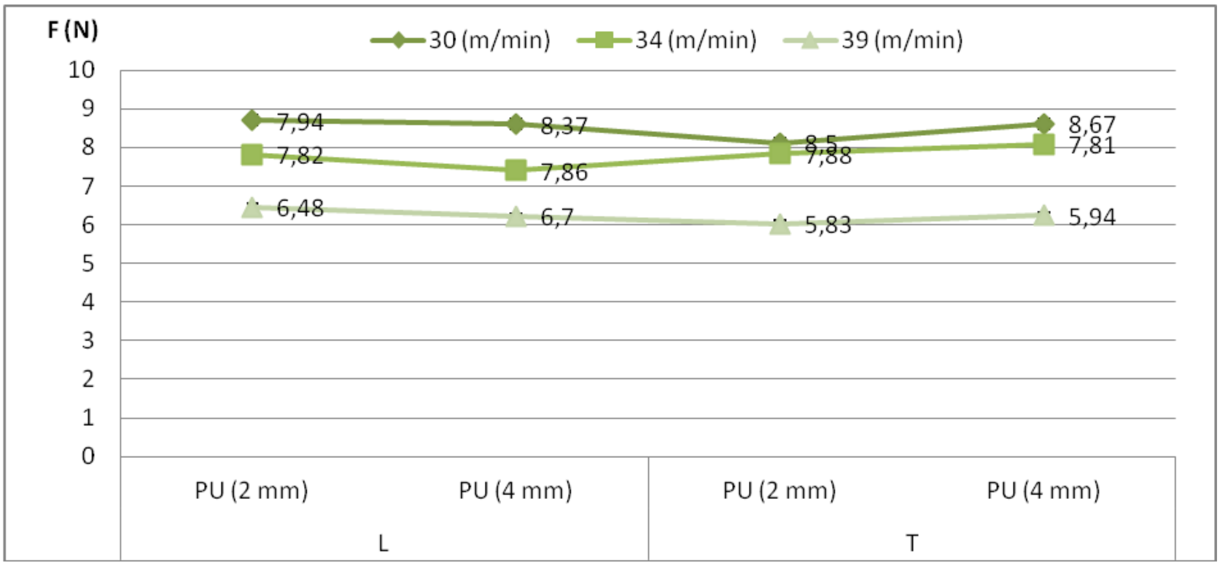

Figure 2: Separation forces of knitted fabric from PU and woven fabric (F: separation force (N))

CONCLUSION

The final results obtained by thermally connecting components in a composite with different speeds are:

Thermal bonding of knitted fabric and PU, resulting in semi-composite and then in woven fabric as final composite, caused a reduction in the thickness of the composite when compared to the thickness of the components that existed before the bonding. This indicates that the woven fabric and knitted fabric have, during surface PU melting, merged in the resulting melt and thus formed a good bond.

During thermal bonding process, longitudinal tension of woven fabric, knitted fabric and PU affects elongation and specific deformation of composites.

Separation force of PU and knitted fabric is greater than the separation force of knitted fabric from PU in all samples in both directions and both thickness.

According to the obtained results it can be concluded that the forces of separation were the smallest when samples in which the components were heat welded together at 39 m / min are concerned, and were highest when samples were thermally binding by 30 m / min.

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REFERENCES

Mogahzy Y. E. (2009). *Engineering textiles*, Integrating the design and manufacture of textile products, Woodhead, Cambridge.

Rowe T.(2009). *Interior textiles Design and developments*, The textile Institute, Woodhead publishing in textiles, Oxford, Cambridge, New Delhi.

Fung W. , Hardcastle M. (2001). *Textiles in automotive engineering*, Woodhead, Cambridge.

Kovačević S., Ujević D. (2013). *Seams in car seat coverings: properties and performance*, Joining Textiles, Principles and applications, edited by: I. Jones, G.K.Stylios, Woodhead publishing series in textiles, Oxford, Cambridge, Philadelphia, New Delhi.

Mukhopadhyay S. K., Patridge J. E. (1999). *Automotive Textiles*, Textile progress, The Textile Institute Manchester.

Ujević D., Kovačević S., Wadsworth C. L. (2005). *Textile in a Function of Car Industry*, The 5th International Scientific Conference of Producing Engineering, Development and Modernization of Production, University of Bihać.

Kovačević S., Ujević D., Schwarz I., Brlobašić Šajatović B., Brnada S. (2009). Analysis of Motor Vehicle Fabrics, *Fibres & Textiles in Eastern Europe*, 71 (16), 32-38.

Ujević D., Kovačević S., Hađina J., Karabegović I. (2002). I*mpact of Joined Place on the Fabric Intended for Manufacturing Car Seat Covers*, 2nd AUTEX Conference, Belgium.

Mcloughlin J., Hayes S. (2013). *Types of fabric and their joining requirements*, Joining Textiles, Principles and applications, edited by: I. Jones, G.K.Stylios, Woodhead publishing series in textiles, Oxford, Cambridge, Philadelphia, New Delhi.

Fung W., Hardcastle M. (2001). *Textiles in automotive enginering*, Woodhead publishing Ltd, Cambridge England.

Bruins P. F. (1969). *Polyurethane Technology*, Polytechnic Institut of Brooklyn, NewYork.

Dombrow B. A. (1965). *Polyurethanes*, Reinhold Publishing Corp. New York.

Horvat-Varga S. (2009). *The impact of technological parameters of the high-frequency welding process*, Master, University of Zagreb, Faculty of Textile Technology Zagreb, Croatia.

Pačavar, S. (2015). *The Influence of Sewing Parameters on the Production Quality of Car Seat Covers*, PhD Thesis, University of Zagreb, Croatia.

ERGONOMIC RISK ASSESSMENT OF WORKERS IN GARMENT INDUSTRY

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ABSTRACT

The work-related musculoskeletal disorders is a crucial health issue in labor-intensive industries. Despite of the developments in workshop practices and technology, garment industry is among the most labor-intensive industries. The purpose of this study is ergonomic risk assessment of workers in garment industry. For this reason, working environment and physical workloads of workers are investigated in a factory that manufactures baby towels, bathrobes and sleeping bags. Rapid Entire Body Assessment (REBA) method is used to calculate physical workloads of workers for thirteen different operations. The evaluation of the results show that inadequately ergonomic working conditions set off serious physical disorders in garment industry.

Key words: garment industry, risk assessment, ergonomics, REBA

INTRODUCTION

The productivity of labor-intensive garment industry is highly influenced by efficient use of human resource. Operations management based solutions for extension of human resources' utilization levels may seem to increase productivity at first sight. However, heavy workloads and inadequately ergonomic working conditions can negatively influence health of the workers since the tasks in garment industry includes repetitive motions. Monotonous body postures during these motions negatively affect workers by causing work-related musculoskeletal disorders. Although companies may gain high efficiency by increasing utilization levels of workers, crucial health problems can occur in the long period if ergonomic conditions are not seriously taken into account. Furthermore, these problems not only cause work-related musculoskeletal disorders that result in high medical expenses for the company, but also employers will have to continue making a payment for the employees due to occupational health regulations. Therefore, employers must consider adequately safe and ergonomic conditions in the design of proper working environments.

The garment industry is usually accepted as a safe place for working compared to other industries. In this industry, the major risks generally do not arise from direct dangerous hazards, instead, the real risk is hidden in indirect hazards that affect over time due to repetitive jobs. The problems often begin as minor pains, but then they can turn into incapacitating disorders that affect daily life standards of the workers (Saravanan, 2011). Ergonomics aims to prevent these type of problems by controlling the risk factors such as vibration, repetition, working environment, force and posture prior to occurrence of disorders. Therefore, the number of ergonomics risk assessment studies in this industry is significantly increased in the recent decade (Gade, et al., 2015; Keawduangdee, et al., 2012; Koruca, 2011; Metgud, et al., 2008; Mungan & Yetiş, 2009; Parimalam, et al., 2006; Reinhold, et al., 2006; Sealetsa & Thatcher, 2011; Tompa, et al., 2013; Wu, et al., 2015).

In this study, risk assessment of garment industry workers is addressed with ergonomics aspects. A systematic ergonomics improvement regarding these risks that prevent workers from musculoskeletal disorders and help improvement to performance and productivity of workers. Rapid Entire

Body Assessment (REBA) method is used to evaluate operations and to determine the physical workload in a garment factory.
This paper is structured as follows. Section 2 introduces the methods for physical workload evaluation methods including REBA. Section 3 includes ergonomic risk assessment for thirteen different operations taken from a garment factory. Finally, Section 4 concludes the paper and present future research directions.

MATERIAL AND METHOD

Work-related musculoskeletal disorders cause expensive health care problems which result in the loss of income and productivity. Risk assessment of physical workloads may help to prevent development of disorders. Demand of repeating activities, workplace and environmental conditions affect the measurement process of physical workloads (Fallentin, et al., 2000).

Common methodological tools used to assess physical workload are JSI - the job strain index (Steven Moore & Garg, 1995), NIOSH - the National Institute for Occupational Safety and Health lifting equation (Waters, et al., 1993), REBA - the rapid entire body assessment (Hignett & McAtamney, 2000), RULA - the rapid upper limp assessment (McAtamney & Nigel Corlett, 1993); MAC - the manual handling assessment charts (Monnington, et al., 2003), OCRA - The concise exposure index (Occhipinti, 1998), OWAS - Ovako Working posture Assessment. System (Karhu, et al., 1977) and QEC - Quick Exposure Check (Li & Buckle, 1999). See David (2005) and Roman-Liu (2014) for detailed comparison of common physical workload assessment tools.

In this study, REBA method enables to analyze repetitive motions and various postures of workers. REBA is an observational methodology used to investigate risk levels of various postures by using aggregate position of the body (Hignett & McAtamney, 2000). Application of a basic REBA method is given as follows: observation of the worker, ergonomic analysis of workplace and working environment, calculation of neck, trunk and leg analysis scores as Score A, calculation of arm and wrist analysis as Score B, calculation of Score C by combining of Score A and Score B and calculating final REBA score between 1 and 15. Final REBA score allows to assess the risk level of the postures and determine actions required for the improvement of working conditions (Table 1) (Hignett & McAtamney, 2000; Polat, et al., 2015).

Table 1: Required actions for REBA scores

REBA Score	Risk Level	Action
1	Negligible	None necessary
2-3	Low	May be necessary
4-7	Medium	Necessary
8-10	High	Necessary soon
11-15	Very High	Necessary now

RESULTS AND DISCUSSIONS

In the content of this study, ergonomic risk assessment related to working postures of workers in garment industry are investigated in a factory that manufactures baby towels, bathrobes and sleeping bags. In this content, firstly, the data of work-related health problems that is logged by workplace doctor is examined. The data show that there is a significant increase in musculoskeletal disorders for the workers working in sewing, cutting, packaging, warehouse and packaging departments in the recent year. Thirteen problematic working areas are selected according to the suggestions of workplace doctor and experienced workers for investigation.

Then, the working environments are investigated and surveys are conducted. Additionally, video and photos from different angels are recorded in order to analyze working postures of the workers from these areas.

The assessment application from packaging department is explained in detail as an example of the process examined in the factory. There is a dynamic working environment in this department since the final operations including quality control, ironing, bagging and boxing of all products are executed. Boxing unit in this department is one of the selected problematic areas. In this unit, employees are not working in stable conditions, on the contrary, they have to walk between boxing areas and bagging bands, carry the products from the bands and bend down to place them to boxes. The noise in this section is reported as 65 decibels and the dust level is found to be lower compared to sewing and cutting departments. Although, lighting, temperature, humidity and thermal comfort levels are also in acceptable levels, working postures of the workers have to be analyzed with a risk assessment method before drawing a conclusion. Figure 1 shows the worker that is under REBA study as an example from this unit. See Hignett and McAtamney (2000) for the details of REBA scores calculation.

Figure 1: Boxing unit of packaging department

In order to determine Score A, trunk, neck and leg positions during the operations are analyzed. Truck position is scored as 4, neck position is scored as 2 and leg positions are scored as 3. These scores are used to calculate posture Score A as in Table 2. Posture Score A is found to be 7 for this worker. Since Force/Load score is 0, final Score A is determined as 7.

Table 2: Calculation of Score A

Table A		Neck score											
		1				2				3			
		Legs score				Legs score				Legs score			
		1	2	3	4	1	2	3	4	1	2	3	4
Trunk score	1	1	2	3	4	1	2	3	4	3	3	5	6
	2	2	3	4	5	3	4	5	6	4	5	6	7
	3	2	4	5	6	4	5	6	7	5	6	7	8
	4	3	5	6	7	5	6	7	8	6	7	8	9
	5	4	6	7	8	6	7	8	9	7	8	9	9

Then, upper arm, lower arm and wrist positions are investigated and scored according to Table 3. By using these sub-scores, posture score B is found to be 4. Since there is no additional coupling score, final Score B is calculated as 7.

Table 3: Calculation of Score B

Table B		Lower arm score					
		1			2		
		Wrist score			Wrist score		
		1	2	3	1	2	3
Upper arm score	1	1	2	2	1	2	3
	2	1	2	3	2	3	4
	3	3	4	5	4	5	5
	4	4	5	5	5	6	7
	5	6	7	8	7	8	8
	6	7	8	8	8	9	9

In order to calculate Score C, Score A and Score B are combined by using Table 4. Score C is calculated as 8 by using this table. Final REBA score is determined by using Score C and activity score is demonstrated in Figure 2.

Table 4: Calculation of Score C

Table C		Score B											
		1	2	3	4	5	6	7	8	9	10	11	12
	1	1	1	1	2	3	3	4	5	6	7	7	7
	2	1	2	2	3	4	4	5	6	6	7	7	8
	3	2	3	3	3	4	5	6	7	7	8	8	8
	4	3	4	4	4	5	6	7	8	8	9	9	9
	5	4	4	4	5	6	7	8	8	9	9	9	9
	6	6	6	6	7	8	8	9	9	10	10	10	10
Score A	7	7	7	7	8	9	9	9	10	10	11	11	11
	8	8	8	8	9	10	10	10	10	10	11	11	11
	9	9	9	9	10	10	10	11	11	11	12	12	12
	10	10	10	10	11	11	11	11	12	12	12	12	12
	11	11	11	11	11	12	12	12	12	12	12	12	12
	12	12	12	12	12	12	12	12	12	12	12	12	12

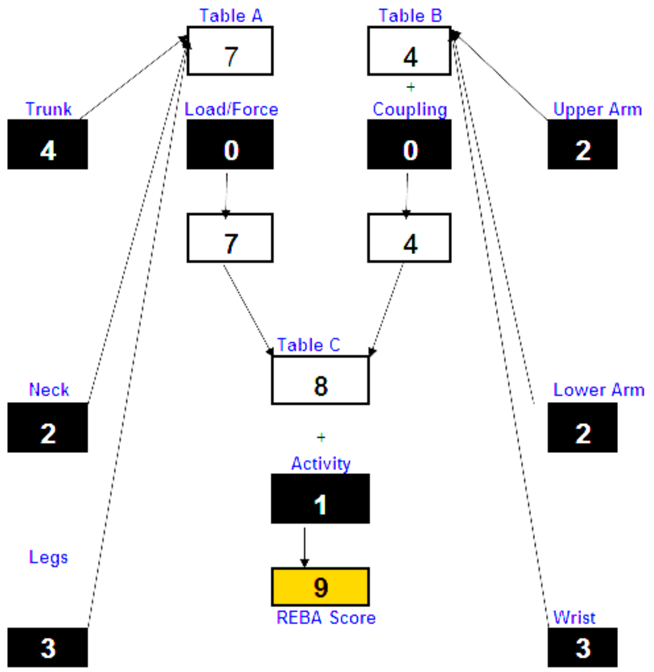

Figure 2: REBA assessment worksheet

Since the boxing operation is repeated more than four times in a minute, an additional activity score 1 is added and final REBA score is determined as 9 for this operation.
According to Table 1. this score points out high risk level. In this case, the management have to immediately investigate and implement improvements in order to prevent and reduce musculoskeletal disorders.

In short, 13 selected areas of saving, cutting, packaging and warehouse departments are analyzed and risk assessments are investigated by using REBA method. According to the results, the working environments, except sewing department, are generally found to be in acceptable levels. In sewing department, the noise is reported as 75 decibels in average that may cause problems to workers in long periods. Moreover, the dust levels are also reported as very high in this department compared to other departments, except cutting department. Analysis of REBA scores show that two of the areas are in low risk level, nine of them is in medium level, two of them is in high level and the finally the warehouse department indicates a very high level risk of injury. Especially high risk level areas require ergonomic implementations to reduce the risk factors that can be done via communication, eliminating excessive force and awkward posture requirements, ergonomic design factors, proper work techniques, job rotations, rest or stretch breaks, training and education.

CONCLUSIONS

Occupational health and safety practices require field observations which can be performed with the help of feedbacks received from workers and health statistics. In this study, the working environment and postures of garment workers are investigated in a textile factory. The ergonomic risk assessment of thirteen critical areas are analyzed by REBA method. The evaluation of the results show that almost quarter of the selected areas include high or very high risk levels which require immediate changes. The operations in these areas could cause serious physical disorders in a short period of time. Risk assessments can protect workers from significant work related musculoskeletal disorders and injuries which could be eliminated by ergonomic improvements. Future research studies may include comparison of alternative assessment methodologies such as OWAS and implementation of improvement suggestions with before/after analyzes.

REFERENCES

David, G. C. (2005). Ergonomic methods for assessing exposure to risk factors for work-related musculoskeletal disorders. *Occupational Medicine, 55*, 190-199.

Fallentin, N., Kilbom, Å., Viikari-Juntura, E., & Wærsted, M. (2000). Evaluation of physical workload standards/guidelines from a Nordic perspective. In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* (Vol. 44, pp. 6-429-426-432): SAGE Publications.

Gade, R., Chandurkar, P., Upasani, H., & Khushwaha, D. (2015). Ergonomic Intervention to Improve Safety and Productivity. *International journal on Textile Engineering and Processes, 1*, 79-88.

Hignett, S., & McAtamney, L. (2000). Rapid Entire Body Assessment (REBA). *Applied Ergonomics, 31*, 201-205.

Karhu, O., Kansi, P., & Kuorinka, I. (1977). Correcting working postures in industry: A practical method for analysis. *Applied Ergonomics, 8*, 199-201.

Keawduangdee, P., Puntumetakul, R., Chatchawan, U., Kaber, D., & Siritaratiwat, W. (2012). Prevalence and associated risk factors of low-back pain in textile fishing net manufacturing. *Human Factors and Ergonomics in Manufacturing & Service Industries, 22*, 562-570.

Koruca, H. İ. (2011). Evaluation of working life quality for a textile company in turkey: A case study. *Gazi University Journal of Science, 24*, 101-112.

Li, G., & Buckle, P. (1999). Current techniques for assessing physical exposure to work-related musculoskeletal risks, with emphasis on posture-based methods. *Ergonomics, 42*, 674-695.

McAtamney, L., & Nigel Corlett, E. (1993). RULA: a survey method for the investigation of work-related upper limb disorders. *Applied Ergonomics, 24*, 91-99.

Metgud, D., Khatri, S., Mokashi, M., & Saha, P. (2008). An ergonomic study of women workers in a woolen textile factory for identification of health-related problems. *Indian Journal of Occupational and Environmental Medicine, 12*, 14.

Monnington, S., Quarrie, C., Pinder, A., & Morris, L. (2003). Development of manual handling assessment charts (MAC) for health and safety inspectors. *Contemporary Ergonomics*, 3-8.

Mungan, M., & Yetiş, Ü. (2009). Environmental Risk Assessment Of A Textile Factory In Turkey. In S. Stec & B. Baraj (Eds.), *Energy and Environmental Challenges to Security* (pp. 415-427). Dordrecht: Springer Netherlands.

Occhipinti, E. (1998). OCRA: a concise index for the assessment of exposure to repetitive movements of the upper limbs. *Ergonomics, 41*, 1290-1311.

Parimalam, P., Kamalamma, N., & Ganguli, A. (2006). Ergonomic interventions to improve work environment in garment manufacturing units. *Indian Journal of Occupational and Environmental Medicine, 10*, 74.

Polat, O., Mutlu, Ö., & Özgörmüş, E. (2015). A Goal Programming Model For Assembly Line Balancing Problem Type 2 Under Workload Constraint. In *The 2015 Northeast Decision Sciences Conference*. Boston, MA.

Reinhold, K., Tint, P., & Kiivet, G. (2006). Risk assessment in textile and wood, processing industry. *International Journal of Reliability, Quality and Safety Engineering, 13*, 115-125.

Roman-Liu, D. (2014). Comparison of concepts in easy-to-use methods for MSD risk assessment. *Applied Ergonomics, 45*, 420-427.

Saravanan, K. (2011). Importance and need of ergonomics in the apparel industry. *Pakistan Textile Journal, 60*.

Sealetsa, O., & Thatcher, A. (2011). Ergonomics issues among sewing machine operators in the textile manufacturing industry in Botswana. *Work, 38*, 279-289.

Steven Moore, J., & Garg, A. (1995). The Strain Index: A Proposed Method to Analyze Jobs For Risk of Distal Upper Extremity Disorders. *American Industrial Hygiene Association Journal, 56*, 443-458.

Tompa, E., Dolinschi, R., & Natale, J. (2013). Economic evaluation of a participatory ergonomics intervention in a textile plant. *Applied Ergonomics, 44*, 480-487.

Waters, T. R., Putz-Anderson, V., Garg, A., & Fine, L. J. (1993). Revised NIOSH equation for the design and evaluation of manual lifting tasks. *Ergonomics, 36*, 749-776.

Wu, X., Chen, L., Pang, S., & Ding, X. (2015). A paratactic subjective-objective weighting methods and SVM risk assessment model applied in textile and apparel safety. *International Journal of Quality & Reliability Management, 32*, 472-485.

INFLUENCE OF FABRIC STRUCTURAL PARAMETERS ON WRINKLE RESISTANCE AND GARMENT DRAPE

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ABSTRACT

The paper investigates the influence of variation in fabric structure and finishing on wrinkle resistance and drape properties of woven fabrics for outerwear garments. There are five pairs of fabric investigated. One structural parameter or type of finishing treatment is varied within fabrics in each pair. The results obtained have shown that variation in weft density and weft yarn count can greatly influence wrinkle resistance and to less extent fabric drape. The effects vary with the scale of variation and testing direction. The greatest influence on wrinkle resistance and fabric drape was achieved with the introduction of higher count weft thread. Also, the F-test confirms finishing treatment to be significant factor for wrinkle resistance.

Key words: wrinkle resistance, drape, woven fabrics, oilproof and waterproof finishing

INTRODUCTION

Wrinkle resistance and drapebility are the most important properties of fabric, having significant roles in providing graceful aestetic effects in garment. Wrinkle is an undesirable qualty of garment, which occurs during usage. There are various finishing materials and treatment methods which enhance fabric crease resistance. However, there are several disadvantages associated with cotton fabric such as poor elasticity and resiliency which creates wrinkles and do not recover from wrinkling readily (Dalbasi E. S., *et al*, 2013, Kan C.W., *et al*., 2012). Although wrinkles could be sometimes a desirable effect for smartness of clothes, it is generally an undesirable appearance occurring during wear (Can Y., *et al.*, 2009). Fiber, yarn, fabric characteristics, and finishing effect the formation of wrinkles. Factors that influence wrinkle development include fiber type, bending performance of fiber, fiber diameter, yarn twist, weft-warp density, fabric construction, and fabric thickness. The crease recovery is one of the fundamental properties of fabrics which affect product performance. Crease recovery refers to the ability of the fabric to return to its original shape after removing the folding deformations. The recovery of the fabric from creasing depends on the elastic recovery of the fibers, in particular whether the stored elastic energy is sufficient to overcome the friction that resists the movement of the yarns and fibers (Omeroglu S., *et al.*, 2010). The ability of fabrics to recover from wrinkles is an important factor for the quality of fabrics. For this reason, the interest of buyers in wrinkle-resistant apparels has diverted the producers' attention to use easycare finishes (Saleemuddin M., *et al.*, 2013). Wrinkle (or crease) resistance is imparted to cellulosic fibers by restricting the slippage of molecular chains through crosslinking (Lu M., 2010). Formulation of the finish is significant to yield the desirable balance of physical properties. If excessive crosslinking is achieved, the strength and abrasion resistance may be too low for adequate wear life of the garment. On the other hand, if too little crosslinking is obtained, there may be inadequate shrinkage control, smoothness, crease retention, and undesirable surface appearance. Abou Nassif G. A., (2012) investigated the effects of weft density and weave structures on the physical and mechanical properties of fabrics, which are micro-polyester woven fabrics with plain, twill and satin weave structures in five different weft densities. The findings of this study revealed that increasing weft density leads to an increase in fabric breaking load, stiffness and crease recovery. Satin weaves have higher air permeability, whereas twill weaves have higher crease recovery.

Weft density was found to have a profound effect on crease angle. An increasing trend was detected assuring that as the weft density increases the crease angle increases.

It was also shown that twill fabrics exhibits higher crease recovery followed by plain and satin weaves respectively. In the study of Omeroglu S., *et al*, (2010), full and hollow fibers having round and trilobal cross-sectional shapes were produced in equal manufacturing conditions and bending, drapability and crease recovery behaviors of the woven fabrics produced from these fibers were investigated. The fabrics produced from full fibers had higher crease recovery angles than those produced from hollow fibers. Considering that the construction properties of the fabrics were kept constant, it was concluded that the differences among the properties of the fabrics which were produced from full and hollow fibers (for both round and trilobalcrosssectional shapes) basically emerged from the very high differences between moments of inertia of full and hollow cross sections. The best results were obtained with round and trilobal full fibers at fabrics in which drapability and crease recovery are desired. Ozguney A.T., *et al*., (2015) evaluated effect of wrinkle resistance finish on wrinkle recovery, tensile, pilling and drape properties of shirt fabrics produced from 100% cotton fabrics. They concluded that crease resistance finishing seems to have an increasing effect on wrinkle recovery angle (WRA) and pilling tendency, whereas it leads to a decrease in drape angle (drapeability), breaking and tearing resistance of the fabrics. Jevšnik S., *et al*., (2004) investigate some mechanical properties and parameters of drapability using different methods from two different points of research area knowledge bases and numerical modeling using the finite element method. The numerous investigations proved that the properties of bending, creasing and draping ability are all related to the factors of fabric structure. Zhang H., *et al*., (2003) tested and analyzed some cotton, wool, silk and man-made fabrics, and they concluded that the bending, creasing and draping are correlated to fabric type. Jing M., (2006) has analyzed the structures of lightweight worsted fabrics. He has investigated some characteristics of worsted fabric, such as wrinkle resistance, blend resistance, drapability and air permeability. He has used the gray interrelation theory to deal with the data of structure parameters and wearing characteristics target, and analyzed the relationship between the wearing fabric characteristics and structure parameters. The results indicated that the most important factor of fabric wearing characteristics was linear density followed by fabric area weight, thickness and tightness. The results provided theoretical basis for designing high-grade worsted fabric.

In this direction, the aim if this paper is to further investigate the influence of variation of fabric structure and finishing treatment on wrinkle resistance and drape properties of woven fabrics for tailored garments.

EXPERIMENTAL

The particulars of fabric structure are shown in Table 1. There are five distinctive pairs of fabrics in the whole investigated range. The differences within pair are created by variation of fabric or yarn parameters (weft thread density or weft yarn count) or by application of particular finishing treatment.

The fabrics of the first pair A and A1 have all structure parameters identical, except weft density. Namely, the sample A1 has higher weft density than its pair. All other parameters, including fibre composition, yarn count, warp density and finishing treatment are identical.

The second pair of fabrics designated B and B1, have all structure parameters identical except weft yarn count. The first fabric of the pair B has single ply weft yarn of lower count, while the second fabric B1 has double ply weft yarn of higher count.

The third pair of fabrics C and C1 have also all the fabric structural parameters identical, except weft density. The fabric C has lower weft density, while C1 has higher weft density.

The fabrics of the fourth pair designated D and D1 have only difference in finishing treatment. Namely, D has standard clear cut finishing, while D1 has additional waterproof and oilproof finishing. All other parameters of both fabrics are identical.

The fifth pair of fabrics, E and E1 has also all structural parameters identical except type of finishing. Here also the second fabric in the pair has standard clear cut finishing while E1 has plus waterproof and oilproof finish.

Regarding fiber composition, the first three pairs of fabric have 100% wool or 100% wool with Lycra. Regarding weave, they are similar and have twill 2/1 or twill 2/2 weave.
The fourth and fifth pair of fabrics has both an identical fibre composition: a blend of wool, PES and Lycra. These pairs have identical warp and weft counts but have different weave.

Table 1: Investigated fabric particulars

Fabric	A	A1	B	B1	C	C1	D	D1	E	E1
Fiber composition	98% wool 2% lycra	98% wool 2% lycra	100% wool	100% wool	100% wool	100% wool	44% wool 54% PES 2% lycra	44% wool 54% PES 2% lycra	44% wool 54% PES 2% lycra	44% wool 54% PES 2% lycra
Yarn count, warp [Tex]	17x2	17x2	15x2	15x2	17x2	17x2	18x2	18x2	18x2	18x2
Yarn count, weft [Tex]	17x2	17x2	24	15x2	17x2	17x2	18x2	18x2	18x2	18x2
Warp density, cm^{-1}	32	32	31.2	31.2	30.8	30.8	29	29	35.4	35.4
Weft density, cm^{-1}	24.80	26.2	27.6	28	25.6	28.2	20	20	24.4	24.4
Fabric thickness, mm	0.36	0.41	0.29	0.34	0.39	0.41	0.39	0.39	0.45	0.45
Fabric weight, g/m^2	213	227	167	187	213	227	200	200	250	250
Finishing	standard	standard	standard	standard	milled	milled	standard	oilproof waterproof	standard	oilproof waterproof
Weave	2x1 twill	2x1 twill	2x1 twill	2x1 twill	2x2 twill	2x2 twill	plain	plain	2x2 twill	2x2 twill

Wrinkle resistance was determined by using the instrument type FF_OT product on Metrimpeks, according to standard MKS F.A1.016. The greater the quality value number K, the greater is fabric wrinkle resistance. The fabric has good wrinkle resistance if it has a higher value over K = 50%. Below the value of 20%, the fabric has a poor quality and is prone to create wrinkles.

The fabric drapeability was tested according AFNOR NF G 07-109. According the standard, two circular fabric samples of 25cm in diameter are tested for each measurement. Measurement is performed by positioning the fabric sample between two discs and left to rest for 15 minutes. Using the slider and the horizontal scale, the contour of the falling fabric value is obtained in 16 points. The average of all 16 measurements gives the diameter (d) of a tested sample. Drape coefficient is calculated by equations (1) and (2):

$$F = \frac{Sc - Si}{St - Si} = \frac{d^2 - di^2}{dt^2 - di^2} \quad (cm^2) \qquad (1)$$

Where:

Sc - surface of the test sample after testing with a measured average diameter (cm)
Si - surface of the disc with a diameter
di = 15cm (cm)
St - initial surface of sample before testing with a diameter dt= 25cm (cm)

Then the drape coefficient is:

$$F = \frac{d^2 - 225}{400} \quad (cm^2) \qquad (2)$$

RESULTS AND DISCUSSION

The results of wrinkling resistance quality number of the investigated fabrics in warp and weft directions are given in Table 2 and Figure 1.

Table 2: Wrinkle resistance quality number in warp (K_1) and weft (K_2) direction

Fabric	A	A1	B	B1	C	C1	D	D1	E	E1
	Wrinkle resistance in warp direction									
K_1 [%]	**75**	**71.6**	**72.7**	**74.5**	**70.8**	**72**	**67.3**	**67.7**	**63.3**	**69.8**
SD [%]	1.48	0.45	3.67	2.88	3.13	2.16	3.35	2.83	2.68	0.7
CV [%]	1.97	0.6	5	3.86	4.42	3	4.97	4.18	4.23	1
α_{60}	162	160	157	163	156	159	155	156	153	159
SD	1.48	2.19	3.11	2.64	3.7	0.89	2.88	1.48	4.87	1.34
CV [%]	0.91	1.37	1.98	1.62	2.37	0.56	1.86	0.95	3.18	0.84
	Wrinkle resistance in weft direction									
K_2 [%]	**70.7**	**72.2**	**70**	**76.5**	**70.1**	**65.7**	**73.1**	**62.8**	**70.3**	**71.4**
SD [%]	1.92	1.82	2.41	0.55	2.74	1.3	1.64	2.58	1.64	2.19
CV [%]	2.72	2.52	3.44	0.72	3.91	1.98	2.24	4.11	2.33	3.07
α_{60}	157	157	162	161	160	152	161	151	160	160
SD	3.03	3.03	4.12	2.61	0.71	0.89	1.67	5.56	0.89	0.44
CV [%]	1.93	1.93	2.54	1.62	0.44	0.59	1.04	3.68	0.56	0.28

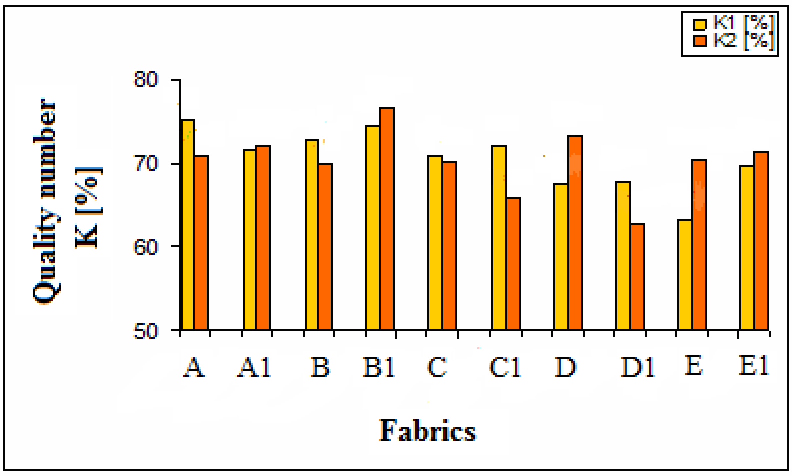

Figure 1: Wrinkle resistance quality number in warp (K_1) and weft (K_2) direction

Increasing the weft density at the first pair results in decreasing of the quality number in warp and increasing the weft direction.

The third pair has a different behavior: fabric with a higher density of weft has decreased quality number on warp, while increasing the weft. The differences behavior may be due to differences in the degree of increasing weft density, different weave, and presence of Lycra fiber in the weft yarn in the first pair.
The second pair, the sample of higher weft yarn count have higher quality number in both directions (warp and weft), but analysis of variance shows that only increase in weft is statistically significant.
Regarding the fourth and fifth pair, in general the samples with waterproof and oilproof finishing have increased quality number. The exception is the fourth pair of fabrics of plain weave where treated fabirc have increased quality number in warp, but decreased in weft.
The influence of structural parameters variation on fabric wrinkle resistence was analyzed by main effects analysis of variance (ANOVA). The results are given in Table 3 for the warp and weft way testing respectively.
The results of F-test confirmed the impact of weft density variation on wrinkle resistance, for the first pair only in warp direction, and for the third pair only in weft direction. The F-test results prove that the yarn count and type has significant influence to wrinkle resistance for weft tested samples. Also, the test confirm finishing treatment to be significant factor for wrinkle resistance, for fourth pair only in weft direction, and for the fifth pair in warp direction.

Table 3: F-test for warp (K_1), and weft direction (K_2) samples

Samples	**A/A1**	**B/B1**	**C/C1**	**D/D1**	**E/E1**
Factor	Weft density	Weft thre count	Weft density	Oilproof and waterproof finishing	Oilproof and waterproof finishing
	Warp way				
F_{K1}	**16.32***	0.39	0.52	0.01	**28.2***
p	**0**	0.55	0.49	0.92	**0.01**
	Weft way				
F_{K2}	1.57	**26.47***	**11.65***	**22.02***	0.66
p	0.25	**0.01**	**0.01**	**0**	0.44

** F- values and p-values marked with asterisk indicate significant influence of yhe investigated factors on the measured properties*

The results of fabric drape testing are presented in Table 4.

Table 4: Drape coefficient of testing fabrics

Drape Coefficient	**Fabric**									
	A	**A1**	**B**	**B1**	**C**	**C1**	**D**	**D1**	**E**	**E1**
F [cm²]	**0.58**	**0.57**	**0.56**	**0.61**	**0.59**	**0.60**	**0.64**	**0.62**	**0.62**	**0.64**
SD [cm²]	0.46	0.49	0.49	0.52	0.30	0.39	0.52	0.40	0.54	0.53
CV [%]	4.30	4.61	4.61	4.79	2.78	3.61	4.75	3.69	4.96	4.83

It can be seen that the drape coefficient ranges from 0.56 to 0.64 cm^2. These values justify the end use of the fabrics intended for clothing where outer fabric does not need to be very drapeable.
The increasing of weft density at first pair of fabrics did not affect increasing the drape coefficient. Moreover, sample A1 of increased weft density has lower drape coefficient. The explanation could be in a smaller magnitude of increasing weft density.

The second pair, a fabric as a result of introduction of higher weft thread count (B1) shows increased drape coefficient for 10%. After introduction of higher weft count, this sample has increased fabric weight, and increased cover factors, which all account for increased drape coefficient.
Again, the increasing of weft density in a second sample of the third pair (C1) resulted in increased drape coefficient. As it was explained previously the scale of increasing weft density is greater compared to first pair of fabric, (10.2% to 5.6%), which is why this variation results in rising drape coefficient.
The fourth and fifth pair of fabrics behave differently on introduction of oilproof and waterproof finishing. Namely, the first pair shows lowering of a drape coefficient as a result of finishing, while fifth pair shows increasing of drape coefficient.

CONCLUSION

The influence of fabric structure variations on wrinkle resistance and drape properties for a range of fabrics for tailored garment was investigated.
It was shown that the variation of fabric structure can affect wrinkle resistance. The effects vary depending of the intensity and type of variation and direction of testing.
Introduction of higher count double ply weft thread has a greatest effect on increasing wrinkle resistance and fabric drape.
The analysis of variance proved that variation of thread density, yarn type, count and oilproof and waterproof finishing has significant factors to fabric wrinkle resistance.
The introduction of higher count weft thread showed greatest effect on increasing drape coefficient.

REFERENCES

Dalbasi E. S., Coban S., Bahtiyari M.I. (2013). *An optimization study on cross linking of linen and cotton fabrics*, Industria Textila, 64(5), 235-240

Kan C.W., Lam Y.L., Yuen C.W.M. (2012). *Microscopic study of cotton fiber subjected to different functional treatments*, Current Microscopy Contributions to Advances in Science and Technology, FORMATEX, Microscopy Series, 2(5), 1130-1136

Can Y., Akaydin M., Turhan Y., Ay E. (2009). *Effect of wrinkle resistance finish on cotton fabric properties*, Indian Journal of Fibre & Textile Research, 3, 183-186

Omeroglu S., Karaca E., Becerir B. (2010). *Comparison of bending, drapability and crease recovery behaviors of woven fabrics produced from polyester fibers having different cross-sectional shapes*, Textile Research Journal, 80(12), 1180-1190

Saleemuddin M., Ali S.T., Pervez M.K., Mughal M.J., Rasheed M. (2013). *Optimization of easy-care finishing of cotton/polyester blend fabric*, Journal of the Chemical Society of Pakistan, 35(3), 560-564

Lu M. (2010). *Crease resistant finishing of cotton fabric with a complex of fibroin and citric acid*, Fibres & Textiles in Eastern Europe, 18(3) (80) 86-88

Wrinkle-Resistant Finishing Of Cotton Fabrics And Garments, (2000). Cotton Incorporated – Technical Bulletin TRI 3013.

AbouNassif G.A. (2012). *Effect of weave structure and weft density on the physical and mechanical properties of micro polyester woven fabrics*, Life Science Journal, 9(3), 1326-1331

Özgüney A.T., Özdil N., Mengüç G.S. (2015). *Mechanical and drape properties of the shirt fabrics applied wrinkle resistance finishing*, Industria Textila, 66 (1), 32-38

Jevšnik S., Gubenšek I., Geršak J. (2004). *The advance engineering methods to plan the behaviour of fused panel*, 2nd International Textile, Clothing and Design Conference, October 3rd to 6th, Dubrovnik, Croatia, pp. 539-544

Zhang H., Zhu H., Zhang J. (2003). *Properties of fabric between bending, creasing and draping*, Wool Textile Journal, 3, 58-61

Jing M. (2006). *Influence of structure parameters of lightweight worsted fabric on wearing characteristics*, Wool Textile Journal, 5, 48-51

TESTING KNITTED FABRICS BY THE FAST SYSTEM

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ABSTRACT

In this study, physical and mechanical properties were testing by the FAST system. Testing knitted fabrics were 100% polyester. The materials were two different color white and navy. This testing shows all parameters of knitted fabrics gave us results. With this results of the FAST system we can predict a possible problems and mistakes for the process like tailoring and sewing. This results can be converted in Optitex system, where we can see all problems before production.

Key words: FAST system, FAST-1 (compression meter), FAST-2 (bending meter), FAST-3 (extension meter), FAST-4 (dimensional stability test), knit, fabric

INTRODUCTION

Today, textile materials are different structure and their behavior in all kind of making process are different too. For fashion companies important thing is to know how material will be have behavior during process of making garments. The testing will be good if we knows all characterists of the fabrics in all research methods. Textile texting in basic mean an application of engineering knowledge and science to determine the properties and characteristics of various textile products [1]. Testing environment should be in the standard textile testing atmosphere (20°C and 65% r.h.). Mechanical properties can be testing objective with instruments like are FAST and KES. *Alimaa* in work tell us that the objective test are accurate, precise, and repeatable, but they not always used for routine quality control in industry and trading mainly because of their high cost [2]. Carrera, Capdevila, Valldeperas in their work told that is the best known, most widely used direct methods are the Kawabata Evaluating System for Fabrics (KES-F) and the Fabric Assurance by Simple Testing (FAST) [3]. With FAST system can be testing compression, bending, extension and dimensional stability. Results from FAST system can import in Optitex System. The Fabric Editor supports FAST industry standards and automatically converts FAST result into OptiTex cloth parameters. Results from FAST which is need from Optitex system are: extensibility, bending rigidity, shear rigidity, surface thickness, and weight. For all testing important thing about testing is needed to be in defined conditions of moisture and temperature, not only for testing material, but also where test will be. Standard Atmosphere (ISO 139:2005) for the environment air temperature is 20°C and the relative humidity is 65% [4].

FAST System

FAST is a simple system of fabric objective measurement for assessing aspects of the appearance, handle and perfomance properties of fabrics. FAST, or Fabric Assurance by Simple Testing, consists of the following three instruments and test method [4].

FAST-1 Compression Meter
FAST-2 Bending Meter
FAST-3 Extension Meter
FAST-4 Dimensional Stability Test [4].

Geršak in her book, about FAST said that FAST is measuring system, which is developed Australian bussines company CSIRO Division of Wool Technology, intended for measuring mechanicall and physical properties of textile structure [5].

EXPERIMENTAL PART

In experimental part, will be show testing knitted fabrics by the FAST system. Testing was conducted under standard conditions, air temperature 20°C and relative humidity of 65%. Before testing, in order to obtain consistent results, fabrics must be conditioned overnight in the standard atmosphere before cutting. Cut test samples of the fabrics need to be marked and precision. Before cutting on every sample need to have mark an arrow on the fabric indicating the warp direction. For testing compression and bias-extension was necessary 6 samples (130x50mm), for bending and extension in the warp direction was necessary 3 samples (200x50mm), for bending and extension in the welt direction was necessary 3 samples (200x50mm), for dimensional stability test was necessary 1 sample (300x300mm), and 5 samples dimension (diameter 110mm). Testing was for both fabrics, white and navy. The fabrics was 100% polyester.

FAST-1

FAST-1 compression Meter provides a direct measure of fabric thickness at selected loads [4]. The testing was done for both fabrics. Measuring thickness fabrics are on the figure 1. Fabric thickness at 2 gf/cm^2 (196 Pa) and 100 gf/ cm^2 (9,81 kPa) are standard fabric specifications, which we used for testing.

Figure 1. Measuring thickness

FAST-2

Bending length is determined by the length of the free part of the fabric that folds due to the effect of its own weight, until its overhead part of it reaches the plane at an angle of 41,5° C to the horizontal level. The device is equipped with a photocell who determine the length whereby the sample is bent at an angle 41,5°C to the horizontal [5]. The instrument is designed to measure bending length of 50 mm width knitwear[6]. Measuring bending is on the figure 2.

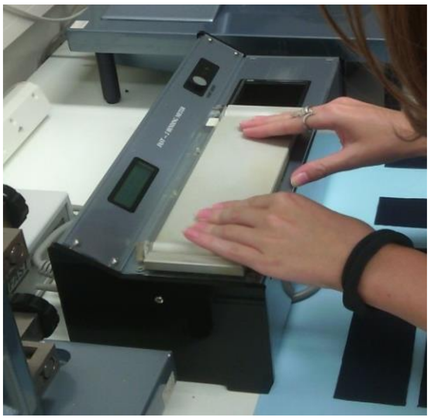

Figure 2. Measuring bending of samples materials

FAST-3

The FAST-3 Extension Meter provides a direct measure of fabric extansion under selected loads [4]. On Figure 3 is instrument with sample of knitwear in process of testing. Loads (weights) for testing are 5, 20 and 100 gf/cm. Values of measurement are usually quoted in the warp and weft directions. The fabric specimens should be handled gently at all times [4].

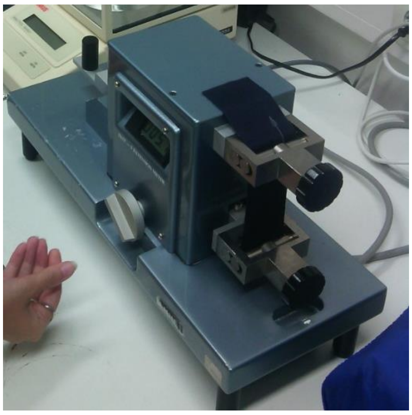

Figure 3. FAST-3 instrument with sample

FAST-4

Fabric dimensional stability is the ability to retain its dimensions during garment making up and subsequently during wear[4]. Jelka Geršak, in her book states the dimensional stability is defined as a change in surface dimensions of textiles which occurs when exposed to different enviromental conditions [5]. Procedure is that the first sample is exposed to a temperature of 105°C in period of 60 minutes. After, the sample need to measure in period of 30 seconds(figure 4). The next step is soak the sample for 30 minutes in water countaining about 0.1% non-ionic wetting agent or roughly 1g wetting agent per litre of water (figure 5). The temperature of water need to be at 25-35°C. After 30 minutes, samples must be measure in interval of 30s. Sample after measurement again going in dryer, on temperature of 105°C (figure 6). After drying samples must be measurement in period 30 s, totally dry sample.

Figure 4. Sample for measuring

Figure5. Plate with water

Figure 6. Dryer

For dimensional stability weght fabric is essential. Procedure for weght fabrics is next. The first task is measuring paperclips on scale (figure 7).

Amount of paperclips write on the paper and then can measure every sample of the fabrics. Sample and paperclips are together during measuring (figure 8). The total amount (sample and paperclips) which we get during the measurement, must be without amount of the paperclips. The results of middle value weight of the samples and the results of dimensional stability must be enter into the computer where are the rest datas of FAST system.

Figure 7. Measuring paperclips

Figure 8. Measuring weght

RESULTS AND DISCUSSION

The results from the FAST-4 are shown in the following tables. Table 1 present the results weight of navy samples and white samples. Table 2 are results of the dimensional stability of white fabric and table 3 are results of the dimensional stability of navy fabric.

Table 1. Results weight of the navy and white samples of the fabrics

White fabric			
Weight clip	0,3974 g m^{-2}		
Serial number	The weight of the sample and clip	The weight of sample (without clip)	The weight of sample in m/mg
1	2,4914	2,0940	209,4
2	2,4460	2,0486	204,86

3	2,4619	2,0645	206,45
4	2,4635	2,0661	206,61
5	2,4363	2,0389	203,89
Middle value			206,242
Navy fabric			
Weight clip	0,3973 g m^{-2}		
Serial number	The weight of the sample and clip	The weight of sample (without clip)	The weight of sample in m/mg
1	2,3798	1,9825	198,25
2	2,3844	1,9871	198,71
3	2,3686	1,9713	197,13
4	2,3782	1,9809	198,09
5	2,3912	1,9939	199,39
Middle value			198,314

Table 2. Results dimensional stability of white fabric

White sample		Dimension of the sample / mm					
		A – F	B – G	C – H	A – C	D – E	F – H
Air-conditioned sample	L_o	252	252	251	251	251	251
After heat treatment	L_1	251	252	251	250	248	249
After wet treatment	L_2	250	251	250,5	248	248	248
After heat treatment (drying)	L_3	250,5	251,5	250,5	249,5	248	248,5
Air conditioned sample	L_k	249	248	248,5	251	251,5	250,5

Tabela 3. Results of dimensional stability of navy sample

Navy sample		Dimension of the sample / mm					
		A – F	B – G	C – H	A – C	D – E	F – H
Air-conditioned sample	L_o	252	252	252	251	252	251
After heat treatment	L_1	251	251	250	251	252	251
After wet treatment	L_2	251,5	250	252	252,5	252,5	252
After heat treatment (drying)	L_3	251,5	250	250,5	251,5	252,5	253
Air conditioned sample	L_k	251,5	252,5	252,5	251,5	250,5	251

Results of the FAST-1, FAST-2, FAST-3 for white samples of fabric are in figure 9. Also in picture are results of the FAST-4 in computer.

Figure 9. FAST result (white fabric)

Results of the FAST-1, FAST-2, FAST-3 for navy samples of fabric are in figure 10. Also in picture are results of the FAST-4 in computer.

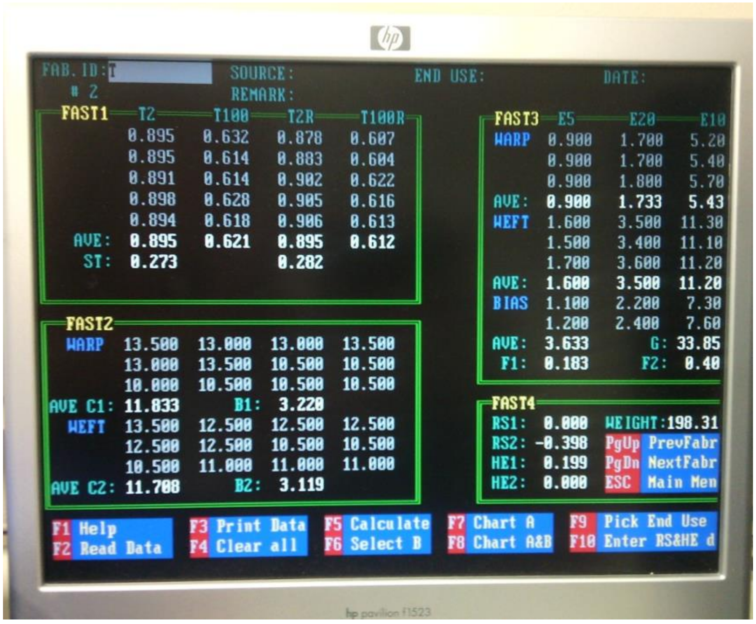

FIGURE 9. FAST result (white fabric)

On the next figures are FAST CONTROL CHART FOR TAILORABILITY for both fabrics. On figure 10 are results for white fabric and on figure 11 are results for navy fabric. Basic on FAST Control Chart for Tailorability, as well knowledge and limited values of individual parameters of the mechanical and physical properties of the fabric ie. those who affecting its behavior in that way is designed FAST Control Chart For Tailorability [5].

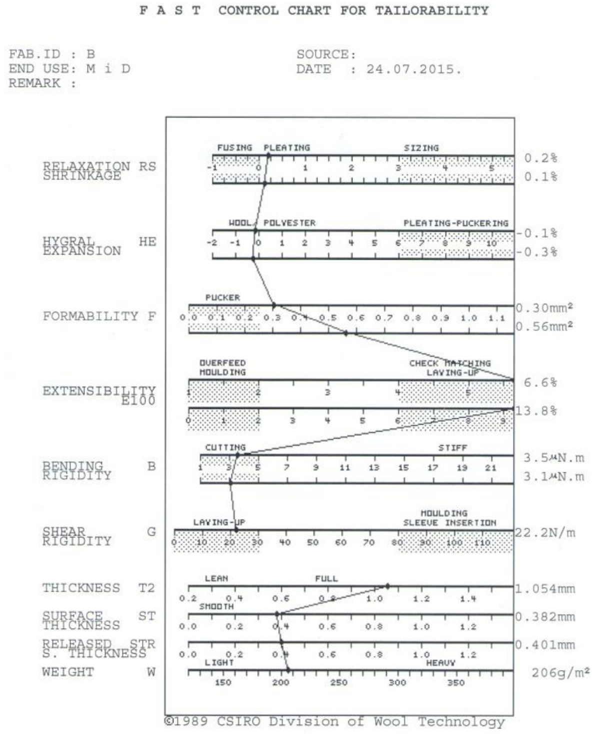

Figure 10. FAST Control Chart for Tailorability for white fabric

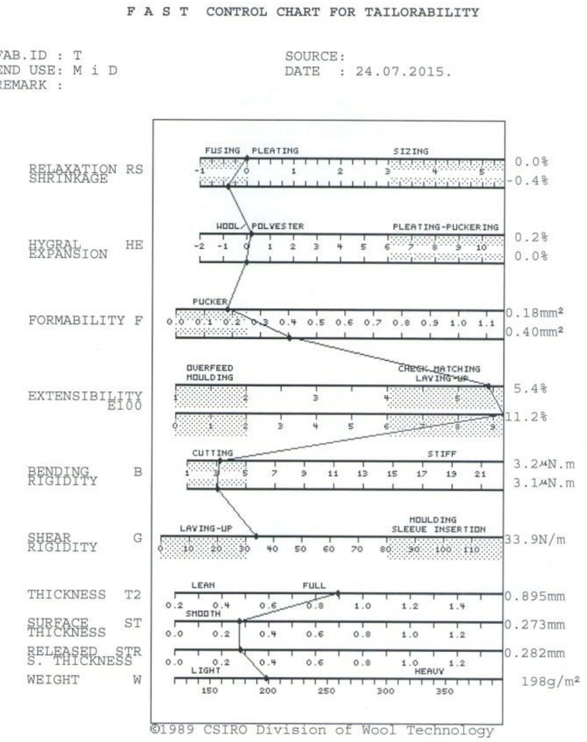

Figure 11.FAST Control Chart for Tailorability for navy fabric

FAST Control Chart for Tailorbility, program by himself can recognized possible problems which could happen during the process of making clothes.

FAST Control Chart for Tailorbility, for white fabric (figure 10). Relaxation shrinkage in the wrap and welt direction which have low value of shrinkage RS, they have negative effect on achieving fullnes 3D shape during the final ironing. Relaxation shrinkage *RS* is till 1%, more precisely for the wrap direction is 0.2% and for the welt is 0.1 %. Hygral Expansion *He* for the wrap direction is -0.1% and for the welt direction is 0.3%, because is lower value for stretching, during the final ironing will be little bit difficult especially for sleeves and on the area for shoulders. That is because for the ironing sleeves it should be some specified stretching and shrinking. In this case is really a little stretching and shrinking. Formability *F* is 0.30 mm^{-2} and 0.56mm^{-2}. For the results below 0.25 mm^{-2} we can considered they are inelastic and have in the same time the low values of bending rigidity. In this case, results are above 0.25 mm^{-2} and fabric has enough elastic and bending. Extensibility *E* for the wrap direction is 6.6% and for the welt direction is 13.8%. This extensibility for the wrap and welt direction are high, because of higher extensibility should be carefull during sewing and laying. Bending Rigidity *B* for the wrap direction is 3.5μN. m and for the welt direction is 3.1 μN. m. Because of this should be carefull during tailoring and sewing. Shear Rigidity is 22.2 N/m. This result is below 30 N/m, so should be carefull during tailoring and sewing, especially for sleeves.

FAST Control Chart for Tailorbility for navy fabric (figure 11). Relaxation shrinkage in the wrap and welt direction which have low value of shrinkage RS, they have negative effect on achieving fullnes 3D shape during the final ironing. Relaxation shrinkage *RS* is till 1%, more precisely for the wrap direction is 0.0% and for the welt is -0.4 %. Hygral Expansion *He* for the wrap direction is 0.2% and for the welt direction is 0.0 %, because is lower value for stretching, during the final ironing will be little bit difficult especially for sleeves and on the area for shoulders. That is because for the ironing sleeves it should be some specified stretching and shrinking. In this case is really a little stretching and shrinking. Formability *F* is 0.30 mm^{-2} and 0.56mm^{-2}. For the results below 0.25 mm^{-2} we can considered they are inelastic and have in the same time the low values of bending rigidity.

In this case, results fpr welt direction is above 0.25 mm^{-2} and fabric has enough elastic and bending. Extensibility *E* for the wrap direction is 5.4% and for the welt direction is 11.2%. This extensibility for the wrap and welt direction are high, because of higher extensibility should be carefull during sewing and laying. Bending Rigidity *B* for the wrap direction is 3.2μN. m and for the welt direction is 3.1 μN. m. Shear Rigidity is 33.9 N/m. This result is above 30 N/m, so should be carefull during tailoring and sewing.

CONCLUSIONS

In this research, testing fabrics with the FAST system showed similar results. Results of testing may be helpful before and during the production of making new garment. With this results that means we can know possible mistakes and problems for production. Testing for two different colors of the same fabric. One color is white, the second is navy. The results for white fabric are: relaxation shrinkage is low; hygral extension is lower for the wrap and welt direction, because of that should be carefull during ironing; formability is good; extensibility for both directions are higher, so it should be carefull in process of tailoring and sewing; shear rigidity is lower, it should be carefull in process of tailoring and sewing. Results of the navy fabrics are next: relaxation shrinkage is low; hygral extension in wrap and welt direction are lower, because of that should be carefull during final ironing the sleeves; formability in the wrap direction is lower and in the welt direction is higher; extensibility in the wrap and welt direction is higher, that could be lead to not so good sewing; bending ridigity in the both directions are lower, it should be carefull during tailoring and sewing; shear rigidity is higher, also be carefull during tailoring and sewing.

REFERENCE

[1] R. Čunko, "Ispitivanje tekstila", Zagreb, 1989.
[2] D. Alimaa, T. Matsuo, M. Nakajima, M. Takahashi, *Sensory Measurements of the Main Mechanical Parameter of Knitted Fabrics*, Textile Reaserch Journal, November 2000.
[3] E. Carrera-Gallissa, X. Capdevila, J. Valldeperas, *Correlation Analysis between a Modified Ring Method and the FAST System*, Journal of Engineered Fibers and Fabrics, Volume 9, Issue 1 – 2014
[4] The CSIRO Division of Wool Technology, Sydney, Australia, 1989.
[5] J. Geršak, "Objektivno vrednovanje plošnih tekstilija i odeće", Zagreb, Hrvatska, 2014.
[6] F. Robaldoni, R. Mossotti, A. Montarsolo, R. Demichelis, R. Innocenti, G. Mazzuchetti, *The Effects of Hmdso Plasma Polymerization on Physical, Low-strees Mechanical and surface Properties of Wool Fabrics*, AUTEX Research Journal, Vol. 8, No3, September 2008

FOOT ILLUSTRATIONS AS BASIS FOR WOMEN'S FOOTWEAR DEVELOPMENT

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ABSTRACT

The first step for a footwear designer is to become familiar with human foot anatomy and proportions. Illustrating the foot in different views and perspectives, designers learn how to illustrate a three-dimensional foot in order to develop different footwear styles. The paper presents elements of illustration approaches in order to construct a foot sketch as a basis for professional footwear development that can be used in the manufacturing process. Designers draw more high-heels that any other kind of shoes. Therefore, the paper also presents the basic drawings elements of women's high heel shoes.

Key words: drawings, fashion, foot proportion, foot movements, high heels

INTRODUCTION

Fashion illustration has developed over hundreds of years and nowadays, there is a need in the development of footwear design and accessories. Footwear illustration is an essential part in the design and development of footwear. General, drawing can be divided as reality drawing by observing real objects, called observational drawings of objects from nature or from appearance, and drawings which are made from designer imagination.

To be able to create own designs, the designer creates an imaginary database of shapes and forms of foot and footwear, which he then uses when he draws his own designs.
'The mind has to be able to collect data and process them to perceive reality. While these two functions are separated in theory, it is not necessary to say the same in practice. Just because the perception collects types of things, the observational material can be used for the thought and vice versa, if the content of the senses doesn't remain present, the brain has nothing to think with '(Rukavina, 2009)
When creating a footwear illustration, designers mind converts collected data in order to perceive reality (Rukavina, 2009). He also practices the way he looks at a model, his hand and he is improving his skills.

‘Arnheim claims that cognitive operations called thinking are not privilege of mental processes above and beyond perception but the essential elements of the observations. With this he has in mind such actions as are actively researching, selecting, perception of the essential, simplification, abstraction, analysis and synthesis, separation, correction, problem solving, comparison and combining, positioning, placing in context. There is no basic difference between what happens when someone perceives at the world directly and when sitting eyes closed and "thinks". We cannot separate the term ‘opinion’ from what happens in perception. Visual observation is visual thinking. Visual observation is extremely active activity’(Rukavina, 2009).

Drawing is the first form in making paintings, graphics, and even sculpture, in form of a sketch. A sketch is a record of particular form on two dimensional surface, as a paper.

Drawing can be observed as a complete work of art. The study is a type of drawing observed as complete visual record of final work of art or a final work of art.
The paper shows a diversity of sketching elements needed in the footwear development of women's high heels.

THE BASIC SKETCHING ELEMENTS

Designer when creating a new model of footwear, uses drawings as a tool for expressing his ideas. Every artist, as well every designer who draws the human body should study the shape of the foot, to know the anatomy of the foot, the number of bones that the foot consists of, muscles and tendons, joint. Also he should know the basic points on which to keep an eye later in construction of footwear (instep point and ball point). The hand is an artist’s tool with which he makes his works. Exercising the hand can occur by drawing and studying on live models, and sculpture casts (in the case shoe designer- casts of the foot and lower limbs. Every designer is advised to have his sketch book, where he records his ideas, and drawings, as a reference book for his later works.

Foot sketching is the first step to putt an idea onto a piece of paper, to concentrate on essential elements, on the form of footwear he creates. With sketching he’s defining the shape of the model, height and shape of the heel or the sole. Sketches in definition are quick drawings, a visual note which contains the basic visual elements such as point, line, surface, texture; depending on how the designer works or draws. Sketch can be made in various art techniques, drawing and painting (pencil, charcoal, ink, aquarelle, collage). Sketch can be made in monochrome and color (Pelizzari, 2013).

After sketching designer selects sketches that will be elaborated, the elaboration is a new drawing that is more detailed and that has more elements that show the decorations, texture, material, shape of heel, construction parts of shoes (patterns of footwear upper and sole).

Such a drawing requires more time than sketching, and depends on the skill of the designer. In order a designer to be able to transfer his idea in form of a sketch or illustration, he should be familiar with the anatomy of the human foot, with the shape of the shoe last, as with constructional elements or anatomy of shoes (Yuan, Jiang, 2013).

Figure 1: Foot illustrations representing the foot movement (Yuan, Jiang, 2013)

The basic visual elements used in drawings are dot, line, and surface. The most common used is line. Line is used divided by it's meaning: contour, structure and texture line, they are divided by their character: thin, wide, short, long, dashed, continuous, broken, and by flow: straight, curved, angled, open, closed.

Combining all the characteristics of a line we can draw a silhouette, make illusion of a surface and texture, but also represent a structure of an object- in this case of foot and shoe. Applying different character lines on the same drawing suggests the depth and three-dimensionality of the foot or shoe shape. Three-dimensionality can be suggested by applying shades and color. Figure 1 shows a human foot in various positions and angles, visualizing the foot movement. The various line characters suggests the illusion of perspective.

Figure 2: Different views of toe drawings (Yuan, Jiang, 2013)

Drawings in Figure 2 presents human toes which are considered as the most difficult foot part to draw.

FEMALE FOOT AND FOOTWEAR ILLUSTRATION

The drawing process of women shoes is frequently the subject of fashion changes, and has a greater range of variation in construction of uppers and heel heights. The illustration of women's shoes can be displayed individually or on human foot, and in the case of boots lower leg is drawn, and therefore it is necessary to study not only foot but also to draw the entire leg.

Figure 3: Foot illustrations representing different heel heights (Yuan, Jiang, 2013)

Drawing women's foot in different positions of view, different angles, helps to understand the foot shape and to get familiar with foot proportions, Figure 3. Incorrect proportions will cause problems in the process of footwear production (Wong, and Luximon, 2013).
It is important to know proportions of human foot, which the designer remembers by making observational foot drawings. There are also some rules and proportions of footwear which corresponds to proportions of the foot, because the heel height and shoe slope together determine whether it will be comfortable, if the person will not have any pain or difficulties during walking or standing, that the shoe doesn’t distort the posture of human body.

Sketches and illustrations are the main designer's communication tool by creating a shoe model or shoe collection. When creating a shoe model it is also important to consider the shoe sole. Shoes should beside the aesthetic view be designed to be comfortable and functional. These are important steps and an exercise that should be practiced in perfecting their art skills.

Figure 4 shows the creation of footwear started from a trapezoid shape. Auxiliary lines are used to define outline proportions, foot shape in geometric manner, and finally, the use of curved lines to define the silhouette of a shoe and leg.

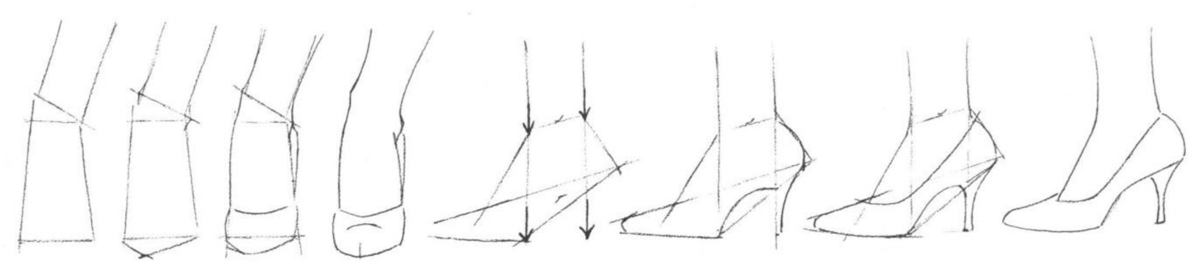

Figure 4: Step from auxiliary form to defined outline of a shoe and foot (Jack Hamm, 1983)

Figure 5 shows foot sketches seen from the heel. The heel should be positioned with the top-back of the sole in one line to assure body balance.

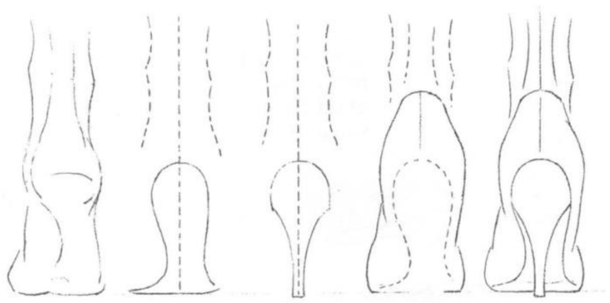

Figure 5: Foot and shoe drawn from back view (Jack Hamm, 1983)

Women's footwear consists of upper and heel which can come in a variety of shapes, Figure 6. A big variation of different types of shoes can be made on women's shoe last, from closed shoes to sandals, from stilettos to platform shoes, from open toes to closed, etc.

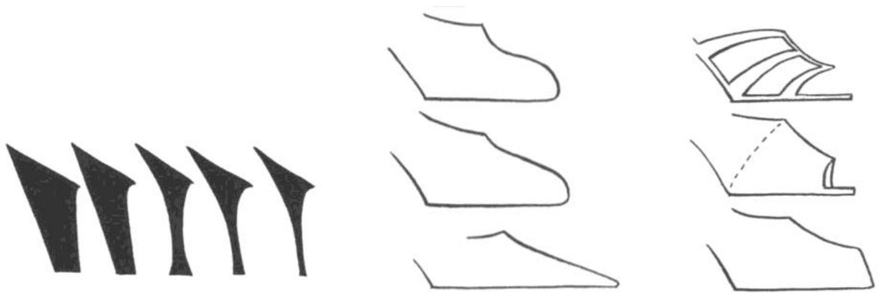

Figure 6: Design variations of the front and back part of women's high heels (Jack Hamm, 1983)

Footwear designer has to be familiar with certain biomechanics of gait, because the foot moves back and forth during walking.

Figure 7: Foot in a sneaker and court shoe; left - proper size of a shoe with a distance of 1.5 cm, the right shoe too small (cast of feet and drawing, Topić, 2015, In Ujević et al., 2015*)*

While designing a shoe, a designer should consider that the length of the last and the length of the foot are equal, he should calculate the difference between the length of the foot and the length of the last- or shoes, which is on top of the last, 'the toe spring' 1.5 cm (with conventional models, and may be more for pointed toe model, square, etc.) Figure 7 shows this difference, the proper and the wrong way seen on top part of a shoe, the shoe is drawn in lines, showing the cast of the foot in real proportion. The last is used for observational drawing (Ujević et al., 2015).

CONCLUSION

Sketching and drawing shoes and knowledge of painting techniques are a great help in the presentation of the designer's ideas. Practicing drawing techniques enhances designers in shaping their artwork, but also teaches them the method of viewing and creation, understanding the shape of the foot, the classic form of the shoe, so that the designer could create untypical, geometric and organic forms, avant-garde shoes, which we can see in high fashion footwear.

REFERENCES

Rukavina, K. (2009) *Istina u umjetnosti,* Filozofska istraživanja, Croatian Philosophical Society, 115 (29), 567-568.

Pelizzari, O. (2013). *Shoe design development*, In Handbook of Footwear Design and Manufacture, ISBN: 978-0-85709-879-5, Woodhead Publishing, USA.

Yuan, GX. & Jiang, K. (2013). *Foot sketch templates and footwear design*, In Handbook of Footwear Design and Manufacture, ISBN: 978-0-85709-879-5, Woodhead Publishing, USA.

Wong, W.C., Luximon, A. (2013). *Footwear drawing templates and shoe design*, In Handbook of Footwear Design and Manufacture, ISBN: 978-0-85709-879-5, Woodhead Publishing, USA.

Hamm, J. (1983). *Drawing the Head and Figure*, Perigee Books, ISBN - 978-0399507915, Berkley Publishing Group, USA.

Ujević, D., Domjanić, J. & Topić, I. (2015). *Morfologija i mjere stopala – važni čimbenici u standardizaciji veličina modne obuće*, In Antropometrija i normizacija modne obuće, Tekstilno-tehnološki i ekonomski fakultet Sveučilišta u Zagrebu, Zagreb.

INFLUENCE OF MATERIAL AND FINISHING TREATMENT OF TOWEL FABRICS ON MECHANICAL PROPERTIES

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ABSTRACT

Towel fabrics designed for water/moisture absorption. Cotton has many advantages as a raw material for this purpose such as its hydrophility, handling, abrasion resistance and soft touch. However, after saturation point of moisture content, these advantages turn into counter-effect and create damp tactile feeling. That is why different types of fibers are also used for production lately. In this study, eleven different towel samples were examined by the standard mechanical property tests namely tearing strength, tensile strength and dimensional stability in order to study about influence of material, structure and finishing treatment of towel fabrics to meet the requirements.

Key Words: towel, fabric, drying rate, moisture transfer

INTRODUCTION

In the mechanical properties, the moisture properties of towel such as water absorbency, air permeability, etc. depend on the material type and manufacturing process [1]. In order to improve soft touch, using softener was effective, but the effectiveness was depending on the type of towel materials [2]. On the other hand, towel durability from the repeat washing damages is important. Cotton is a conventional towel material because of its water absorptivity. It was found that fabric thickness, mass per unit area and fabric tightness factor had strong relation with the drying rate of cotton fabrics [3]. However in terms of the fabric strength, generally cotton durability is lower than synthetic fibers. In addition, drying rate of synthetic fibers such as polyester, polypropylene, etc. is expected better, since their moisture absorptivity is much less than natural fibers.

In this paper, the influences of materials of the ground and loop yarn, loop length and finishing treatment on the towel's properties were discussed based on the results of fabric strength and dimensional stability.

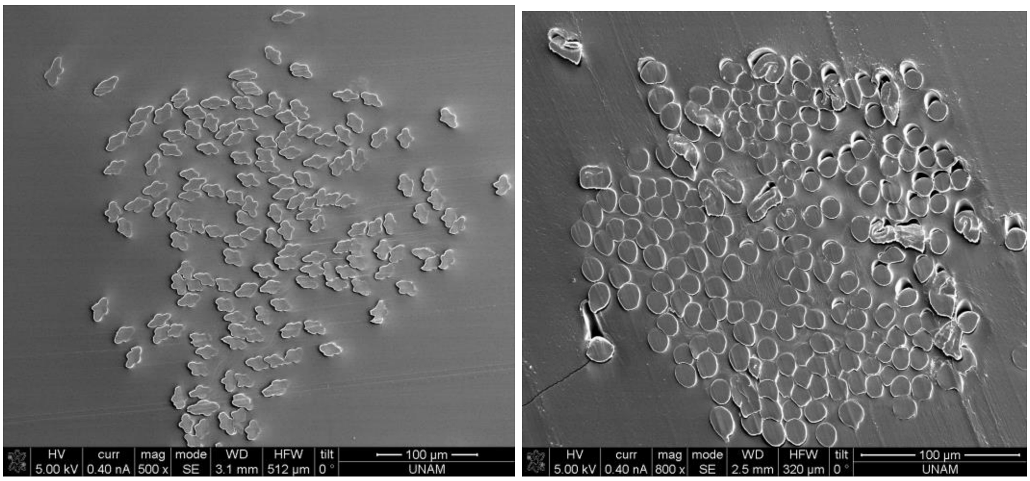
Materials

The eleven towel samples were produced to examine mechanical properties as shown in Table 1. There were four considerations: material of ground yarn, material of loop yarn, loop length, and finishing method. To be specific, there were three different ground yarn types (Ga: 100% PES-1, Gb: PES-2 with 15% cotton, Gc: 100% cotton); four different loop yarn types (La: PES-2 with 15% cotton, Lb: 100% PES-3, Lc: 100% cotton, Ld: PES-1 with 20 nylon); two different loop lengths (68 cm and 88 cm loop yarn for 10 cm warp length); two different finishing treatments (cationic and nonionic).

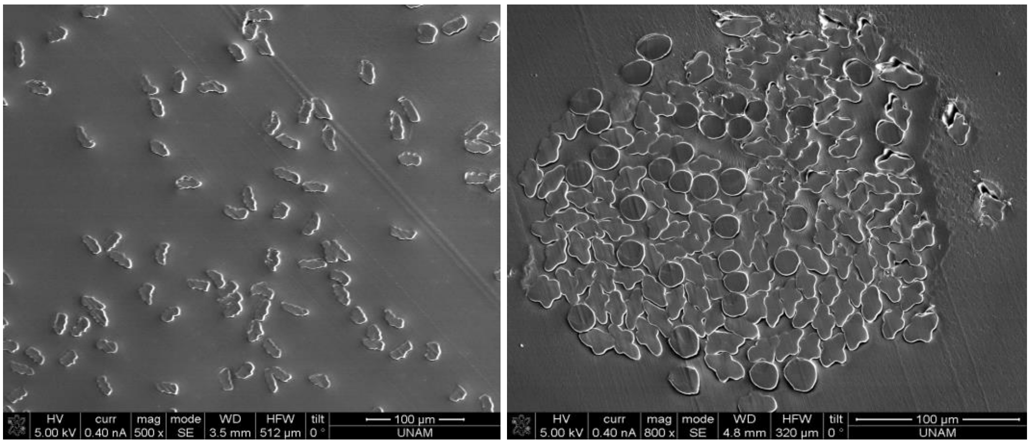
Table 1. Details of the eleven towel samples

Sample	Ground yarn	Loop yarn	Loop length (cm)	Thickness (mm)	Finishing/ Surfactant
T_1	Ga: 100% PES-1	La: PES-2 with 15% Cotton	68	2.96	Cationic
T_2				2.91	Nonionic
T_3			88	3.93	Cationic
T_4				3.90	Nonionic
T_5	Gb: PES-2 with 15% Cotton			3.89	Cationic
T_6				3.34	Nonionic
T_7	Gc: 100% Cotton (Ne 20/2 K.D.)	Lb: 100% PES-3		5.77	Cationic
T_8			68	5.21	
T_9		Lc: 100% Cotton (Ne 18/1 P.D.)	88	5.06	Cationic
T_{10}			68	4.25	
T_{11}		Ld: PES-1 with 20% Nylon	88	3.98	Cationic

PES-1, PES-2 and PES-3 are the products of different fiber producers and their cross sections are different in shapes as can be seen from SEM images in Fig. 1. The towel thickness was related to yarn type and loop length. Depending on the loop yarn type, towel thicknesses in order are PES-2 with 15% cotton, PES-1 with 20% nylon, 100% cotton and 100% PES-3. Loop length 88 mm created thicker towel than loop length 68 mm with same material.



(a) (b)



(c) (d)

Fig. 1: SEM images of 100% PES-1 (a), 85% PES-2 with 15% cotton (b), 100% PES-3 (c), and 80% PES-1 with 20% nylon yarns.

RESULTS

Tearing strength and tensile strength tests were carried out to investigate the towel fabric strength. As to towel tearing strength, the warp strength results of the towel samples were more than 64 which value is the maximum of the test except T_5's warp. However, the weft strength results were different by the towel type. The material of ground yarn influenced on the weft strength, especially the towels made by 100% PES materials ground yarn T_1, T_2 and T_3, and T_4, were superior tearing strengths. The towels made by PES with 15% cotton materials ground yarn T_5 and T_6 were obtained lower strength than 100% cotton materials ground yarn. These results indicated that blended yarn might be weaker to weft strength.

Tensile strength values of weft and warp had similar except the towels made by PES with 15% cotton materials ground yarn T_5 and T_6. Particularly T_6 had a large strength difference between weft and warp. T_6's weft strength was the lowest tearing strength and the highest tensile strength in the towel samples. The finishing F_d treated towels T_5, T_9, and T_{10} were relatively lower tensile strength values.

The results of dimensional stability after washing test carried out once under the 40°C was as shown in Table 2. The dimensional stabilities of each towel sample especially warp changes were significantly differed by the type of ground yarn's materials. Where the towels made by 100% PES materials ground yarn T_1, T_2 and T_3, and T_4, the weft and warp changes were relatively less than the towels made by cotton or cotton blended PES yarn. Higher shrinkage values obtained from T_9, T_{10}, which were made by 100% cotton yarn both ground and loop yarn, and T_{11} was made by 100% cotton ground yarn and PES with 20% nylon yarn.

Table 2. Towel fabric strength and dimensional stability properties

TEST	TEST STANDARD		Sample										
			T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	T_{11}
Tearing strength	ISO 13937-1	Weft (N)	64+	64+	64+	56.73	37.22	28.17	43.02	38.9	34.47	49.85	41.65
		Warp (N)	64+	64+	64+	64+	53.05	64+	64+	64+	64+	64+	64+
Tensile strength	ISO 13934-2	Weft (N)	756.1	772.8	554.6	766.5	340.5	791.5	490.2	515.0	389.7	251.3	415.0
		Warp (N)	743.6	815.9	611.5	753.6	192.2	377.3	491.7	512	338.9	245.6	414.8
Dimensional stability after washing	ISO-6330/ 2000	Test condition	40 °C * 1	40 °C * 1	40 °C * 1	40 °C * 1	40 °C * 1	40 °C * 1	40 °C * 1	40 °C * 1	40 °C * 1	40 °C * 1	40 °C * 1
		Dimension before test	49.5 X 98	48.5 X 97,5	52.5 X 104	53 X 102,5	50.5 X 100	50 X 99	51.5 X 101	51.5 X 101	51 X 102	159 X 100	52 X 100
		Dimension after test	49 X 97.5	48 X 97.5	52.5 X 104	53 X 102.5	49 X 98.5	48.5 X 98	51 X 98.5	51 X 98	51 X 97	156 X 96	50.5 X 96
		Weft (%)	-1.0	-1.0	0.0	0.0	-3.0	-3.0	-1.0	-1.0	0.0	-2.0	-3.0
		Warp (%)	-0.5	0.0	0.0	0.0	-1.5	-1.0	-2.5	-3.0	-5.0	-4.0	-4.0
Thickness	ISO-5084 (mm)		2.964	2.913	3.934	3.897	3.888	3.340	5.766	5.208	5.060	4.250	3.982

DISCUSSION AND CONCLUSION

The mechanical properties of towel samples were investigated to understand the influences of materials of the ground and loop yarn, loop length and finishing treatment on the towel's durability and sensibility. Obtained results showed that;

1. As can be seen from the comparison of T_1 and T_2, Fb/nonionic finishing showed better results for tensile strength. Similar results were observed for T_3 and T_4 that Fc/nonionic finishing showed better results over Fa/cationic finishing.
2. Comparison of T_5 and T_6 showed that Fe/noionic finishing had better tensile strength results over Fd/cationic finishing.
3. Comparison of T_1 and T_3 showed that 68 mm pile length showed better tensile strength results over 88 mm pile length. It is also valid discussion for tearing strength by comparing T_9 and T_{10} weft direction.
4. Comparison of T_5 and T_9 showed that 100% cotton towels showed lower tensile strength results over PES materials.
5.

ACKNOWLEDGEMENT

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REFERENCES

1. Yamamoto, T., Miyazaki, K, Ishizawa, H., Matsumoto, Y., 2005, “Structure and Water Absorbency of Towel Fabric”, *Journal of the Textile Machinery Society of Japan*, 58 (11), 147-152.
2. Ushioda, H., Nakajima, T., 1996, “Effects of Towel Fabrics Treated with Household Softneners on Human Cataneous Sensation”, *Journal of Home Economics of Japan*, 47 (6), 579-588.
3. Önal, L., Arslan, C., Paşayev, N., 2013, “Relation Between Structural Parameters and Drying Properties of Cotton Knitted Fabrics”, *Tekstil ve Konfeksiyon*, 23 (4), 357-363.

COCONUT CHARCOAL/CARBON FIBER

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ABSTRACT

Sustainable and renewable resources are recently increasingly preferred for different textile applications owing to the growing ecological concerns. Coconut is a sustainable, renewable, natural and biodegradable resource option for textile materials. Coconut shell wastes can be used for both coir fiber and coconut charcoal polyester fiber manufacturing. Coconut charcoal fiber is generally manufactured by adding activated coconut shell carbon particles into the synthetic polymer such as polyester. The resultant fiber, coconut charcoal/carbon polyester fiber, exhibits very good textile performance properties such as nice moisture management, antimicrobial advantages, odor control properties and anti-pilling effect, mildew resistance and higher moisture absorbency. This paper highlights the production, properties and end-use applications of coconut charcoal/carbon polyester fiber.

Keywords: Coconut, Activated Carbon, Charcoal, Polyester, Coconut charcoal fiber

INTRODUCTION

Coconut fiber is one of those sustainable, renewable, natural and biodegradable candidates for more sustainable world. Botanical name of coconut is *Cocos Nucifera* [1]. Coconut palm tree belongs to *Arecaceae* family (3), and it grows up in the tropical world zones (Figure 1) [2-4].

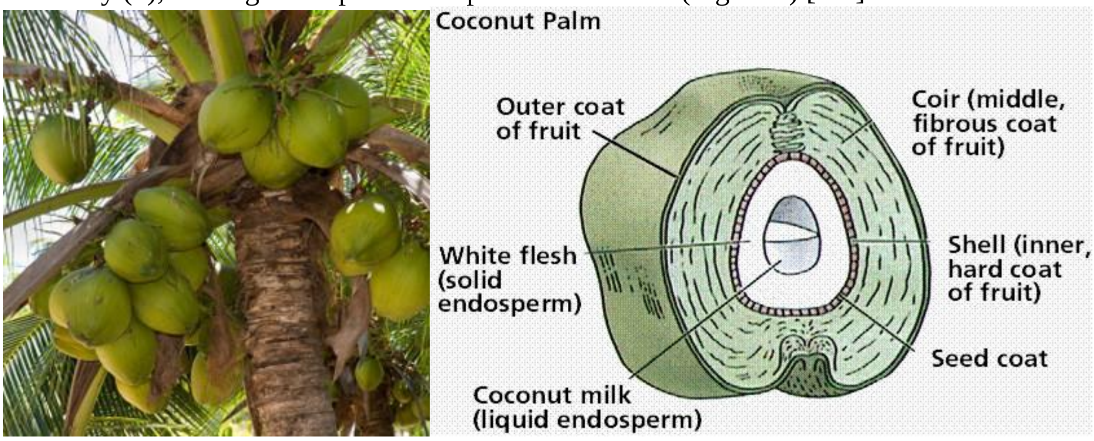

Figure 1 Coconut tree and the cross section of coconut fruit [5, 6]

The natural habitat of the coconut palm tree is shown, drawn by the red line, in the world map (Figure 2) [1]. Coir fiber is a natural fiber which is extracted from the husk of the coconut fruit (Figure 1). Coir fiber and coconut charcoal/carbon fiber are not the same fiber. Coconut charcoal/carbon fiber is a modified polyester fiber. Coconut charcoal/carbon polyester fiber exhibits very nice textile performance such as good moisture management, antimicrobial advantages, odor control properties and anti-pilling effect. Hence, coconut charcoal/carbon fiber finds a place in many different textile applications such as apparel, home textiles and technical textiles.

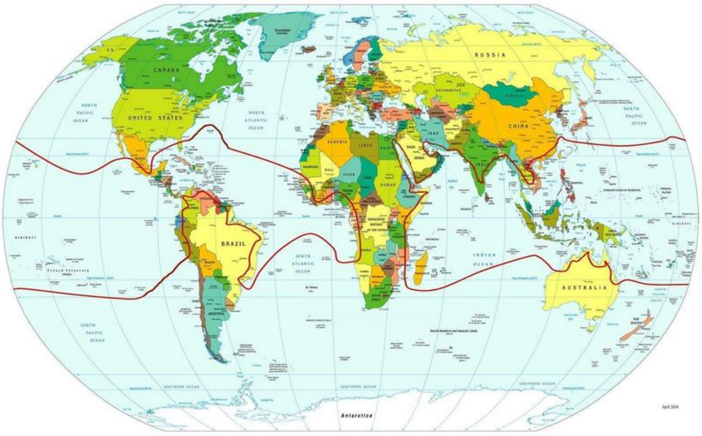

Figure 2 Coconut palm tree distribution throughout the world [1]

COCONUT CHARCOAL/CARBON POLYESTER FIBER PRODUCTION

After the taking of the coconut flesh and milk for food industry, the coconut shells are soaked, beaten, removed from impurities and dried for the extraction of coir fiber [7]. As a composite material, coconut charcoal fiber can be manufactured by adding activated coconut carbon particles into the synthetic polymer such as polyester [8].
The processing steps of coconut charcoal/carbon fiber production can be explained as follows [9, 10];

a) Crushing, sizing and drying of the coconut shells (Figure 3)

Figure 3 Crushed coconut shells [11]

b) Carbonizing and activating the coconut shells at elevated temperature (approximately around 1200^{o}C) in the presence of steam (Figure 4).

Figure 4 Carbonized coconut shells [12]

c) Crushing/powdering of activated coconut charcoal/carbon and treatment with silicon surfactants (Figure 5).

Figure 5 Carbonized coconut shell powder [13]

d) Mixing the coconut charcoal powder with polyester chips at high temperature into masterbatch (Figure 6)

Figure 6 Coconut shell charcoal PET chip [14]

e) Diluting the coconut charcoal masterbatch with polyester pieces

f) Extruding and fiber spinning (Figure 7)

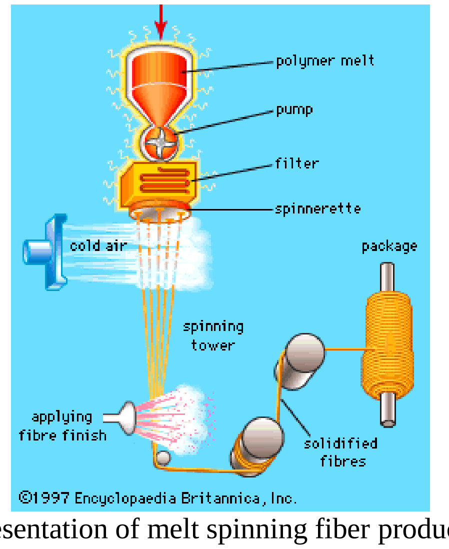

Figure 7 Symbolic representation of melt spinning fiber production process of coconut charcoal/carbon polyester fiber [15, 16]

g) Oiling and winding of fiber (Figure 7) and final coconut charcoal/carbon polyester fiber filament yarn (Figure 8)

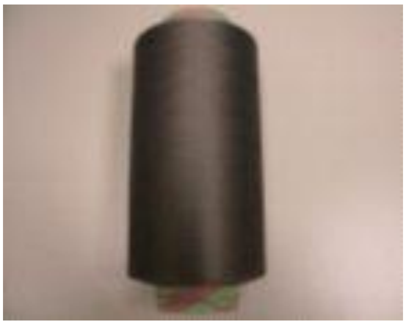

Figure 7 Coconut charcoal/carbon polyester filament yarn [14]

Both staple (short) and filament coconut shell charcoal/carbon polyester fibers can be produced (Figure 8).

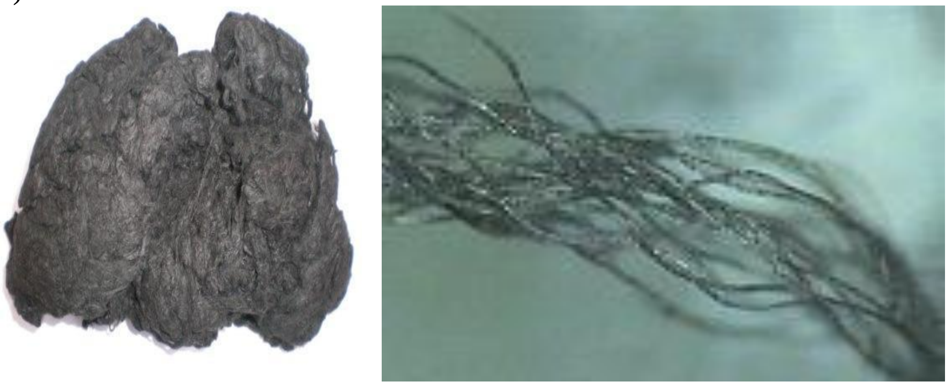

Figure 8 Coconut shell activated carbon/charcoal polyester staple and filament fibers [14, 20]

Activated carbon materials made from coconut shell, wood, bamboo etc. can be utilized in order to produce polyester based charcoal/carbon fiber. The small macrospore structure of the coconut shell provides an effective behavior for gas and/or vapor adsorption [10]. Activated carbon is a non-graphite form of carbon with high absorption properties because of the porous structure and high surface area [8, 10, and 17]. The SEM micrographs of coconut shell carbon and coconut shell activated carbon exhibits the difference in their surface morphology, mainly the pores (hollow pits) (Figure 9) [17].

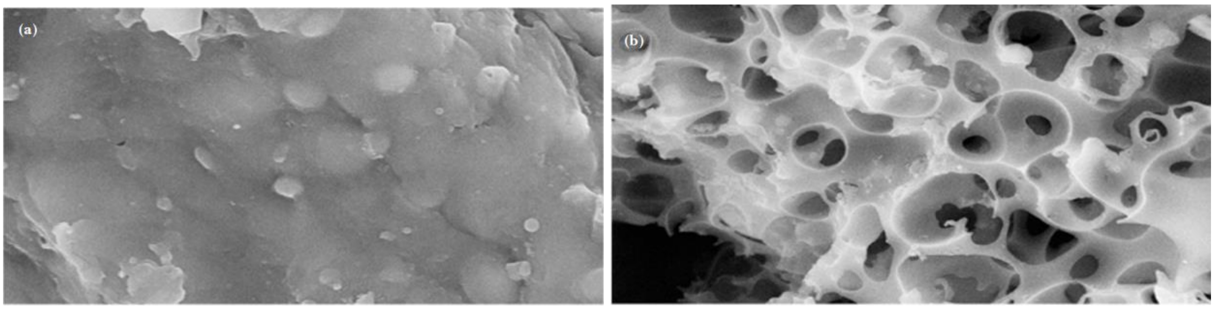

Figure 9 SEM micrographs of *a)* coconut shell carbon and *b)* coconut shell activated carbon [17]

A protective layer is needed to reserve the pores during the spinning of polyester fiber from the filling up with polyester melt. After the production of the fiber, the protective layer will be removed in order to bring back the absorbency capacity of the activated carbon pores [10, 18]. This process is patented under the trademark name Cocona™ [18].

PROPERTIES OF COCONUT CHARCOAL/CARBON POLYESTER FIBER

Coconut charcoal/carbon polyester fiber puts on display quite good textile performance levels such as nice moisture management, antimicrobial advantages, odor control properties and anti-pilling effect etc. Since activated carbon usage can render such new utilities to the polyester fibers. Some of these features are listed below;

a) Adsorption and deodorization of smells, body smell, smoking smell, chemical materials in the air [7, 8, 18-22]. The coconut shell activated carbon possess pore sizes which are just right to adsorb the molecules of body odors, such as butyric acid, isovaleric acid, and trimethyl amine, at ambient usage temperatures and desorb these bad odor molecules at typical temperatures found in a washing machine (hot water cycle) and tumble dryers [18].

b) Moisture management through absorbing excess moisture and keeping the body dry [8, 19, 20]

c) Anions (negative ions) generated by the coconut charcoal/carbon polyester fiber can be absorbed by the skin and it can activate the body cells and purify the blood [8, 19, 20]

d) Far-Infrared ray emission can be absorbed by the body and it can promote heat preservation and strengthen the blood circulation [7, 20]

e) Antimicrobial advantages like bacteria and mildew resistance [20, 22, 23]

f) High and permanent water/moisture absorbency, quick drying effect [8, 20, 21], the moisture regain of coconut charcoal polyester fiber is higher than the regular polyester fiber [24]. It is reported that the moisture regain of coconut charcoal polyester fiber is about 1,02% which is 2,5 times of regular polyester [25].

g) Anti-pilling and Anti-fuzzing effect [20]

h) After spinning the color of the fiber is black-grey because of the coconut carbon/charcoal ingredient [26]. Dyeing advantages like low temperature dyeing (82-100^{o}C), dark color dyeing with high color fastness properties (4 grade gray scale of rating) [20]. Hia and Wang has attempted to dye coconut charcoal polyester fiber with a single disperse dye and a mixture of two disperse dyes [8]. The coconut charcoal polyester fiber was dyed darker than the regular polyester fiber. Effective dyeing of the fiber without carrier was obtained at 130^{o}C with dye concentration of 1-5% owf. The color fastness properties of coconut charcoal polyester fiber which was dyed beyond 5% dye concentration tend to be poor. However generally fastness values about 4 or above were reached for rub and wash fastness properties [8].

i) Quiling and Ding [24] compared the coconut charcoal modified polyester fiber with the regular polyester fiber. Breaking tenacity was lower in dry or wet state for coconut charcoal modified polyester fiber. However, breaking elongation was not affected [24].

APPLICATIONS OF COCONUT CHARCOAL/CARBON POLYESTER FIBER

Coconut charcoal/carbon polyester fibers are used in many different textile applications such as apparel, home textiles and technical textiles due to their aforementioned nice good textile performance and properties. The main application areas can be summarized as follows;

a) Sportswear: T-shirt, short, underwear, sport shoe, socks, knee/wrist/waist guards etc. Since coconut charcoal/carbon polyester fiber sportswear products can vaporize the human sweat rapidly and exhibit a permanent effect even after several washes [20, 26].

b) Home textiles: Bed sheet, quilt cover/filling, cushion cover/filling, mattress cover/filling, curtain, towel, bathrobe, decoration, furnishing, rugs etc. due to its moisture management and warm keeping effects [10, 20, 26].

c) Garment: Garment, garment lining, baby cloth, underwear, corset, knitwear, fleecewear, T-shirts, outerwear, men's shirts etc. because of high and renewable odor absorption capacity [10, 20, 23, 26].

d) Technical textile uses such as automotive upholstery, geotextiles (netting), cleaning brushes, filtering material, mask and industrial filters [10, 23, 26].

Some different usage applications of coconut charcoal/carbon polyester fiber are shown on Figure 10.

a) Yarns and Apparels [27]

b) Mattress pad and pillow case [28]

c) Air filter [29]

d) Shoe upper material [30]

e) Active sportswear examples [31]

Figure 10 Different textile and textile-related materials made from coconut carbon/charcoal fiber

CONCLUSIONS

Coconut is a sustainable, renewable, natural and biodegradable resource. Coconut shell wastes can be used for textile fiber production. Coir fiber is the natural fiber form which is derived from the husk of the coconut fruit. Other alternative usage of these coconut shell wastes in textile fibers was realized by carbonization and activation of the coconut shells at elevated temperatures to create coconut charcoal active carbon powder which then be mixed with polyester polymer to obtain coconut charcoal polyester fiber. Coconut charcoal fiber is generally manufactured by adding these activated coconut shell carbon particles into the synthetic polymer such as polyester. So the resultant fiber, coconut charcoal/carbon polyester fiber, possess very good textile performance properties such as nice moisture management, antimicrobial advantages, odor control properties and anti-pilling effect, mildew resistance and higher moisture absorbency. And therefore, they are used in many different textile applications such as apparel, home textiles and technical textiles.

ACKNOWLEDGEMENT

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REFERENCES

[1] https://en.wikipedia.org/wiki/Coconut, Accessed on May 2016.
[2] Dam J.E.G., "Coir Processing Technologies", Common Fund for Commodities, Amsterdam, Netherlands, (2002).
[3] Ali M., "Coconut Fibre: A Versatile Material and Its Applications in Engineering", Journal of Civil Engineering and Construction Techonology, 2011, Vol. 2(9), pp. 189-197
[4] http://www.madehow.com/Volume-6/Coir.html, Accessed on April 2015.
[5] http://agritech.tnau.ac.in/horticulture/horti_pcrops_coconut_botany.html
[6] http://www.coconutgroveyogurt.com/making-organic-coconut-milk/
[7] http://www.aolingfangzhi.com/en/Products/26.htm
[8] Xia D., Wang L., "Dyeing Performance Of Coconut Charcoal Polyester Fabric", Sen'ı Gakkaishi, Vol.69, No.11(2013).
[9] http://www.scientific.net/AMR.503-504.1137
[10] http://fabriclink.com/university/Charcoal.cfm

[11] http://vdelta.trustpass.alibaba.com/product/50001235306-103913453/Crushed_Coconut_shell_Low_price_in_2015.html
[12] http://www.indiamart.com/sivatraders/coconut-products.html
[13] http://elamgreenexports.com/?teslawp_portfolio=coconut-shell-powder
[14] http://www.ttri.org.tw/econtent/energy/energy01_02.aspx?cat1type=11&sid=161
[15] http://textilebd-yarn.blogspot.com.tr/2011/07/textile-spinning-for-man-made-fibers.html
[16]http://encyclopedia.che.engin.umich.edu/Pages/PolymerProcessing/FiberSpinning/FiberSpinning.html
[17] Iqbaldin M.M., Khudzir I., Azlan M.M., Zaidi A. G., Surani B., Zubri Z.,"*Properties Of Coconut Shell Activated Carbon*",Journal of Tropical Forest Science, 25(4): 497-503, 2013.
[18]http://www.metaefficient.com/clothing/cocona-a-fabric-enhancer-derived-from-coconuts.html
[19] http://www.huamao.com.tw/en/product.html
[20] http://www.bamboo-china.com/product/coconut-charcoal-pet-staple-fiber.html
[21] http://www.treehugger.com/sustainable-fashion/sweat-and-smell-absorbing-fabrics-from-coconut-shells.html
[22] Eza T.S.M., Wan Ahmad W.Y., Ahmad M.R., Omar K., Ahmad M.N., "*Effectiveness Of Activated Carb on Produced From Coconut And Oil Palm Shells As Anti-Odour On Textile Fabrics*", Indian Journal Of Fibre&Textile Research, Vol.39, June 2014, pp.190-195.
[23] Qin-Rong T., "*Development and Application of PET Staple Fiber Modified by Active Charcoal"*, Synthetic Fiber in China, 2006-03.
[24] Qiuling L.H.C., Ding S.,"*Property Analyses of Coconut Charcoal Modified Polyester Fiber*", Cotton Textile Technology, 2012-08.
[25] Li-mei J., Pei-yun W.,"*Measurement and Analysis of Coconut Charcoal Fiber Properties*", Textile Auxiliaries, 2011-01.
[26] http://www.made-in-china.com/showroom/daniel2214125/product-detailRenJSsMvnkWI/China-Coconut-Charcoal-Pet-Yarn-Filament.html
[27] http://demarkaward.net/th/demark_winner/detail/60-Coconut%20Charcoal%20in%20Polyester%20Fiber
[28] http://99speedmart.info/tag/katil-ensembel
[29] http://icanbreathe.com/products/icb-coconut-activated-carbon-filter-refills-for-the-honeycomb-mask
[30] https://www.nakedape.uk.com/vibram-five-fingers-treksport-women-s-coconut-black-charcoal.html
[31] http://www.innovationintextiles.com/sports-outdoor/vital-eco-wear-redefines-active-sportswear/

OXIDATIVE BLEACHING OF COCONUT CHARCOAL POLYESTER FIBER

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ABSTRACT

Coconut charcoal polyester fiber displays gray color shade and therefore not white. Textile fibers are generally whitened via bleaching to achieve a nice white appearance and/or also bleached prior to dyeing to ensure desired final color shade successfully after dyeing in order to avoid any possible reproducibility problem and unwanted colorimetric shift. Therefore, the bleaching possibility of coconut charcoal polyester fiber with different oxidative chemicals, including sodium chlorite, sodium hypochlorite and hydrogen peroxide, was investigated. Moreover, different oxidative bleaching processing times and bleaching chemical concentrations were also studied. The color strength (K/S) and lightness (*L**) properties of bleached coconut charcoal polyester fiber were examined. There was no significant and/or drastic change in the lightness (*L**) and color strength (K/S) properties after various oxidative bleaching processes. Not only the bleaching effect but also the color fading and/or color loss were not observed after oxidative bleaching operations studied.

Keywords: Coconut, Coconut charcoal fiber, Bleaching, Oxidative Bleaching, Sodium chlorite

INTRODUCTION

Growth of the world population and the deficit of complacent natural fibers lead to new researches of other fiber options for more sustainable world. From an environmental perspective, utilization of continual natural fibers like coir etc. offers an attractive area [1]. Coconut is botanically named as *Cocos Nucifera* and its plant belongs to *Arecaceae* family, known as palm [2], which grow up in the tropical zones of the world (Figure 1) [3,4].

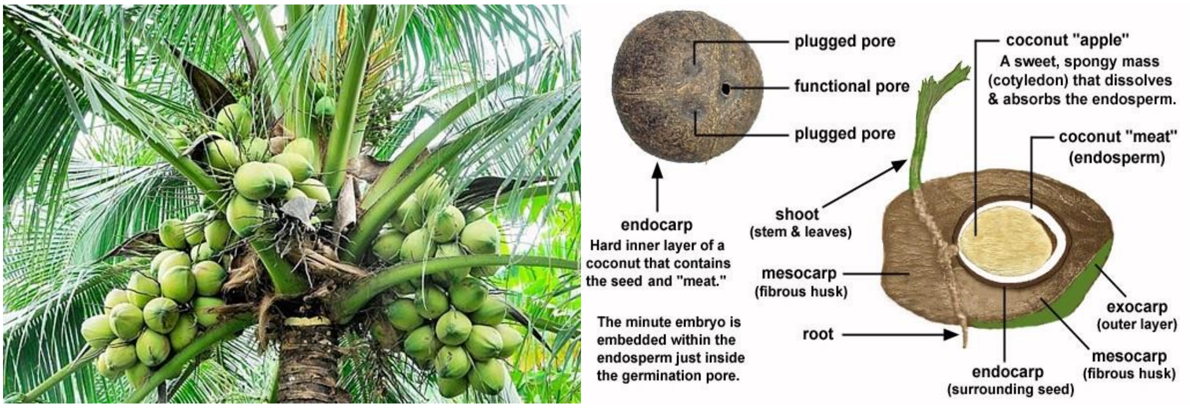

Figure 1 Coconut palm tree and its fruit [5, 6]

As a composite material, coconut charcoal fiber can be manufactured by adding activated coconut carbon particles into the synthetic polymer such as polyester [7].
Coconut charcoal polyester fiber displays very good textile performance qualities such as good moisture management, antimicrobial advantages, antiodor control properties etc. [7-10]. Therefore, this fiber can be used in many different textile fields such as sportswear, apparel, technical textiles and home textiles (Figure 2) [10-12].

Figure 2 Coconut charcoal fiber and its fabric [10, 13]

Coconut charcoal fiber displays gray, grayish color shade and therefore not white (Figure 2). Textile fibers are generally whitened via bleaching to achieve a nice white appearance and/or also bleached prior to dyeing to ensure desired final color shade successfully after dyeing in order to avoid possible reproducibility problem and unwanted colorimetric shift. The common bleaching agents for polyester fiber and its blends are sodium chlorite and partly sodium hypochlorite bleaching [14-16]. There is a requirement to know whether coconut charcoal polyester fiber, considering as a modified polyester fiber, can be bleached similar to regular/common polyester or not. So, bleaching possibility of coconut charcoal polyester fiber with different oxidative chemicals including sodium chlorite, sodium hypochlorite and hydrogen peroxide was investigated. Different oxidative bleaching processing times and bleaching chemical concentrations were studied. The color strength (K/S) and lightness ($L*$) properties of coconut carbon fiber treated with different oxidative bleaching operations were examined.

EXPERIMENTAL

Single jersey knitted fabric made from 30/1 Ne yarn which is derived from 100% coconut charcoal polyester fiber is utilized for this bleaching study. The used conventional bleaching methods and their application recipe details are explained below;

Oxidative Bleaching Methods

a) Conventional sodium chlorite bleaching process is carried out at 95°C and pH 4 (via acetic acid) with 1:30 liquor ratio. 1g/l wetting agent is also added to the bleaching bath to ensure better wetting of the hydrophobic polyester fiber. In order to determine the optimum bleaching conditions for coconut charcoal polyester fiber, wide variety of sodium chlorite (100%) concentrations (1, 5, 20, 35, 50 g/l) were applied for 120 minutes as a bleaching process time. Moreover hydrogen peroxide (1, 5, 10, 20, 30 g/l), stabilizer (1, 2, 5, 7, 10 g/l) and sodium nitrate (1, 5, 20, 35, 50g/l) are added to the bleaching baths. Sodium nitrate is added to the bleaching bath in order to protect apparatus from corrosion. Hydrogen peroxide is added to the bleaching bath to prevent the possible red nuance after the bleaching.

b) After bleaching, coconut charcoal polyester fiber fabric samples were treated with 10g/l sodium sulphite at 20°C for 30 minutes with 1:30 liquor ratio in order to remove any chlorine residue. As an alternative 1.85% sodium chlorite concentration at 50ºC for 15 minutes in presence of 2g/l oxalic acid (pH 3) and sodium nitrate was also implemented.

c) Regular sodium hypochlorite bleaching process is realized at room temperature (20ºC) and pH 4 (via 3g/l acetic acid) with 1:30 liquor ratio in company with 1g/l wetting agent. The applied sodium hypochlorite concentrations were 10, 20, 30, 40, and 50 ml/l for 120 (2 hours) and 240 minutes (4 hours). In order to remove any chlorine residue, coconut charcoal fiber fabric samples were then treated with 10 g/l sodium sulphite at 20ºC for 30 minutes with 1:30 liquor ratio after the bleaching process.

d) Typical hydrogen peroxide bleaching process is performed at 95°C with 1:30 liquor ratio at about pH 10 (with 3g/l sodium hydroxide). 1g/l wetting agent, 3g/l stabilizer and 2g/l sequestering agent are also added to the bleaching bath. In order to determine the optimum bleaching conditions for coconut charcoal polyester fiber, wide variety of hydrogen peroxide (50%) concentrations (10, 30, 50, 60, 80 and 100 ml/l) were applied for different bleaching processing times (60 and 120 minutes).

Following the aforementioned various bleaching treatments, the lightness (L^*) and K/S values of the coconut charcoal polyester fiber fabric samples were determined using a DataColor 600 spectrophotometer. Each sample was measured from four different areas, and the average value was calculated and presented.

RESULTS AND DISCUSSION

The lightness (L^*) and color strength (K/S) values of coconut charcoal polyester fiber fabrics bleached with different oxidative chemicals including sodium chlorite, sodium hypochlorite and hydrogen peroxide varying bleaching times and concentrations are shown on Figures 3-8.

In general, as the oxidative bleaching chemical concentration increased and conventional bleaching duration prolonged, the K/S (color strength) degrees of the bleached samples are expected to be gradually decreased due to the removal of colorful matters from the fiber, and oppositely the lightness value (L^*) of the bleached samples should be increased due to the same aforementioned reason leading to lighter color shade.

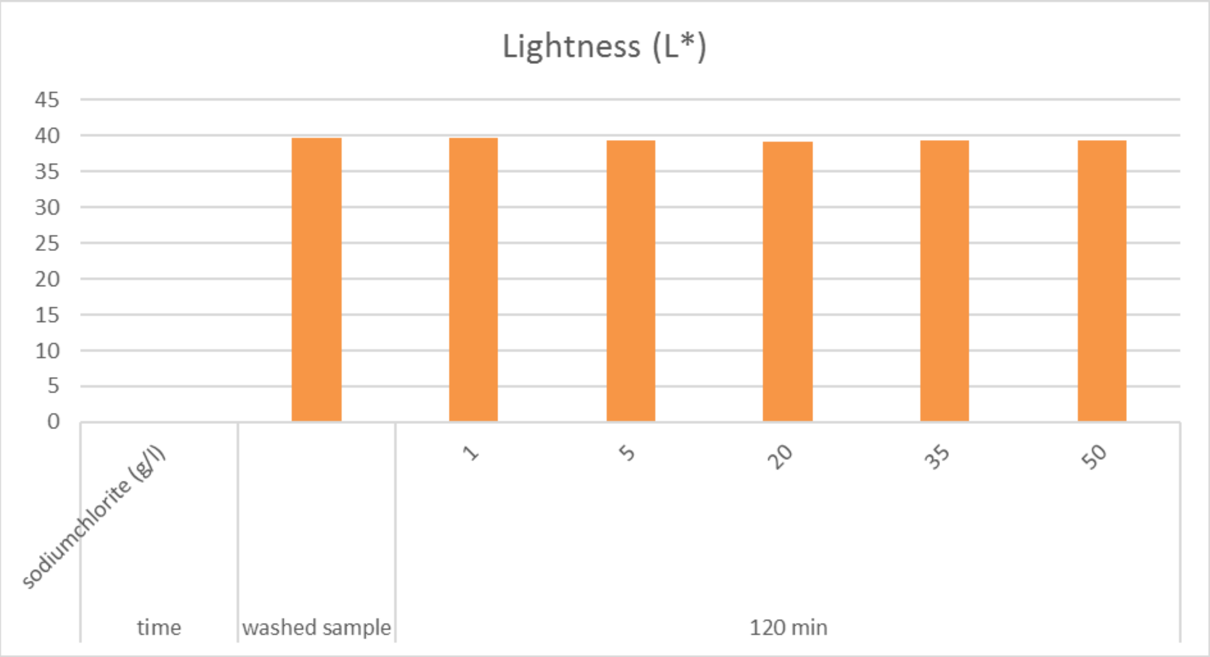

Figure 3 Lightness (L^*) properties of bleached coconut charcoal fibers with sodium chlorite

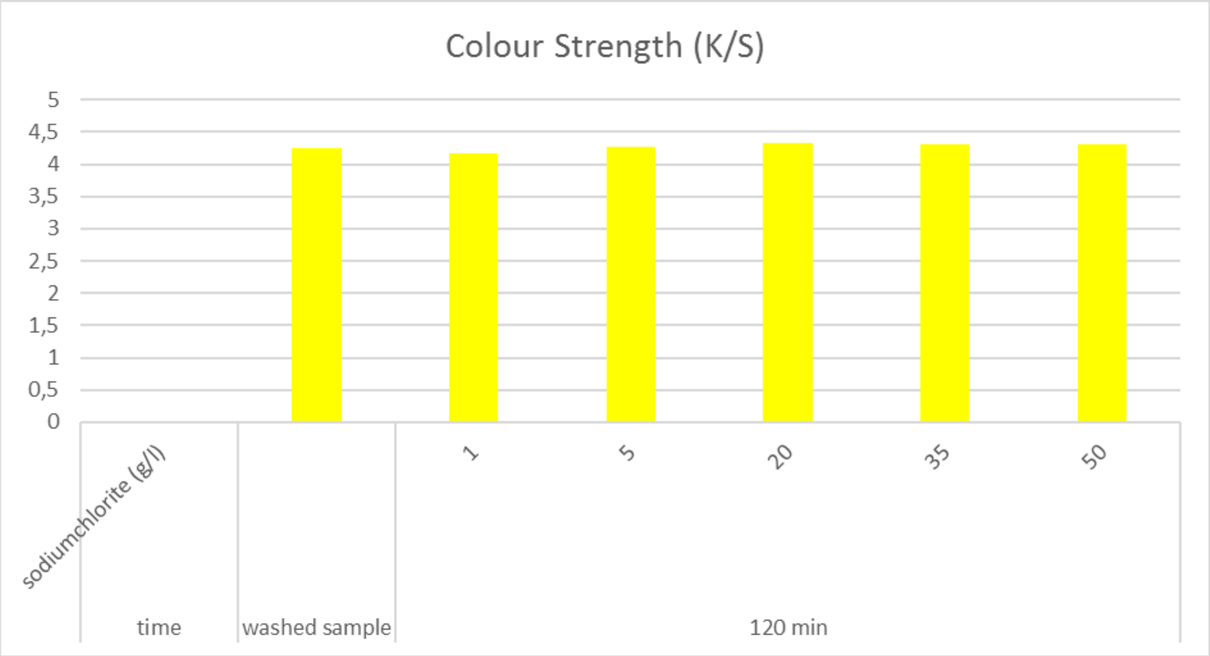

Figure 4 Color strength of bleached coconut charcoal fibers with sodium chlorite

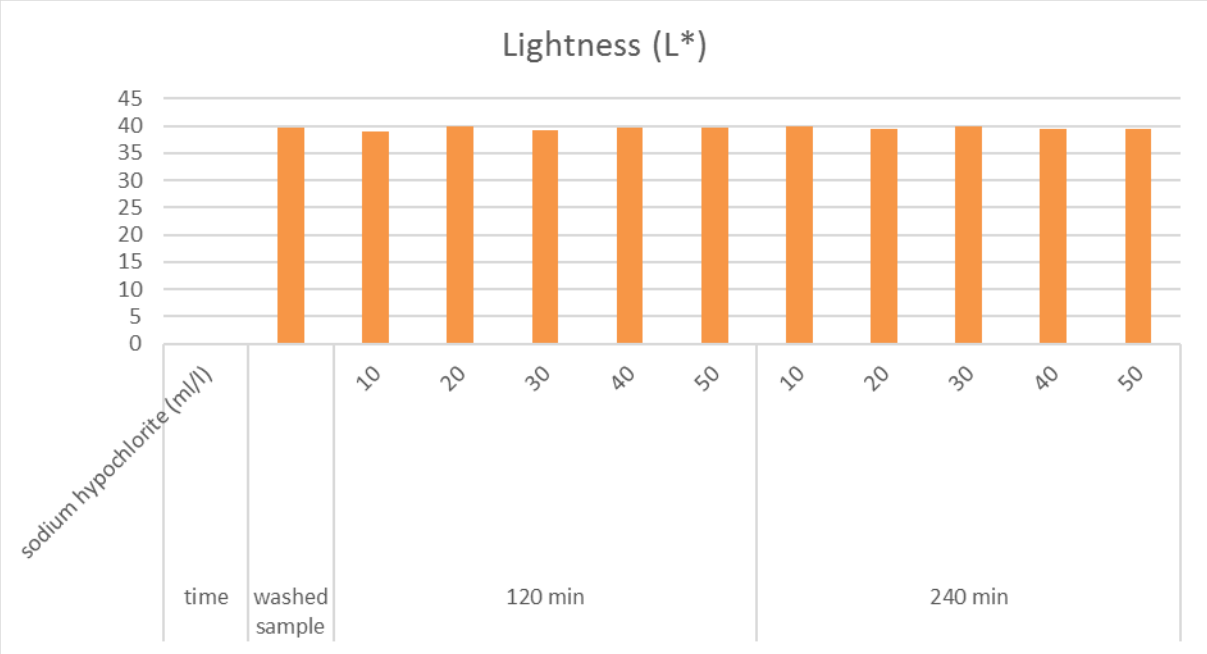

Figure 5 Lightness ($L*$) properties of coconut charcoal fibers bleached with sodium hypochlorite

However, actually there was not any significant change in the lightness ($L*$) and color strength (K/S) values after bleaching with sodium chlorite (Figures 4 and 5) and bleaching with sodium hypochlorite (Figures 5 and 6) even after bleaching applications using quite high bleaching agent concentrations for prolonged bleaching application times. Moreover the color and the appearance of the bleached coconut charcoal fiber fabrics didn't change at all and all the control and bleached fabric samples looked similar visually without any bleaching effect or color loss.

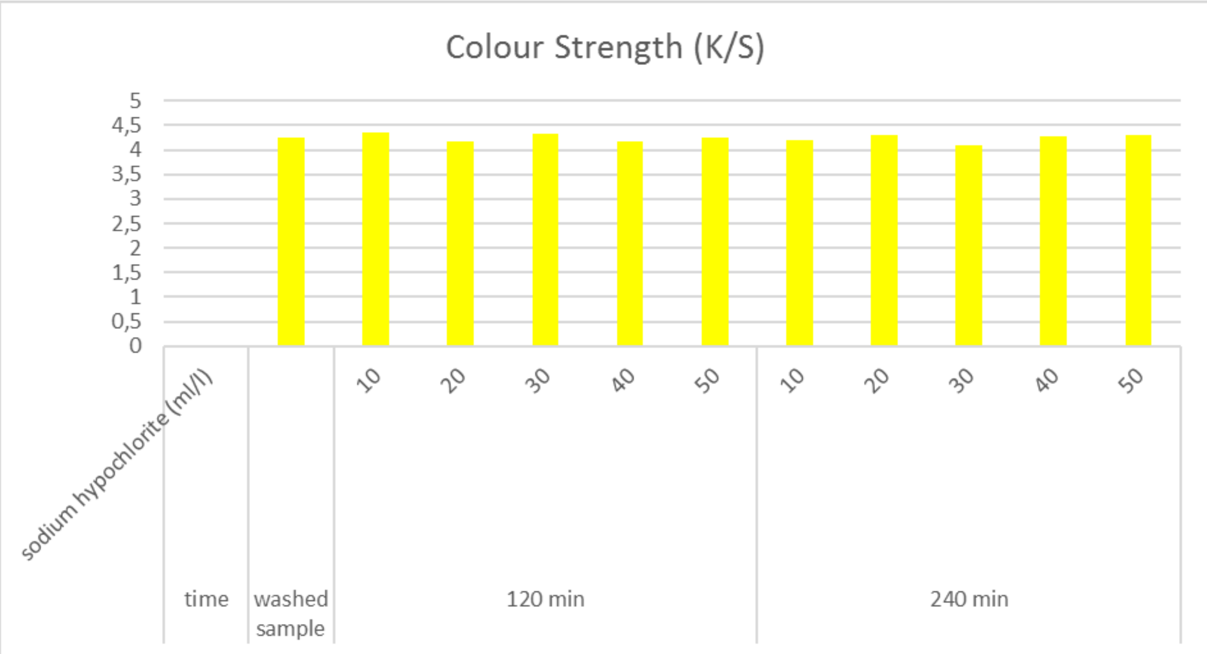

Figure 6 Color strength of coconut charcoal fibers bleached with sodium hypochlorite

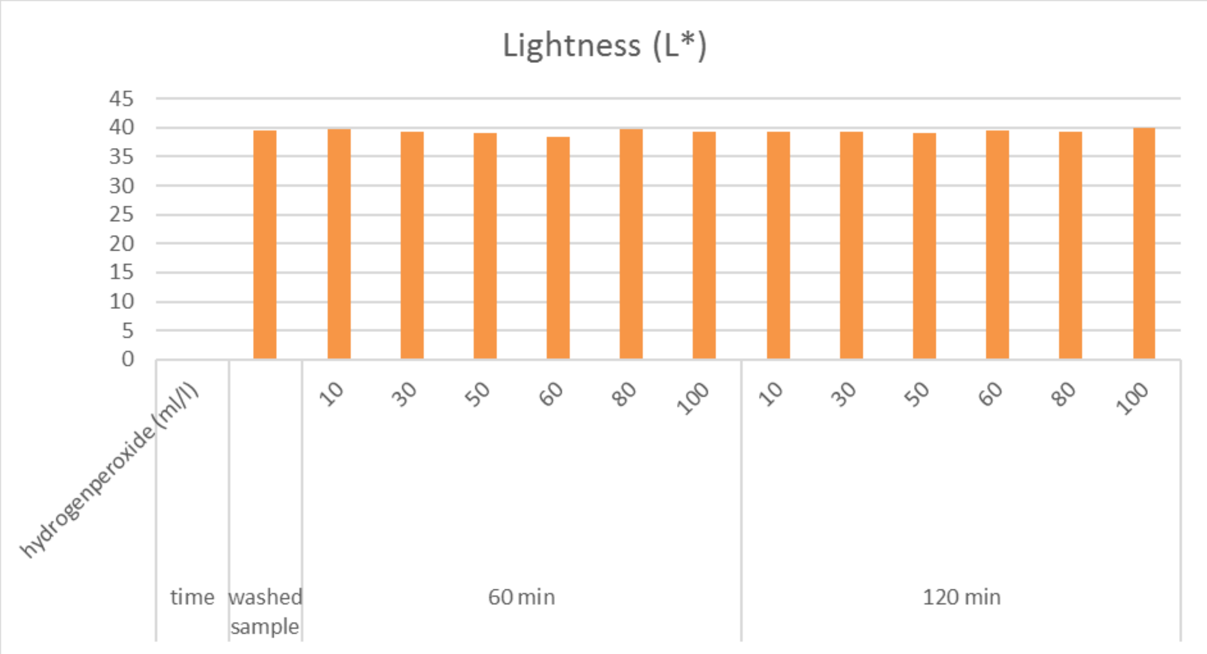

Figure 7 Lightness (L^*) properties of bleached coconut charcoal fibers with hydrogen peroxide

Exactly similar observation can be made for bleaching with hydrogen peroxide (Figures 7 and 8). There was no significant and/or drastic change in the lightness (L^*) and color strength (K/S) performance after bleaching with hydrogen peroxide (Figures 7 and 8) again even after peroxide bleaching applications using quite high bleaching agent concentrations such as 100 ml/l for prolonged bleaching application time as 2 hours.

Figure 8 Color strength of bleached coconut charcoal fibers with hydrogen peroxide

The typical glass-transition temperature (T_g) of polyester fiber is around 80-90ºC. It is known that the tight physical structure of the polyester fiber loosens up more by thermal agitation at higher application temperatures leading to reduction in the intermolecular bonding and rise in the penetration of chemicals used in the processing bath [17]. In our case, sodium chlorite and hydrogen peroxide bleaching processes were performed at 95°C, which is slightly higher than the T_g of polyester fiber, for 120 minutes. It seems that the used oxidative bleaching chemicals (sodium chlorite, sodium hypochlorite and hydrogen peroxide) could not affect the activated coconut carbon ingredient of the coconut charcoal polyester fiber structure leading to non-bleaching effect.

CONCLUSIONS

In this study, the lightness (*L**) and color strength (*K/S*) properties of coconut charcoal polyester fibers were investigated before and after different oxidative bleaching processes using oxidative chemicals including sodium chlorite, sodium hypochlorite and hydrogen peroxide. Interestingly, there was no significant and/or drastic change in the lightness (*L**) and color strength (K/S) properties after oxidative bleaching with hydrogen peroxide, sodium chlorite and sodium hypochlorite even after oxidative bleaching applications using quite high bleaching agent concentrations for prolonged bleaching application times. Therefore the color and the appearance of the bleached coconut charcoal fiber fabrics didn't change whatsoever and all the control greige coconut charcoal polyester fiber fabrics and bleached coconut charcoal polyester fiber fabric samples seemed to be similar by visually without any bleaching effect, color loss or color fading. In conclusion, any of these conventional oxidative bleaching chemicals studied (sodium chlorite, sodium hypochlorite and hydrogen peroxide) cannot be recommended for coconut charcoal polyester fiber bleaching operation.

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REFERENCES

[1] http://en.wikipedia.org/wiki/Coir, Accessed on April 2015.
[2] Ali M., "Coconut Fibre: A Versatile Material and Its Applications in Engineering", Journal of Civil Engineering and Construction Techonology, 2011, Vol. 2(9), pp. 189-197.
[3] Dam J.E.G., "Coir Processing Technologies", Common Fund for Commodities, Amsterdam, Netherlands, (2002).
[4] http://www.madehow.com/Volume-6/Coir.html, Accessed on April 2015.
[5] http://waynesword.palomar.edu/ecoph10.htm
[6] http://www.coconut-info.net/general/coconut_trees.php
[7] Xia D., Wang L., "*Dyeing Performance Of Coconut Charcoal Polyester Fabric*", Sen'ı Gakkaishi, Vol.69, No.11(2013).
[8] http://www.aolingfangzhi.com/en/Products/26.htm
[9] http://www.huamao.com.tw/en/product.html
[10] http://www.bamboo-china.com/product/coconut-charcoal-pet-staple-fiber.html
[11] http://www.made-in-china.com/showroom/daniel2214125/product-detailRenJSsMvnkWI/China-Coconut-Charcoal-Pet-Yarn-Filament.html
[12] Qin-Rong T., "*Development and Application of PET Staple Fiber Modified by Active Charcoal*'**"**, Synthetic Fiber in China, 2006-03.
[13] http://www.nontoxic.com/activatedcarbonblanket/activatedcarbonblanket.htm
[14] Tarakçıoğlu I., ''Tekstil Terbiyesi ve Makinaları Cilt :3'', Mayıs 1986.
[15] Karmakar S.R., (1999), Chemical Technology in the Pre-Treatment Process of Textiles, Elsevier, Amsterdam, Netherlands.
[16] http://www.ehow.com/how_8617474_bleach-polyester.html
[17] Gorkem Gedik, Ozan Avinc, Arzu Yavas, Akbar Khoddami, "*A Novel Eco-friendly Colorant and Dyeing Method for poly(ethylene terephthalate) Substrate*", Fibers and Polymers, 2014, Vol.15, No.2, 261-272.

PATTERN CONSTRUCTION OF WOMEN'S LINGERIE

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ABSTRACT

The perception of a well-fitted piece of underwear is when it acts as the second skin to the wearer. A productive pattern development depends on a combination of factors that should be considered when designing and developing an underwear garment. The work presents the way of garment construction of women's bodysuit.

Key words: fashion illustration, underwear, knitted fabric, bodysuit.

BACKGROUND

Bodysuit (shorter - body) is an one-piece garment which covers the upper body and the crotch. It is connected with fasteners between the legs. Usually, the bodysuit is worn as lingerie, sports outerwear or as a body shaper. It can be worn as a smooth lined undergarment because it is fixed on the body itself so it cannot be untucked (Wikipedia, 2015). As a result of thinking how to make lingerie which isn't only functional, we came up with an idea for a visually enhanced bodysuit. The presented bodysuit model, shapes woman's figure in the waist area with see-through laced parts making it look slimmer and showing the woman's body in its full beauty. For making the designed model, we wanted to use natural fibers, so we made it in cotton blend usually used in lingerie products.

FASHION SKETCH

In the fashion sector, every new garment begins with a fashion sketch, where designers transfer their own idea onto a piece of paper.

Figure 1: Fashion sketch of women's underwear (student drawing)

Figure 1. shows the fashion illustration that helps the patternmaker to develop a precise pattern in order to make the final garment.

PATTERN DEVELOPMENT

A well-fitted piece of underwear is considered when it acts as the second skin to the wearer, allowing the body to move without any restraints (Lindqvist, 2013, Tsaousi, 2011).

The educational literature after Ujević et al., was used to draft the two-dimensional pattern of women's bodysuit based on the measurements given by the measurement chart for the international clothing size 36.

Figure 2 shows the drafted flat pattern. The starting point was the back neck point, that usually acts as the initial balance point for all upper body garments. Primary body measurements such as body height, chest girth, waist girth and hip girth were taken from the standard size chart for women's wear (Ujević et al., 2010) and served as a basis to calculate auxiliary measurements. The auxiliary measurements needed for the pattern construction were: scye depth, back waist length, hip depth, neck width, front length, back width, scye width, bust and waist width. The drafted pattern is aimed for stretch fabrics, thus the calculated auxiliary measurements were reduced for the stretch ratio of the jersey knitted fabric, the undergarment is intended to be made from (Haggar, 2004, Watkins, 2011).

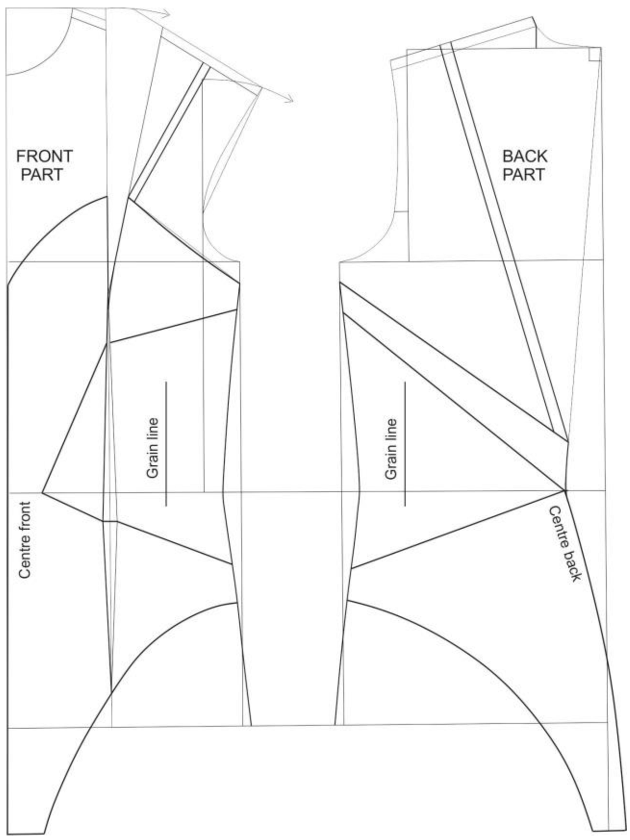

Figure 2: Front and back pattern block (student drawing)

Having finished the basic front and back pattern block, the block was altered (see Figure 2) in order to achieve the designed underwear garment. Straps were drawn on the pattern block in order to measure the total strap length. The interchangeable straps enabled several ways in which they can be fastened on the back part (Figure 5).

SELECTED KNITTED FABRIC

Nowadays, technology advances of fabric creation has led to a domination of knitted fabrics in the underwear production. In order to test the drafted pattern, two types of knitted fabrics were selected, and used as the fabric for tailoring of women's bodysuit, Figure 3.

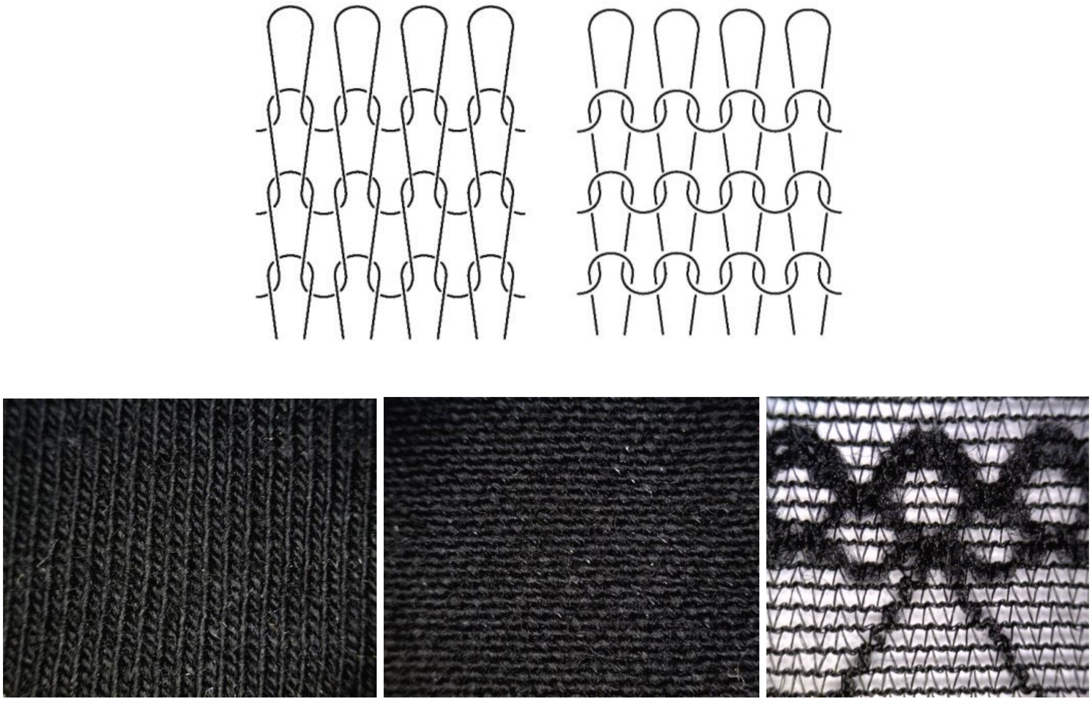

Figure 3: Yarn flow in jersey knitted structure used for the production of a bodysuit (student pictures)

The front and back part was made from cotton jersey knitted fabric, while the waist insertion was made from jacquard knitted fabric.

GARMENT SAMPLE

The drafted pattern was tested by cutting a trial garment of the selected knitted fabric (see Figure 4 and 5).

Figure 4: Front view of the developed underwear garment (student pictures)

Figure 5: Back view of the developed underwear garment (student pictures)

The stitch types: lockstitch (class 300), overedge chainstitch (class 400) and covering chainstitches (class 500) were used for tailoring (Tyler, 2000). Nylon hook and eye tape were used as fasteners in the crotch area.

CONCLUSION

The work has presented the way of underwear development. The first step in the garment tailoring is to create a fashion sketch of the desired garment. In the next step, based on the measurements given by the measurement chart for the international clothing sizes the pattern was drafted and altered. To test and refine the garment pattern a bodysuit was tailored and confirmed that the drafted pattern provided the desired comfort and functionality.

REFERENCES

Bodysuit, Available from: *https://en.wikipedia.org/wiki/Bodysuit*, Accessed: *January, 2015*
Lindqvist R (2013). On the Logic of Pattern Cutting. University of Boras
Tsaousi, C (2011). Consuming Underwear: Fashioning Female Identity, PhD Thesis, University of Leicester
Ujević D., Rogale D, Hrastinski M. (2010). *Tehnike konstruiranja i modeliranja odjeće*, Third edition, Zrinski d.d., Čakovec
Haggar, A (2004). *Pattern Cutting for Lingerie*, Beachwear and Leisurewear, Blackwell Publishing.
Watkins, P. (2011). Designing with stretch fabrics, *Indian Journal of Fibre & Textile Research*, 36(4):366-379
Tyler, D. J. (2000). *Carr and Latham's Technology of Clothing Manufacture*, Blackwell Publishing

FUTURISTIC DESIGN APPROACHES FOR NEW GENERATION TEXTILES

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ABSTRACT

Importance of technical textile applications has become more and more important for the textile industry. Many textile producers in the world are trying to develop new ideas and studies collaboration with researchers for futuristic textile applications. Today, it is possible to find significantly different technical textile applications which are being used in various areas from constructions to space applications. Furthermore, textile materials have already been a part of many futuristic applications owing to their unique irreplaceable properties. It is obvious from the history; every dream gives people inspiration to make it real. For this reason, we believe that futuristic approaches to textile may also give new inspirations to the researchers for their futuristic advanced applications. In this paper, we intend to bring light on some futuristic approaches for new generation textile materials.

Keywords: Futuristic approaches, futuristic, design, fashion, textile, material

INTRODUCTION

It is possible to define “textile” as “a flexible material consisting of a network of natural or artificial fibers, yarns or threads” (1). Textile is one of the largest scale industries in the world economy and it has a great economic importance for some countries which are mainly dependent on textile production for their economic survival. Textile is moving forward very rapidly like other locomotive industries with advanced technologies and new materials. After multidisciplinary studies became more prevalent, science has started to come up with more surprising and fascinating results.

“Futuristic” term has been defined as ‘strange and very modern, or intended or seeming to come from some imagined time in the future’ in the Cambridge Dictionary (2). This term has been started to be used more frequently owing to the rapid growth of science and technology recently. Even it is commonly known as a fashion term for textile industry, it is possible to reach futuristic approaches and designs with textile materials in different industries. Futuristic products are usually developed with biological science, artificial intelligence, genetic engineering, advanced materials and nanotechnology (3). Also, some global problems such as climate change can give inspiration for scientists to produce futuristic garments (3). In this paper, we aim to enlighten some recent futuristic applications and approaches of textile materials.

APPLICATIONS

As we all know, textile materials are located in our lives for centuries. It is possible to count numerous textile applications in various areas. Most of them are traditional textile applications. These products are produced by traditional methods and produced from conventional textile materials. Technical textiles differ from these markets with their unique properties and utilized technology. Even though, technical textiles have a small slice in the textile market, technical textile products are high value-added products and there is a growing tendency on technical textiles manufacture. Therefore, the following up new studies and new approaches become more important for the future of textile industry (3).

Futuristic designs or approaches inspire technical textiles. It is possible to find numerous projects or ideas which aim to develop extraordinary, futuristic products which can be used for technical textile materials (4, 5). We would like to touch on some recent futuristic approaches to the new generation textiles.

NASA Z-2 Space Suit Prototype

Space suits are one of the most important examples of usage areas of technical textiles (6). Due to everyday growing airspace technology and its demands, space suits should be adapted to meet these increased innovative request. Even, it is preferred that space suit is one step forward of this technology because of life quality of astronaut is defined by space suit (6, 7).

NASA Z-2 space suit prototype is the last created space suit. It has been created by ILC Dover for a competition executed by NASA. ILC Dover' design captured the most votes in this competition. NASA aimed to use Z-series on a path to Mars (Figure 1) (5, 8). Z-2 space suit is made from hard composite material and therefore it can be performed long term (8). This prototype is still under investigation and development. Every detail has to be evaluated before making a trip to space (5). It has been defined that cover layer of suit protects the lower layers and technical details from abrasion and snags during ground-based testing (8). Moreover, cover layer also gives the suit an aesthetic appeal, it also helps to protect spacewalker from micrometeorite strikes, the extreme temperatures in space and the harmful effects of radiation (5, 8).

Figure 1: Z-2 Space suit prototype (5)

EDAG Light Cocoon Concept Car

The EDAG Light Cocoon is a concept car designed by EDAG for Geneva Motor Show in 2015. It is an extraordinary car with its bionically-inspired trellis body structure and weatherproof textile panels. Body structure of EDAG Light Cocoon is based on previous model EDAG Genesis (Figure 2) (9). EDAG Genesis is employed biomimicry by using the turtle's shell. This biomimic model provides more protection and cushion against accidents. Also it can be produced by 3D printing method. Even though, EDAG Genesis was quite interesting and extraordinary, EDAG Light cocoon has been created by EDAG (9).

As a result of more futuristic view, it differs from genesis by using a weatherproof textile material instead of traditional metal cover. It is believed that Light cocoon will inspire many manufacturers due to its weight which is one the most important parameters. Apart from this, almost all things are enjoyable about this concept such as motoring acceleration, braking, efficiency, handling and brain-crushing cornering G-forces. Using textile materials as car covering provides to get motorcycle-like performance or economy on four wheels (9)

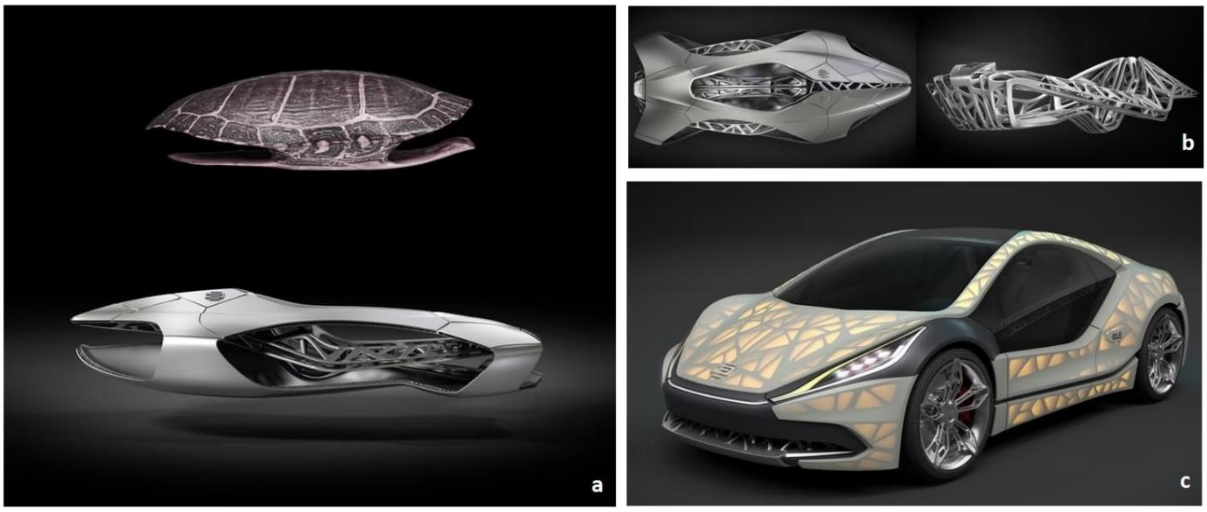

Figure 2: a-b) EDAG Genesis (9), c) EDAG Light Cocoon (9)

Wearable Smart Clothes

Smart clothes have been already started to be the part of our daily life (Figure 3). Most of the popular textile brands have already introduced at least few smart clothes for their customers (10). Today, nearly half of the humanity are addictive to technology, especially the people who live in metropolitan cities. People are trying to make their life easier because of the rush and chaos. Smart devices present a solution to ease the burden of their daily life so they cannot imagine a life without their technological devices such as smart phones, tablet, etc. Although we carry our smart devices with us every second, in the future we may need lees smart devices owing to widespread usage of smart textiles. Since textile materials have been already located in our daily life in everywhere.

Wearable conductive fabrics are already studied by many researchers (10). These studies mostly aim to create conductive fabrics/to impart conductivity to the fabric. However, developed products are commonly need a battery or energy storage device. Generally functional and high performance fibers are preferred to be used for developing conductive wearables. Although natural fibers have good textile properties especially for wearer comfort, they have rarely been used in technical textiles applications such as conductive wearables.

According to a multidisciplinary research realized in 2016, it is possible to produce a conductive wearable textile garment with natural fibers anymore. Cotton fiber is embedded to a functional material such as activated carbon (10, 11). However, it has to be firstly treated with a molten salt which results in fiber swelling. Therefore, activated carbon can be located in the opening fiber structure (11). Embedding process is made by sliding the yarn through a syringe filled with a mixture of the material in the ionic liquid. As a result of these processes, produced materials exhibit both original flexibility of cotton and also capacitive properties of activated carbon. Moreover, when the activated carbon-natural fiber welded yarn is twisted with a highly conductive stainless steel yarn, stainless steel yarn allows the materials to be charged more easily (11).

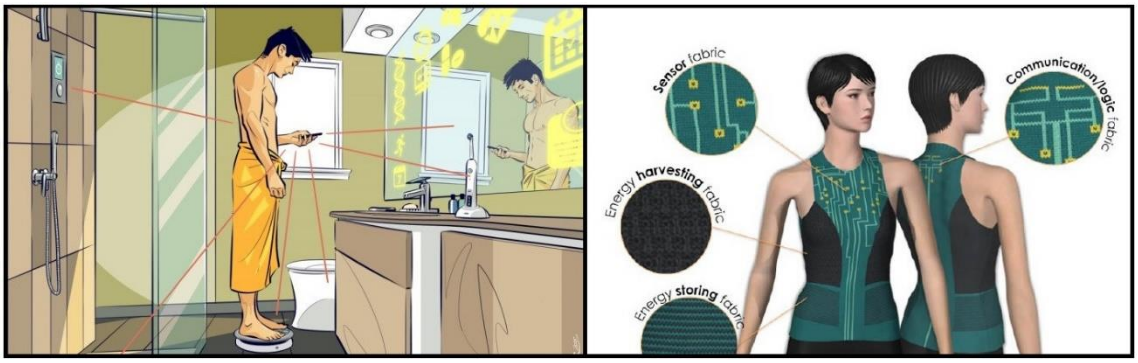

Figure 3: Importance of smart devices in our daily life (10), natural fiber welted conductive fabric (11)

3D Printed Self-Assembling Materials

3D printers may be one of the most important inventions in this century. They provide us to save time, money and labor force. 3D printers find an increasing usage day by day and they have promising great future not only in the world but also in the space (3). Every day, they are becoming more and more advanced and improved. Commonly known brands have already started to patent fights for 3D printed/printable products. Self-assembling materials used in 3D printers are also important as much as 3D printers. 3D printed textile materials, wood or even carbon fiber can actively transform into predetermined patterns and shapes in return for heat or other environmental stimulant. These materials can be adapted in various areas and they provide countless benefits. For example, boxes can be shipped flat but it can deploy into storage on arrival. Their future is open to be used in many new applications such as building, product manufacturing, shipping equipment, 3D printed clothes and shoes.

In this research area, it is possible to reach different futuristic ideas and projects. “Active shoes” project is only one of them (12). “Active shoes” project is a study belong to industrials designers at MIT’s Self-assembly Lab. They aim to create a significant light shoes that can automatically conform to the precise shape and size of user’s own foot by using 3D printing technology (Figure 4) (12). Basically, plastic material in different layer thicknesses patterns onto stretched textile materials and when the textile material is released from stretch, 3D printed product contract into the pre-programmed shape and also it jumps into the exact shape of the foot. While it is very difficult to use stretching fabrics with conventional methods due to complex molding and mechanical processes requirement, 3D printing method make it easier and reduces the complexity of formation processes (12). Moreover, it is a sustainable textile production method compared with conventional textile manufacturing processes because it reduces the production, transportation, energy and employment costs.

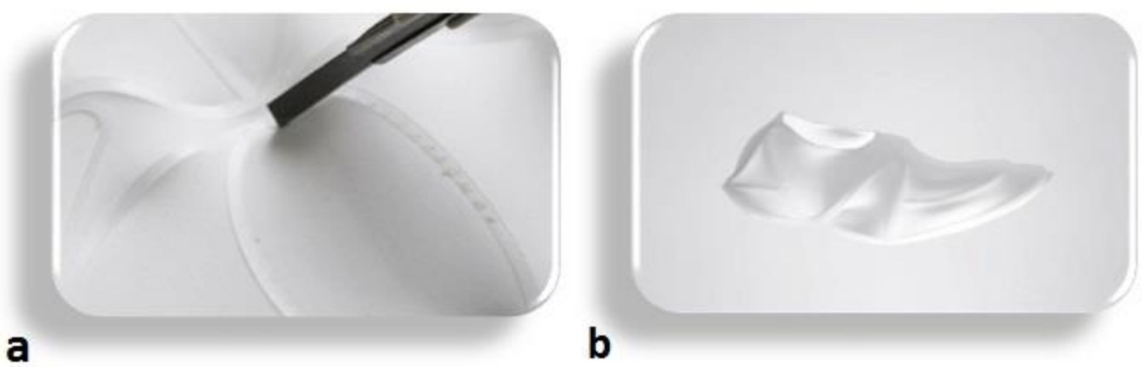

Figure 4: a) 3D printed self-assembling material on strectched fabric (12)
b) after realising fabric product jump the pre-planned shape (12)

Space Balloons, Space Lift and Space Hotel

Today, it is known that there are wide range of technical textile applications used in space related equipment and vehicles such as aforementioned space suits, space shuttle, satellite, space shields, etc. Weight is a unique parameter for selecting material for space applications. It is required that the space related materials should be durable, resistant to radiation, high temperature and as much as light and maintain its high strength (13). Therefore, textile materials and composite materials with textile materials are good candidate for producing space products. Particularly, high performance fibers (such as PBI, PBO, HPPE, PIPD, Aramids, spider silk, etc.) are widely used in various space applications (13, 14). For instance, NASA's Balloon Program Office uses multiple kind of balloons for collecting scientific information and most of these balloons are made from high performance fiber composites. They are called with different names like "zero pressure balloons" or "super pressure balloons" which depends on the distance from Earth due to surrounding atmospheric pressure effects (Figure 5) (15). Furthermore, there is also planetary balloons used for collecting information about other planets. These kind of balloons are required to be resistant to environmental conditions of the atmosphere layers of the planet. For example, Venus is covered with a sulfuric acid cloud approximately 48 km distance from the surface. The surface temperature is about 460 °C. However, the temperature of sulfuric acid cloud is nearly minus 10 °C. Planetary balloon needs to move up and down for collecting information and transmitting the information from Venus to Earth so it has to be built from heat and chemical resistant material (13, 15, 16).

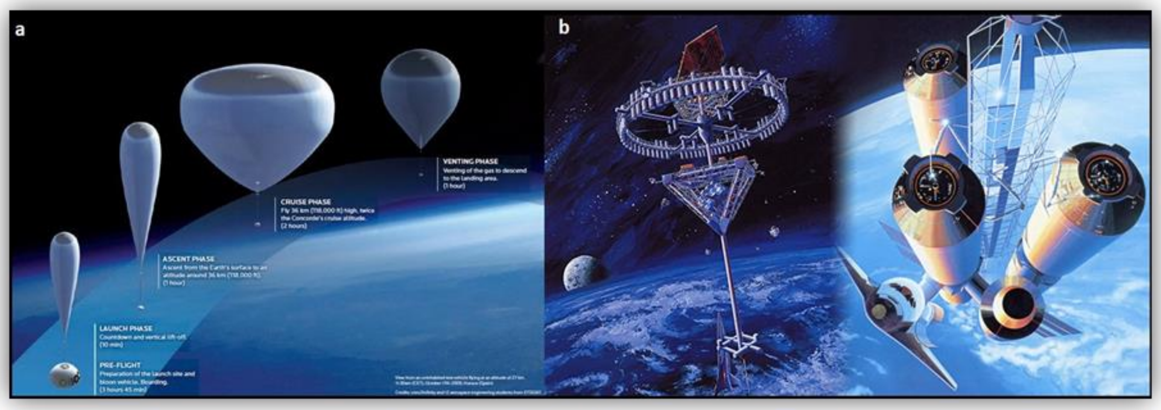

Figure 5: Space balloons and Space elevator (17)

Futuristic applications of textile materials in space is not limited with only balloons. There is an also super futuristic design that is planned to build with widely textile materials. Although realization of this project does not seem to be possible in a short period of time, it is going to obviously effect the future of human nation when it is successfully completed (17). The project contains a space elevator between Earth and Lunar, also a space hotel on the Lunar surface. Lightweight and durable materials such as carbon fiber and high performance polyethylene are planning to be used in this futuristic project (17).

CONCLUSION

Textile industry has a significant role for the future of our planet even for the space. The usable textile materials and technologies are developing every passing day and they can be easily adapted for futuristic applications. Technical textiles have already gained a great importance by all the textile produces around the world. Futuristic designs and futuristic approaches are very important for technical textiles applications. Inspiration and design ideas are really important for the development and improvement of futuristic technical textile applications. For this reason, we aimed to elaborate on the futuristic approaches on the new generation textiles in this paper.

REFERENCES

1. [cited 2016 April]. Available from: https://en.wikipedia.org/wiki/Textile.
2.futuristic [cited 2016 April]. Available from: http://dictionary.cambridge.org/dictionary/english/futuristic.
3.Quinn B. Fashion futures. London: Merrell; 2012.
4.Invisibility Cloak [cited 2016 April]. Available from: http://www.toxel.com/tech/2012/12/15/invisibility-cloak/.
5.Image(s) of the day: A history of US spacesuits in pictures 2015 [cited 2016 April]. Available from: http://www.electronicproducts.com/Packaging_and_Hardware/Shielding_and_Insulation/Image_s_of_the_day_A_history_of_US_spacesuits_in_pictures.aspx.
6.De Monchaux N. Spacesuit: Fashioning Apollo. Cambridge: MIT press; 2011.
7.Heinlein RA. Have Space Suit, Will Travel: Simon and Schuster; 2005.
8.NASA's Next Prototype Spacesuit Has a Brand New Look, and It's All Thanks to You. [cited 2016 April]. Available from: http://www.nasa.gov/content/nasa-s-next-prototype-spacesuit-has-a-brand-new-look-and-it-s-all-thanks-to-you.
9.Hanlon M. EDAG Light Cocoon concept employs weatherproof textile skin over a bionically-inspired, back-lit trellis frame 2014 [cited 2016 April]. Available from: http://www.gizmag.com/edag-light-cocoon-concept-car-uses-weatherproof-textile-outer-skin-panels/35258/.
10.Smart Clothes and the Future of Wearables [cited 2016 April]. Available from: http://www.bostoncommons.net/smart-clothes-and-the-future-of-wearables/.
11.Holding Energy By The Threads [cited 2016 April]. Available from: http://www.materialica.com/lightweight-design-en/holding-energy-threads/#more-3920.
12.MIT's Self-Assembly Lab 3D prints shape-shifting shoe [cited 2016 April]. Available from: http://www.3ders.org/articles/20151103-mits-self-assembly-lab-3d-prints-shape-shifting-shoe.html.
13.Kalaycı E, Avinç OO, Yavaş A. Yüksek Performanslı PBO (poli-p-fenilenbenzobisoksazol) Lifleri. Tekstil ve Mühendis. 2015;22(98):62-83.
14.Kalaycı E, Avinç O, Yavaş A. Polibenzimidazol (PBI) Lifleri. Tekstil ve Mühendis. 2014;21(96):51-67.
15.Hongu T, Takigami M, Phillips G. New millennium fibers. Cambridge: Woodhead Publishing Limited; 2005.
16.Seely L, Zimmerman M, McLaughlin J. The use of Zylon fibers in ULDB tendons. Advances in Space Research. 2004;33(10):1736-40.
17.Japanese Firm Designing Futuristic Space Mega-Projects [cited 2016 April]. Available from: http://www.universetoday.com/66108/japanese-firm-designing-futuristic-space-mega-projects/

TEXTILE RELATED EXTREME SKY SPORTS

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ABSTRACT

Textile materials are widely used in various sport garments and equipment. These textile materials are also known as sport technical textiles (sportech). Sport textiles' products are generally manufactured with high technology and/or specialized fibers such as high performance fibers. All sport textiles should possess specific unique properties and structures. It is very important to prefer the correct material and the manufacturing methods during its construction. At this point, some sport types such as extreme sports differ from others due to higher risk and danger probability. Especially, extreme sky sports may be accepted as one of the most dangerous sports and their most components contain textile materials. In this paper, we aim to enlighten the usage of textile materials in extreme sky sports and to draw attention on its importance for this specific field.

Keywords: Extreme sky sports, extreme air sports, wingsuit, jet powered wingsuit, parasailing, paragliding, bungee jumping, slacklining, space diving

INTRODUCTION

'Extreme sport' is a popular term to define the activities with high level of inherent danger. These activities are also known as action sport, adventure sport, free sport or even individualistic sports (1, 2). Also they involve highly dangerous and risky conditions like speed or height. Extreme sports become more popular in the last 30 years (1). Extreme sport is classified as land, air and water extreme sports. For instance, barefoot water skiing, cliff diving, free-diving, jet skiing, open water swimming, powerboat racing, round the world yacht racing, scuba diving, snorkeling, speed sailing, surfing, wakeboarding, whitewater kayaking, windsurfing, and kitesurfing are in the classification of water extreme sports.

Generally known extreme land sports are adventure racing, aggressive skating, BMX, motocross, extreme skiing, freestyle skiing, land and ice yachting, mountain biking, outdoor climbing, skateboarding, snowboarding and snowmobiling. Air extreme sports are base jumping, gliding, hang gliding, high wire, ski jumping, sky diving, sky surfing, and sky flying (2).

Extreme sports are quiet dangerous activities; therefore, extreme sport equipment is required to be manufactured from durable safety materials. The construction materials and fundamental components of most extreme sport equipment are textiles and/or textiles related materials. Textile materials used in extreme sports are called as sport textiles (sportech). Although, the required properties are various and depend on the usage conditions, all these materials have to be durable and reliable during the sportive action. Material preference has a great importance for such extreme activities since there is no chance to make a mistake, which could cause a death or serious injury for the sportsmen, with this equipment. For this reason, we investigated the textile materials that are used in extreme sports and what kind of materials and must properties are required for extreme sports equipment.

TEXTILE RELATED EXTREME SKY SPORTS

Wingsuit

Wingsuit is a type of a garment that enables a person to glide through the air when in free fall (3-6). The garment has some sections between the arms and legs and these sections inflate when the wearer jumps from a high place (Figure 1) (3, 7). Wingsuit flying is the newest skydiving discipline (8). Wingsuit provide to fly long horizontal distances with a very slow descent rate until the user open his/her parachute (a safety landing with using solely wingsuit is currently not feasible) (4, 6, 8). Wingsuit needs to be built very carefully same as other sky sports equipment due to potentially high risk existence leading to death. Particularly, proper material choice and aerodynamic forces on manufactured garment during flight needs to be evaluated attentively (3, 9).
Even though wingsuit has different names such as "birdman suit", "skydiver suit" and "flying squirrel suits", "wingsuit" is the most popular one (6). This suit has a serious research background. Although, the various types of wingsuits are available in the market, there are many researches that aim to improve performance of wingsuits (7-9). For example, a wing suit must be capable of high lift. The expected requirements about wingsuit are listed below from the most important ones to the least important ones;

Wingsuit (9);

- must produce high lift, building potential glide ratio up to >5:1
- needs to be manufactured as small as enable to be tested in wind tunnel but also it has to be enough size for good consideration
- must have optimal aspect ratio for high lift while keeping flow attached
- is needed to produce from light and durable materials.
- is needed to be light and rigid.
- should not exceed 25% of the weight of the user
- must provide enough space for parachute system and its ripcords.

High strength composite, membrane and woven fabric structures with various textile materials with light weight, good tenacity properties [such as polyamide fiber (9, 10)] are commonly used for wingsuit manufacture (10, 11).

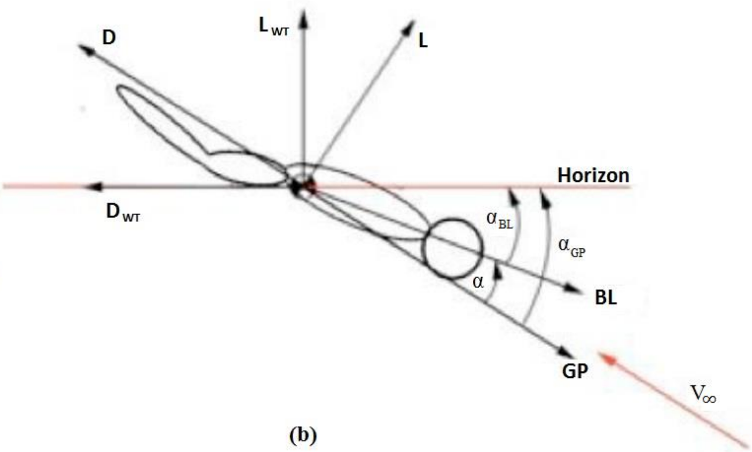

Figure 6: (a) Design of wingsuit, (b) Wingsuit flight and angle of attack [L: lift force, D: drag force, V∞: free-stream velocity, GP: pilot's glide path, BL: bodyline,α: the angle of attack, αBL: the angle from the bodyline to the horizon, Lwt and Dwt: correspond to the lift and drag components as reported by the wind tunnel force balance (4)

Jet powered wingsuit (Jetman)

Powered wingsuit is an experimental wingback and it has been under investigation since 2005. This suit has been designed with small jet engines provide the wingsuit to reach horizontal speeds of over 255 km/h (160 mph). Today, it became possible to attain flight distances of an aircraft and to maneuver with only body moving of the wearer (Figure 2). However, this invention is still experimental due to highly expensive construction materials requirement. For instance, Yves Rossy, Jetman using the jet powered wing suit, took an eight-minute flight over the Swiss Alps (12).

Figure 7: Jetman (12)

Parasailing:

Parasailing is a kind of kiting activity also known as parascending or parakiting (Figure 3)(13). A vehicle (usually a boat) is used to tow the person wearing parasail wing into the wind like a giant kite (5). Boat, car or truck may be used as moving anchor. Parasail wing are attached to the vehicle and also the pilot (a person wearing parasail wings) with cords. When the sufficient lift is provided by the moving of vehicle pilot rises into the sky (2, 5). If the vehicle has enough power and conditions are suitable two or maybe tree people can parasail at the same time behind the same parasail wing. Vehicle slows and ceases to generate lift for safety landing (5).

Although the pilot has a little control or no control on the parasailing wings, recent parasailing equipment allow the pilot having greater control over the center of gravity of the glider, as well as the ability to make a wider variety of changes in position during flight (5). There are commercial parasailing operations all over the world; especially it is popular in touristic places. Besides, land-based parasailing has been started to perform as a competition sport in Europe.

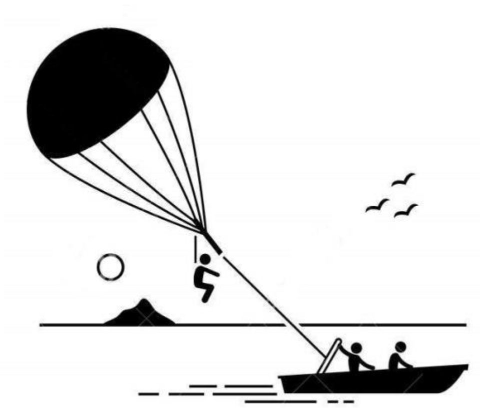

Figure 8: Icon clipart for parasailing (13)

Paragliding:

Paragliding is another extreme sky sport (Figure 4). There is no engine used in paragliding. However, paragliders can fly for hours in the sky more than hundreds of kilometers. Up to two hours flight time and some tens of kilometers are just a part of regular flight schedule for the paragliders who sit in a harness suspended underneath a fabric wing comprising a big number of interconnected baffled cells. Moreover, wing shape of the paraglide is maintained by the suspension lines, the air pressure entering vents in the front of the wing, and the aerodynamic forces of the air flowing over the outside (2).

Figure 9: Icon clipart for paragliding (13)

Bungee jumping:

It is possible to classify Bungee jumping under extreme sky sports category due to its flying and free fall phenomenon. Bungee jumping is an activity that involves jumping from a high point while connected to a large elastic band/cord (Figure 5). Commonly non-moving objects such as high buildings, skyscrapers, bridges, cranes but also moving objects such as helicopter or balloon can be used as tall structure for bungee jumping activity. When the person jumps, the elastic band stretches and the jumper flies upward again as much from free-fall as from the first rebounds (14). These falls and jumping bands in other way of saying bungee cords (14-16). Natural rubber exhibits excellent extensibility, resilience and strength. Although synthetic rubber (elastomeric fiber) is more resistant to sunlight and air than natural rubber, resiliency and tensile strength of synthetic rubber is slightly worse than the natural one (15).

There are two types of rubber material which are used as bungee cord. First one is called 'mil-spec' (military specification) and the second one is more basic type of rubber that is called 'all-rubber'. First rubber type is held in a pre-stretched position by a braided nylon sheath. However, the second type of rubber has no sheath and thus no pre-stretch (16).

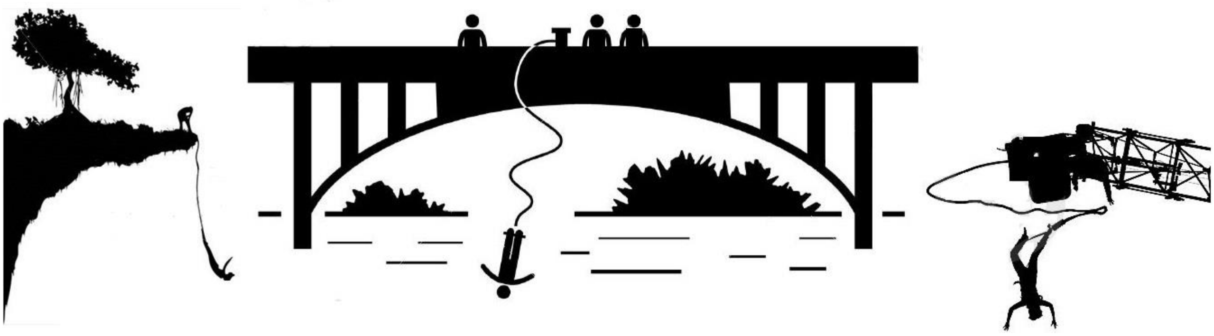

Figure 10: Icon clipart for bungee jumping (17-19)

Slacklining:

Slacklining is a kind of the extreme sports but there is not a certain classification for this sport. Slacklining is similar to voltage. Because it refers to act of walking or balancing along a suspended length of flat webbing that is tensioned between two anchors (Figure 6) (20, 21). It also looks like tightwires and tightropes but it differs from these activities with the required material properties (21). It is possible to define slacklining as “long and narrow trampolin”. The cord should be tensioned significantly less than tightropes or tightwires because a dynamic line is needed for stretching and bouncing. Slacklining can be performed in various circumstances and the tension of slack line can be adjusted according to the user. Its simplicity and versatility make this extreme sport more popular due to only a few components’ requirement and it also fits various environments. Slacklining can also be accepted as a training method for enhancing the human proprioceptive system, athletic performance, athletic speed, athletic agility, athletic vertical leap, athletic eye/hand coordination, spatial awareness, left/right brain organization and increasing the muscular development (20).

Figure 11: Slacklining iconic demonstration (22)

Space diving:

When extreme sky sports are investigated, space diving differ from all other extreme sky sports due to its uncommonness and also it is maybe the most dangerous one. Space diving was practiced in reality by Felix Baumgartner in 2012 (23). He jumped from a specially constructed capsule at over 128,000 feet (39km) above the earth. He broke the world records for the highest-altitude skydive and the highest speeds in free fall (Figure 7). He also broke speed of sound and the record for fastest free fall during his descent (23).

Figure 12: Felix Baumgartner’s space diving (24, 25)

When the space diving journey investigated, it can be encountered too many textile materials which are used in this special activity and all these materials had an important role during this journey (Figure 8). First, Felix was wearing an astronaut suit. Astronaut suits are one of the most qualified textile garments.
They are always designed with specialized materials in the light of last technology and innovation. Secondly, a weather balloon was used for rising of capsule that was carrying Felix.
Weather balloons are also created from well-designed fabrics or composite structures containing special treatments and coatings. Also, being lightweight has great importance for aviation vehicles. Aforementioned capsule is made of composite structures with lightweight materials. Moreover, high strength fibers are commonly used for their manufacturing. Finally, After Felix jumped from a capsule, he had used a parachute, also made from textile materials, for safe descending.

Figure 13: Felix Baumgartner's space diving route (26)

TEXTILE APPLICATIONS IN EXTREME SKY SPORTS

Material choice has a great importance for extreme sky sports same as other extreme sports. There are some unique properties which are required to be better than normal. Mainly, high strength materials are needed to be used for all extreme sports and being lightweight material is also a good advantage for many extreme sports. Moreover, sunlight resistance is very important and vital as sun can be very dangerous for textile materials in the long run leading to severe strength loses and deterioration which could cause deadly results. Extreme sky sport products are commonly built from lightweight materials but these materials have a limited lifecycle since they lose their stiffness and porosity increases after a short time. For this reason, it is required to slow down the aging effect of the used textile material and even/or to avoid this aging effect as much as possible as a consequence of UV exposure. Polyurethane or silicone coatings can be applied on the extreme sky sport constructions or high performance fibers can be used as a material during the manufacturing of extreme sky sport products.

There is also another way to decrease harmful effects of UV lights. Metals such as aluminum can be coated on the lightweight and/or high performance fiber structures as an ultra-thin layer (27).

This coated surface has a silvery shine and blocks and reflects to harmful UV lights (up to 90 percent of UV lights). Therefore, this can create more durable products (27).

Most of the extreme sky sports contain parachute or other similar equipment to parachute and polyamide (nylon) fibers are widely used for production of these equipment (23).

Cords, bands and strips have also a big importance for life safety of user as much as surface materials of extreme sport products. Traditional fibers are usually used in extreme sports as cord. However, it is also possible to see cords made from high performance fibers.

Sometimes, both conventional fibers and high performance fibers can be used together to meet the required specifications of extreme sport products. For instance, PBO (polybenzobisoxazole) fibers covered with high strength polyester fibers can be used as cord in paragliding (28, 29). Although, both fibers are suitable for their use in extreme sport products, PBO fibers are needed to be covered with some UV resistant fibers or polymers due to its sensitivity against to sunlight and moisture. This research reported that high strength polyester covered PBO fiber cords exhibited good elongation and strength performance and it has potential for being used as a textile cord in extreme sky sports (30).

CONCLUSION

It is obvious that textile materials are everywhere and they became an irrevocable part of our daily life. However, its importance is not limited with only our daily life; textile materials have a great importance for extraordinary applications. Extreme sports are one of the examples of these extraordinary applications. In our day life, maybe it is possible to handle and live with torn shirts or jeans but there is no excuse for using such damaged products in extreme sports. For this reason, in this paper, we intended to draw attention and to highlight the importance and use of textile materials in extreme sky sports.

REFERENCES

1.Puchan H. Living “extreme”: Adventure sports, media and commercialisation. Journal of Communication Management. 2005;9(2):171-8.

2.Classification of extemely dangerous sports [cited 2016 April]. Available from: http://d3tt-35-01.blogspot.com.tr/2012/05/classification-of-extemely-dangerous.html.

3.Robson G, D’Andrea R, editors. Longitudinal Stability Analysis of a Jet-Powered Wingsuit. AIAA Atmospheric Flight Mechanics Conference; 2010.

4.Berry M, Fargeas JL, Blair KB. Wind tunnel testing of a novel wingsuit design. Procedia Engineering. 2010;2(2):2735-40.

5.Hagler G. Human Innovation. Modeling Ships and Space Craft: Springer; 2013. p. 25-43.

6.Kalman B, Crossingham J. Extreme Skydiving. New York: Crabtree Publishing Company; 2006.

7.McQuaid M, Beesley P. Extreme textiles: designing for high performance: Princeton Architectural Press; 2005.

8.Warren J, Mello C, Borland G, Ballas J, Reed C, Douglas S, et al. Improving Wingsuit Performance (proposed research). 2014.

9.Stephanopoulos K, Levy B, Rabadan Jr I. Designing a High-Lift Performance Wingsuit. 2015.

10.Johnson K, Sullivan M, Sutton J, Mourtos NJ, editors. Design of a skydiving glider. Proceedings, Aerospace Engineering Systems Workshop; 2009.

11.Sestak TA. Developing a Robust Balance for Wingsuit Aerodynamic Research. 2015.

12.Jetman [cited 2016 April]. Available from: http://www.topgear.com/car-news/weird/jetman-vs-jaguars-542bhp-xjr#1.

13.Extreme Sports Icons Cliparts Set 2 [cited 2016 April]. Available from: http://www.dreamstime.com/stock-photo-extreme-sports-icons-cliparts-set-human-pictogram-representing-base-jumping-parachuting-paragliding-hang-gliding-image40590380.

14.Zemitis MS, inventor; Google Patents, assignee. Elastic cord apparatus patent US 5205803 A. 1993.

15.What are the different types of material used in bungee cords? [cited 2016 April]. Available from: https://prezi.com/pox2lw4fq2f-/what-are-the-different-types-of-material-used-in-bungee-cords/.

16.Heck A, Uylings P, Kędzierska E. Understanding the physics of bungee jumping. Physics Education. 2010;45(1):63.

17.Bungee Jumping [cited 2016 April]. Available from: http://www.dreamstime.com/stock-photography-bungee-silhouette-image2845912.

18.Bungee Jumping from Bridge [cited 2016 April]. Available from: http://www.123rf.com/clipart-vector/bungee.html?mediapopup=28524134.

19.Extreme Jumping [cited 2016 April]. Available from: http://www.gograph.com/clipart/extreme-jumping-gg60144010.html.

20.Klopman JE, Engle RC, Stacy MI, De'Varus M, HUDSON BT, Kelley CL, inventors; Google Patents, assignee. Slackline apparatus and training method. USA patent US 20150157890 A1. 2015.

21.Dao V, Yeh PH, Vogel KS, Moore CM. Applied neuroanatomy elective to reinforce and promote engagement with neurosensory pathways using interactive and artistic activities. Anatomical sciences education. 2015;8(2):166-74.

22.Slacklining [cited 2016 April]. Available from: https://www.fotolia.com/p/201062508.

23.Day Jr DW. Circular Error Probability (CEP) & Reefed Parachute Payload Recovery Red Bull Stratos Space Dive. Aerodynamic Decelerator Systems Technology Conferences, AIAA Balloon Systems (BAL) Conference, 25-28 March 2013, Daytona Beach, Florida Florida2013.

24.Felix Baumgartner [cited 2016 April]. Available from: http://www.advenport.com/sporcu/felix-baumgartner.

25.Felix Baumgartner Jump Video: Watch The ENTIRE Sky Diving Space Jump [cited 2016 April]. Available from: http://www.enstarz.com/articles/8069/20121015/felix-baumgartner-jump-video-watch-the-entire-sky-diving-space-jump.htm.

26.The tech behind Felix Baumgartner's stratospheric skydive [cited 2016 April]. Available from: http://www.extremetech.com/extreme/137521-the-tech-behind-felix-baumgartners-stratospheric-skydive.

27.The development of new materials plays just as important a role in paragliding as it does in aerospace [cited 2016 April]. Available from: http://skywalk.info/en/development-2/aerofabrix/.

28.Chung T, Hsing W, Tsai F. Application the PBO Fiber of the Paragliding Cord. 華岡紡織期刊. 2005;12(1):29-33.

29.Kalaycı E, Avinç OO, Yavaş A. Yüksek Performanslı PBO (poli-p-fenilenbenzobisoksazol) Lifleri. Tekstil ve Mühendis. 2015;22(98):62-83.

30.鍾則翰, 陳銘進, 吳明杰, 邢文灝. 碳弧光對 PBO 纖維編織飛行傘傘繩力學性質之研究. 2006.

DETERMINATION OF SEPARATION FORCE FOR COMPOSITE MATERIALS

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ABSTRACT

The ubiquitous application of composite materials are possible because of their unique combination of characteristics. The composite is artificially made, that gives the possibility to improve this combination of properties. In the present study separation force was tested of a three layered composite material which were thermally bonded with three different process speeds (30, 34 and 39 m/min) and the two PU thickness (2 mm and 4 mm). The results show that lesser speed of thermal bonding resulted in stronger bond of components, which has contributed to greater PU melt and its penetration into woven fabric and knitted fabric.

Key words: car cushion, polyurethane foam, thermal bonding, bonding speed, woven and knitted fabric

INTRODUCTION

The quality and appearance of car seat cover is important, because it is the part of the vehicles interior that making the first contact with the traveller. Single-layer car seat covers was produced before the appearrance of the multi-layer composite material and had poor resistance to abrasion and tearing, especially on the folded areas, were uncomfortable during prolonged sitting and had an extreme anisotropy. Deterioration resulted in pad shaped seat, especially when woven fabrics were used, and their life span was shorter than the life span of a car. It is worth noting that among the first composite materials that have appeared on the market were car seat covers and nowadays these materials are the most manufactured type of fabric in a group of technical fabrics (Mogahzy, 2009, Rowe, 2009).

In the last few decades, intensive development of new materials has resulted in composites that meet all the requirements of car manufacturers. Life span of basic car seat covers should be, on average, at least the lifetime of car. It is important to choose materials that will have the necessary properties in the final composite. The value of composites (woven fabric + polyurethane foam (PU) + knitted fabric) depends on the force of the separation of the individual components (Fung, Hardcastle, 2001, Kovačević, Ujević, 2013, Mukhopadhyay, Patridge, 1999, Ujević et al., 2005).

The usage and qualitative values of textile materials and composites are commonly evaluated by its physical and mechanical properties, wear resistance, resistance to UV radiation, resistance to high and low temperatures, good physiological properties, design and comfort (Kovačević et al., 2009, Ujević et al., 2002, Mcloughlin, Hayes, 2013).

The usage of composite materials for car seat covers improved their physical and physiological mechanical properties and resistance to abrasion, UV radiation as well as resistance to variations in temperature. Composite materials with PU inside allow better longevity, greater comfort and less deformations on the folded areas. This composite longer retains the look and shape of the car seat cover without folds, especially if the components in the composite are thermally well bonded.

The properties of materials used in the composite covers for car seat covers affect the properties of the final composite. This means that the properties of composites are inherited from its components and can be changed by selecting components until a composite of the best properties for given car seat covers is made (Fung, Hardcastle, 2001, Bruins, 1969, Dombrow, 1965).

Nowadays, the properties of materials and composites often change, in order to improve the quality and produce a more durable car seat cover (Horvat-Varga, 2009, Pačavar, 2015).

EXPERIMENTAL PART

Separation forces of a newly developed composite fabric with two PU thickness (semi-composite: knitted fabric + PU and composites: woven fabric + PU + knitted fabric) was conducted with dynamometer Pellizzato/Tinius Olsen type H5KS, according to DIN 53 357 standard. The testing was conducted by using particular methods under strictly defined temperature and humidity of the material being tested. The moisture conditions were defined as 65 ± 2% and temperature of 20 ± 20C, as the standard atmosphere conditions for testing.

Materials

Woven fabric: 100% polyester (PES) multifilament, dobby weave, the density of warp / weft: 29 / 20.5 (yarn / 10 cm), the fineness of warp / weft: 620 dtex f 144 / f 167 48 × 3 dtex
Knitted fabric: 100% polyester (PES) multifilament, Locknit (Charmeuse), density arrays / rows: 13 / 11 (cm), the fineness of the yarn: 75 - 84 f 36 dtex.
Polyurethane foam (PU): two thicknesses: 2 mm and 4 mm were used to make the composites.

RESULTS

Testing results are shown in Table 1 and Figures 1 and 2.

Table 1: Sample thickness

Samples	**Thickness (mm)**		
	The measured values	Sum of components	The difference (reduction, %)
(PU) 2 mm	0.70		
(PU) 4 mm	1.40		
KF	0.22		
PU 2 mm + KF	0.88	0.92	4.55
PU 4 mm + KF	1.60	1.62	1.25
WF	0.70		
WF + PU 2 mm + KF	1.44	1.62	12.50
WF + PU 4 mm + KF	2.18	2.32	6.42

WF: woven fabric; KF: knitted fabric; PU: polyurethane foam

According to the results presented in Table 1 and Figures 1 and 2 the following can be determined: Thickness of each sample with different bonding process speeds was measured and the values are shown in Table 1. By thermally bonding components into composite, the thickness of the composite were reduced, in comparison to the sum of the components in the composite before the thermal bonding.

Separation force of knitted fabric in the composite and PU of 2 mm is 6.45 N (speed at 39 m / min) to 8.69 N (speed at 30 m / min) in the longitudinal direction, and 6.21 N (at a speed of 39 m/min) to 8.59 N (at a speed of 30 m / min) in the transversal direction. Forces of separating knitted fabric from PU of 2 mm and woven fabric in the longitudinal direction was 6.48 N (speed at 39 m / min) to 7.94 N (speed at 30 m / min), while in the transversal direction it was 6.70 N (at the speed of 39 m / min) to 8.37 N (at a speed of 30 m / min).

Composites with thicker PU do not show any significant difference in the forces of separation, it varies from 6.03 N (speed at 34 m / min) to 8.11 N (speed at 30 m / min) in the longitudinal direction and from 6.24 N (speed at 39 m min) to 8.62 N (speed at 30 m / min) in transversal direction. Force of separating knitted fabric from 4 mm PU and woven fabric in the longitudinal direction is 5.83 N (speed at 39 m / min) to 8.5 N (at speed 30 m / min), and in the transversal direction is 5.94 N (in speed of 39 m / min) to 8.67 N (at a speed of 30 m / min).

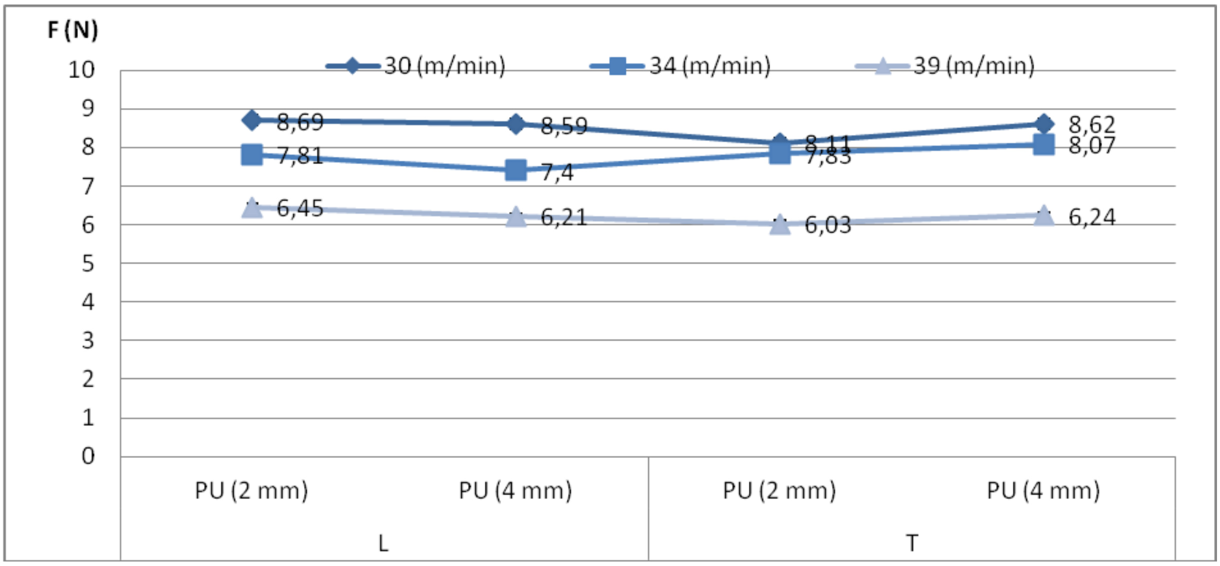

Figure 1: Separation forces of woven fabric from PU and knitted fabric (F: separation force (N))

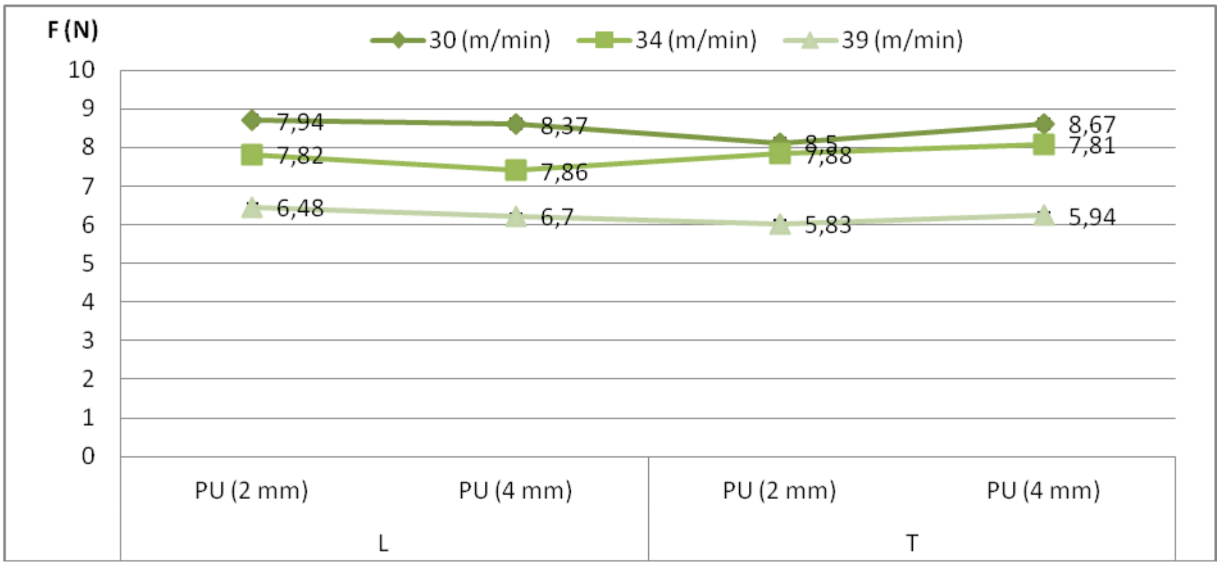

Figure 2: Separation forces of knitted fabric from PU and woven fabric (F: separation force (N))

CONCLUSION

The final results obtained by thermally connecting components in a composite with different speeds are:
Thermal bonding of knitted fabric and PU, resulting in semi-composite and then in woven fabric as final composite, caused a reduction in the thickness of the composite when compared to the thickness of the components that existed before the bonding. This indicates that the woven fabric and knitted fabric have, during surface PU melting, merged in the resulting melt and thus formed a good bond.
During thermal bonding process, longitudinal tension of woven fabric, knitted fabric and PU affects elongation and specific deformation of composites.
Separation force of PU and knitted fabric is greater than the separation force of knitted fabric from PU in all samples in both directions and both thickness.
According to the obtained results it can be concluded that the forces of separation were the smallest when samples in which the components were heat welded together at 39 m / min are concerned, and were highest when samples were thermally binding by 30 m / min.

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REFERENCES

[1] Mogahzy Y. E. (2009). *Engineering textiles*, Integrating the design and manufacture of textile products, Woodhead, Cambridge.
[2] Rowe T.(2009). *Interior textiles Design and developments*, The textile Institute, Woodhead publishing in textiles, Oxford, Cambridge, New Delhi.
[3] Fung W. , Hardcastle M. (2001). *Textiles in automotive engineering*, Woodhead, Cambridge.
[4] Kovačević S., Ujević D. (2013). *Seams in car seat coverings: properties and performance*, Joining Textiles, Principles and applications, edited by: I. Jones, G.K.Stylios, Woodhead publishing series in textiles, Oxford, Cambridge, Philadelphia, New Delhi.

[5] Mukhopadhyay S. K., Patridge J. E. (1999). *Automotive Textiles*, Textile progress, The Textile Institute Manchester.
[6] Ujević D., Kovačević S., Wadsworth C. L. (2005). *Textile in a Function of Car Industry*, The 5th International Scientific Conference of Producing Engineering, Development and Modernization of Production, University of Bihać.
[7] Kovačević S., Ujević D., Schwarz I., Brlobašić Šajatović B., Brnada S. (2009). Analysis of Motor Vehicle Fabrics, *Fibres & Textiles in Eastern Europe*, 71 (16), 32-38.
[8] Ujević D., Kovačević S., Hađina J., Karabegović I. (2002). I*mpact of Joined Place on the Fabric Intended for Manufacturing Car Seat Covers*, 2nd AUTEX Conference, Belgium.
[9] Mcloughlin J., Hayes S. (2013). *Types of fabric and their joining requirements*, Joining Textiles, Principles and applications, edited by: I. Jones, G.K.Stylios, Woodhead publishing series in textiles, Oxford, Cambridge, Philadelphia, New Delhi.
[10] Fung W., Hardcastle M. (2001). *Textiles in automotive enginering*, Woodhead publishing Ltd, Cambridge England.
[11] Bruins P. F. (1969). *Polyurethane Technology*, Polytechnic Institut of Brooklyn, NewYork.
[12] Dombrow B. A. (1965). *Polyurethanes*, Reinhold Publishing Corp. New York.
[13] Horvat-Varga S. (2009). *The impact of technological parameters of the high-frequency welding process*, Master, University of Zagreb, Faculty of Textile Technology Zagreb, Croatia.
[14] Pačavar, S. (2015). *The Influence of Sewing Parameters on the Production Quality of Car Seat Covers*, PhD Thesis, University of Zagreb, Croatia.

THE EFFECTS OF DIFFERENT FINISHING APPLICATIONS ON THE COLORIMETRIC AND COLOR FASTNESS PROPERTIES OF REACTIVE DYED COTTON FABRICS

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ABSTRACT

Humanbeing has been dressed throughout the human history due to the covering need of their body for many different reasons. However, nowadays, people desire textile products which could exhibit different functional performances. It is possible that new functional properties can be imparted to textile products with various textile finishing processes. Reactive dyed cotton products are widely used in textile industry due to their adequate fastness values and vivid color range. In this study, the effect of different finishing processes on the colour strength (K/S), colorimetric properties (L^*, a^*, b^*) and color fastness (washing, rubbing and light fastness) properties of cotton fabric dyed with different reactive dyes. The results exhibited that the final colour strength and colorimetric values and color fastnesses of dyed and finished cotton fabrics are dependent on the color of the dyed cotton fabric, the type of finishing processes and the mutual interaction of used finish and dye.

Key Words: finishing process, reactive dye, color strenght, fastness, softener, antifungal finish agent, antibacterial finish agent, water-oil repellant finish agent

INTRODUCTION

Colour fastness is one of the most important parameter for dyed textile materials according to buyers demand (1). It is desired that the colour of fabric should be resistant to various types of influences that is normal to exposed in day-life such as water, light, rubbing, washing, perspiration etc. (2, 3). Insufficient fastnes values are leading to the mainly problems of dyed textile structures during their usage. Reactive dyeing agents are the mostly used dyeing agents for colouring of sellulosic materials due to they are providing highly enough fastness values. These type of dyeing agents are suitable to different application methods and they exhibit good fastnesses bright colours so reactive dye agents have a great importance for textile industry especially for materials contain cotton fiber (4).

Finishing process is the final stage of textile wet processings. Various finishing processes can be applied on textile material depends on the desired performance properties and character of end-product (5). Functional finishes became a necessity due to there is a growing demand of consumers (6). Handle is an important property that has a great role in the preferences of consumers. Softeners and silicons are the widely used finishing agents in the textile industry. Silicons can be classifed into 3 groups according to their particle size as macro, micro and nano silicons.

Today, especially coated textile textiles with various finishing agents such as flame retardency, water repellency, antimicrobial, UV light ageing and encapsulated fragrances etc. are inreasingly demanded by costumers. Water and soil repellency are under investigation by fibre and textile scientists and manufacturers for centuries. Water repellency can be define as repelling water from the surface of the fabric and it is possible to use various applicaitons to make the fabric water repellent (7).

Cotton is still the globally most used natural fiber in the textile industry and wrinkle-free cotton fabrics continue to dominate the market and are gaining universal acceptance (8).
Cotton is generally used for apparel due to its satisfied comfort properties. However, it has two main drawbacks, susceptibility to creasing and bacterial degradation (6). Cotton fibers are more susceptible than synthetic fibers. Cotton fibers have porous hydrophilic structure containing water, oxygen and nutrients so they provide a perfect ambient to the growing of bacteries. It is clear that, it is an undesired character for custemers. For this reason, some finishing agents that make products antibacterial are developed by researchers and chemical companies.

Today, various finishing agents and different techniques are avaliable for gaining protection the textile materials against bacteria, yeast, dermatophytic fungi, and other related microorganisms for aesthetic, hygienic, or medical purposes. It is also possible to protect textile materials from insects, other pests and biodeterioration caused by mold, mildew, rot-producing fungi (8).

It is available to meet some studies that is evaluated the effects of finishing processes on colour parameters and fastnesses. In a pHd thesis, it is defined that it is developed a proper model for forecasting the effects of softeners, water repellenct and anti-crease agents on the colour properties by Balcı (2008) (9). Saleemi and his colleques determined that direct dyed cotton fabrics are treated with water repellecy agents by using sol-gel method and the results showed that sol-gel coatings increased the colour depth and washing fasteness of dyed samples (10). Influence of anti-crease on perspiration fastness is investigated in another study and it is emphasised that concentration of finishing agent is needed to be determined carefully. Since, color bleeding is observed on the samples applied with 100 g/l concentration of resin despite perspiration fastness does not effect negative (11).

The results of other research indicated that dyeing with proper reactive dye not only enhance the fastness and repellency properties, but also the molecular re-orientation of fluorocarbon polymers for water repellency may reach to fulfilment level at ambient temperature. Moreover, it is defined that there was no negative effect on tensile properties and samples colour had been observed (12).

Reactive dyes have a great usage due to having a wide color range and a greater color fastness rating. Most of the wet processing industries are using reactive dyes on textiles for coloration purposes. In most of the dyeing the final shade and fastness properties of the dyed fabric after finishing are affectted by the type of finish. In this study, the effect of various finishing agents (Softener, water repellent, oil repellent, antibacterial, antifungal, fragnence agents) on colour parameters (CIE $L^*a^*b^*$) and fastnesses (washing, rubbing and light fastnesses) of different reactive dyed materials was studied. It is aimed to compare colour and fastness values of reactive dyed samples without finishes with colour and fastness values of reactive dyed samples with finishes.

MATERIAL METHOD

In this study, cotton fabrics were dyed to 8 different colours (Table 1). The cotton fabric weaving types, their dyeing recipes and their final achieved appearance are shown in Table 1. Dyeing process was carried out using pad-batch method. After dyeing, the cotton fabric samples were dried and finished with many different finishing processing types such as softening, anti-crease, antibacterial, antifungal, water-oil repellant and odor finishes with the following recipes (Table 2).

Table 1: Dyeing recipes of dyed cotton fabric samples

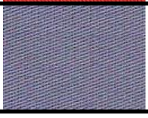
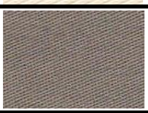
	Appearance	Weaving Type	Recipe for dyeing	
1		Gabardine	Remazol Ulra Oranj RGB=7,75 gr/l Rem. Red RGB=16,5 gr/l; Levafix Schwarz CA=17 gr/l;	Sodium hydroxide 21ml/l; Sodium silicate 95 ml/l
2		Gabardine	Remazol Gelb GL(%150)=0,83 gr/l; Rem. Red FLM=2,56 gr/l; Rem. Blue BB %133=12,6 gr/l;	Sodium hydroxide 15 ml/l; Sodium silicate 95 ml/l
3		Gabardine	Remazol Ulra Yellow RGBN=8,5 gr/l; Rem. Red RGB=6,85 gr/l; Rem. Blue RR=42,8 gr/l;	Sodium hydroxide 24 ml/l; Sodium silicate 95 ml/l
4		40/30 Diagonal	Remazol Gelb GL %150=6,5 gr/l; Rem. Ulra Red RGB=3,98 gr/l; Rem. Dark Blue SL=21,87 gr/l;	Sodium hydroxide 18 ml/l; Sodium silicate 95 ml/l
5		40/30 Diagonal	Remazol Gelb GL %150=0,665 gr/l; Rem. Red FLM=0,428 gr/l; Rem. Blue B %133=2,23 gr/l;	Sodium hydroxide 15 ml/l; Sodium silicate 95 ml/l
6		40/30 Diagonal	Novacron Yellow NC=1,885 gr/l; Novacron Brown NC=1,46 gr/l; Novacron Grey NC=3,75 gr/l;	Sodium hydroxide:8 ml/l; Sodium silicate 50 ml/l
7		40/30 Diagonal	Levafix Gelb E3RL=0,275 gr/l; Levafix Brown E2R=0,257 gr/l; Levafix Blau CA=0,248 gr/l;	Soda=10,5 ml/l; Sodium hydroxide 0,3 ml/l
8		Gabardine	Remazol Ulra Oranj RGB =2,135 gr/l; Rem. Red FLM=1,93 gr/l; Levafix Blau CA=5,575 gr/l;	Sodium hydroxide 15 ml/l; Sodium silicate 95 ml/l

Table 2: Finishing application recipes applied on dyed cotton fabric samples

Finish agents	Chemical type:	Application recipe
Crease resistance finish agent	DMDHEU	50 g/l Stabitex CL Plus (Pulcra) 1 g/l acetic acid liquor pick up % 70 Drying condition 120 ^{0}C 3 min Curing condition 150^{0}C 4 min
Water-oil repellent finish agent	fluorocarbon	100 g/l Ruco-Guard USR (Rudolf Duraner) liquor pick up % 70 pH :5-7 Drying condition 120 ^{0}C 3 min Curing condition 150^{0}C 3min
Softener	macro silicone	30 g/l Ultraphil HMS (Huntsman) pH: 5-5.5 liquor pick up % 70 Drying condition 120 ^{0}C 3 min
Softener	micro silicone	30 g/l Rucofin PRO (Rudolf Duraner) liquor pick up % 70

		pH: 5-5.5 Drying condition 120 ^{0}C 3 min
Softener	cationic	20 g/L Bestamin WK-15 (Alfa Chemie) liquor pick up % 70 Drying condition 120 ^{0}C 3 min
Softener	nano	30 g/l Perisoft nano (Dr. Petry GmbH) liquor pick up % 70 Drying condition 120 ^{0}C 3 min
Softener	nonionic fatty acid condensate	10-30 g/l Perrustol MMU 90 (Rudolf Duraner) pH: 5-6 liquor pick up 70 % Drying condition 120 ^{0}C 3 min
Antifungal finish agent	silver chloride	2-5 g/l Ruco Bac AGP (Rudolf Duraner) pH: 4.5-5 liquor pick up 70 % Drying condition 120 ^{0}C 3 min
Antibacterial finish agent	based on Diphenylalkane	5 g/l Ruco- Bac MED (Rudolf Duraner) pH: 5-6 liquor pick up 70 % Drying condition 120 ^{0}C 3 min
odour finish agent	melamine copolymer and eucalyptus perfume	20 g/l Pericoat Micro Mint (Dr. Petry GmbH) 60 g/l Peripret PW (based on polyacrylate) liquor pick up 100 % Drying condition 110 ^{0}C 3 min Curing condition 150^{0}C 4 min

Colorimetric analysis

The dyed and then finished cotton fabric samples were evaluated and compared according to their their colorimetric values. The colour strength value (*K/S*), CIE *L**, *a**, *b**, *C**, and *h*^{o} coordinates were measured from the reflectance values at the appropriate wavelength of maximum absorbance for each dyed sample using a DataColor SpectraFlash 600 (Datacolor International, Lawrenceville, NJ, USA), spectrophotometer under illuminant D65, using a 10º standard observer. K/S color strength values were calculated according to Kubelka - Munk equation.

Color fastness measurements

Wash, rub and light fastness properties were investigated. Wash fastness to domestic laundering (C06) was carried out according to ISO 105:C06 A2S test in a M228 Rotawash machine (SDL ATLAS, UK). Both dry and wet rub fastness tests were performed following the ISO 105: X12 protocol. Color fastness of the dyed fabrics to washing and to dry & wet rubbing was determined via using ISO grey scales. Light fastness testing was carried out according to ISO 105: B02: color fastness to artificial light (Xenon arc lamp). Color fastness to light was assessed using the blue wool scale.

RESULTS AND DISCUSSION

Colorimetric Properties

Measured color yield values by *K/S* and CIELAB values of *L**, *a**, *b**, *C**, and *h°* of red dyed cotton fabric samples are given on Table 3.

Table 3: *K/S values and color coordinates of red dyed cotton samples*

 **red**	**Color Strength (K/S)**	***L****	**a^***	**b^***	**ΔE**	***C^****
Non-treated (before finishing)	**19,82**	**41.32**	**56.77**	**33.6**	**Reference**	**65,97**
Crease resistance finishing	21,26	41.02	56.97	32.81	0.87	65,74
Water-oil-soil-repellent finish (fluorocarbon based repellents)	22.72	41.13	58	34.95	**1.84**	67,72
1.1.1 Macro silicone softener (softening finish)	22.58	41	57.86	34.43	**1.41**	67,33
Micro silicone softener (softening finish)	**24.00**	40.92	58.29	34.93	**2.06**	67,95
Cationic softener (softening finish)	20.12	41.94	57.49	34.41	**1.25**	67,00
Nano softener (softening finish)	23.26	41.24	58.24	34.81	**1.91**	67,85
Nonionic fatty acid condensate softener (softening finish)	21.86	41.08	57.64	33.95	0.97	66,90
Antifungal finish	22.58	41.09	57.99	34.46	**1.51**	67,46
Antibacterial finish	22.14	41.19	58.14	34.51	**1.65**	67,61
Odour finish	22.86	40.36	58.23	34.81	**2.13**	67,84

When the Table 3 is investigated, it can be seen that finishing process applied on red dyed sample provided colour strength increasing (it means the colour became darker) and the highest colour strength increasing was provided with micro and nano slicion based softeners. Surface of material is coated with silicon particles at the macro or micro level during the silicon finishes and it causes surface smoothness so it causes an incraese in the amount of of reflected light from the surface. Furthermore, a^* value (red-green axis) during all the processes is increased and became more red. Having higher dE value than 1 shows us there is a difference when compared with the without finishes samples are accepted reference. All the finishes except crease resistance finishing ve nonionic fatty acid condensate softeners causes colour differences and also C^* values of all the samples increased but not more than 2, after all the finishing processes except crease resistance finishing. It is reported that on the literature, C^* value differences up to 3 points can be tolerated (13).

Table 4: *K/S values and color coordinates of bright green dyed cotton samples*

 **bright green**	**Color Strength (K/S)**	***L****	**a^***	**b^***	**ΔE**	***C^****
Non-treated (before finishing)	**0,84**	**66,31**	**-8,75**	**-4,61**	**Reference**	**9,89**
Crease resistance finishing	0,81	67,24	-8,75	-4,55	0,86	**9,86**
Water-oil-soil-repellent finish (fluorocarbon based repellents)	0,81	67,29	-8,62	-4,79	0,93	9,86

1.1.2 Macro silicone softener (softening finish)	0,82	67,22	-8,73	-4,78	0,86	9,95
Micro silicone softener (softening finish)	0,82	67,18	-8,75	-4,86	0,85	10,01
Cationic softener (softening finish)	0,80	67,48	-8,64	-5,01	**1,17**	9,99
Nano softener (softening finish)	0,82	67,33	-8,84	-4,76	0,97	10,04
Nonionic fatty acid condensate softener (softening finish)	0,84	67,01	-8,88	-4,84	0,7	10,11
Antifungal finish	0,81	67,28	-8,6	-4,93	0,96	9,91
Antibacterial finish	0,81	67,41	-8,78	-4,91	**1,08**	10,06
Odour finish	**0,92**	66,13	-9,51	-4,97	0,92	10,73

It is possible to observe from Table 4, finishing processes applied to bright green dyed samples does not significanltly effect to colour strength. dE values of cationic softener and antibacterial finishes applied samples are higher than 1 shows that there is a colour diference according to reference sample without finishihes and also all the dE values exhibit close values.

***Table 5:** K/S values and color coordinates of blue dyed cotton samples*

blue	**Color Strength (K/S)**	***L****	**a***	**b***	**ΔE**	***C****
Non-treated (before finishing)	**4,35**	**45,23**	**-5,58**	**-20,03**	**Reference**	**20,79**
Crease resistance finishing	4,15	46	-5,71	-20,41	0,87	21,19
Water-oil-soil-repellent finish (fluorocarbon based repellents)	4,56	44,9	-5,6	-20,97	0,99	21,70
1.1.3 Macro silicone softener (softening finish)	4,39	45,34	-5,43	-21,07	**1,05**	21,76
Micro silicone softener (softening finish)	4,60	44,66	-5,42	-20,89	**1,04**	21,58
Cationic softener (softening finish)	4,32	45,47	-5,4	-20,67	0,70	21,36
Nano softener (softening finish)	4,38	45,36	-5,43	-20,98	0,97	21,67
Nonionic fatty acid condensate softener (softening finish)	4,35	45,51	-5,56	-20,9	0,91	21,63
Antifungal finish	4,29	45,46	-5,26	-20,64	0,72	21,30
Antibacterial finish	4,18	45,91	-5,54	-20,46	0,80	21,20
Odour finish	5,12	43,54	-5,8	-21,35	**2,15**	22,12

When Table 5 is investigated, it is observed that finishes applied on blue dyed samples does not cause an important difference on colour strength. The highest colour strength is measured at odour finish applied sample. A long with a^* value (red-green axis) does not exhibit a significant difference, b^* value (blue-yellow axis) decreased a little. It means, samples become more blue compared with reference sample. dE value is higher than 1 in the samples treated with micro and nano silicon based softeners. C^* value of the entire sample rised but this increasing does not reach to 1 point.

Table 6: K/S values and color coordinates of navy blue dyed cotton samples

navy blue	Color Strength (K/S)	*L**	a*	b*	ΔE	*C**
Non-treated (before finishing)	**23,35**	**18,49**	**-0,85**	**-6,61**	**Reference**	**6,66**
Crease resistance finishing	**27,52**	17,79	**-1,58**	**-8,51**	**2,2**	8,66
Water-oil-soil-repellent finish (fluorocarbon based repellents)	**32,59**	16,38	**-1,58**	**-8,47**	**2,91**	8,62
1.1.4 Macro silicone softener (softening finish)	**34,87**	15,8	**-1,66**	**-8,47**	**3,37**	8,63
Micro silicone softener (softening finish)	**38,86**	14,8	**-1,49**	**-8,57**	**4,23**	8,70
Cationic softener (softening finish)	**31,85**	16,7	**-1,73**	**-8,65**	**2,86**	8,82
Nano softener (softening finish)	**36,74**	15,53	**-1,76**	**-8,85**	**3,82**	9,02
Nonionic fatty acid condensate softener (softening finish)	**33,72**	16,13	**-1,7**	**-8,62**	**3,21**	8,79
Antifungal finish	**30,31**	16,96	**-1,61**	**-8,54**	**2,58**	8,69
Antibacterial finish	**31,24**	16,78	**-1,74**	**-8,53**	**2,72**	8,71
Odour finish	**30,59**	15,96	**-1,08**	-6,78	**2,55**	6,87

Table 6 shows that finishes applied on navy dyed samples provide a appereant rising (K/S value of reference sample: 23,354). Especially, micro (K/S 38,864) and nano (K/S 36,736) silicon based softeners applied samples are the darkest samples. The main reason of colour changing after finishing process is related with reflected beam from surface due to the processes enhanced the smoothness of sample structure as a result of surface coating of samples with macro and micro silicon particle in the silicon finishing processes. Improving smoothness of samples lead beams coming from a light source to reflect more and straight in a single point. In this conditons, colour is measured more depth (9). C* values of all samples increased and this increasing approaches up to 3 point.
While colour became more green due to a^* (red-green axis) value decreased in the all samples, colour became more blue as a result of b^* (blue-yellow axis) value decreasing. dE value calculated with L^*, a^* and b^* values rised up to 4 that is not among acceptle limits.

Table 7: K/S values and color coordinates of fume dyed cotton samples

fume	Color Strength (K/S)	*L**	a*	b*	ΔE	*C**
Non-treated (before finishing)	**10,74**	**27,18**	**0,63**	**-3,71**	**Reference**	**3,76**
Crease resistance finishing	10,28	27,93	**0,3**	**-4,22**	0,96	4,23
Water-oil-soil-repellent finish (fluorocarbon based repellents)	11,84	26,21	**0,29**	**-4,09**	**1,09**	4,10
1.1.5 Macro silicone softener (softening finish)	11,67	26,45	**0,3**	**-4,26**	0,97	4,27
Micro silicone softener (softening finish)	11,78	26,3	**0,3**	**-4,14**	**1,03**	4,15

Cationic softener (softening finish)	11,99	26,06	**0,22**	**-4,45**	**1,40**	4,46
Nano softener (softening finish)	13,42	24,73	**0,34**	**-4,24**	**2,52**	4,25
Nonionic fatty acid condensate softener (softening finish)	11,25	26,86	**0,11**	**-4,24**	0,81	4,24
Antifungal finish	11,23	26,81	**0,27**	**-4,09**	0,64	4,10
Antibacterial finish	11,71	26,3	**0,22**	**-4,17**	**1,07**	4,18
Odour finish	12,36	25,44	**0,03**	**-3,82**	**1,84**	3,82

It is clearly observed from Table 7, finishing processes apllied on the navy samples significantly effect the colour strength by increasing (K/S value of reference sample: **23,354**). Particularly, micro mikro (K/S **38,864)** and nano (K/S **36,736)** silicon based softeners applied samples are the darkest colour.

Colour became more green and blue as a result of not only a* (red-green axis) value close to green by decreasing but also b* (blue-yelloe axis) value close to blue by decreasing. All the samples's C* value increased but rising did not pass 1 point.

Table 8: *K/S values and color coordinates of mink dyed cotton samples*

 **mink**	**Color Strength (K/S)**	***L****	**a***	**b***	**ΔE**	***C****
Non-treated (before finishing)	**1,80**	**53,42**	**4,04**	**4,64**	**Reference**	6,15
Crease resistance finishing	1,71	54,33	3,84	4,81	0,95	6,15
Water-oil-soil-repellent finish (fluorocarbon based repellents)	1,80	53,76	4,17	5,19	0,66	6,66
1.1.6 Macro silicone softener (softening finish)	1,80	53,62	4,19	4,9	0,36	6,45
Micro silicone softener (softening finish)	1,73	54,25	4,09	5,08	0,94	6,52
Cationic softener (softening finish)	1,74	54,07	4,04	4,83	0,68	6,30
Nano softener (softening finish)	1,87	53,18	4,29	5,03	0,52	6,61
Nonionic fatty acid condensate softener (softening finish)	1,78	53,75	4,09	4,86	0,39	6,35
Antifungal finish	1,73	54,13	4,09	4,79	0,73	6,30
Antibacterial finish	1,71	54,26	4,08	4,77	0,85	6,28
Odour finish	1,83	53,29	3,84	4,84	0,31	6,18

When Table 8 examined, it is understood that finishes applied on the mink coloured sample did not cause a difference in the colour strength and L*, a* and b* values. dE value is lower than for all the samples. Although, C* value of all the samples increased, increasing was not upper than 1 point similar as dume dyed samples.

Table 9: K/S values and color coordinates of grey dyed cotton samples

 **grey**	**Color Strength (K/S)**	***L****	**a***	**b***	**ΔE**	***C****
Non-treated (before finishing)	**2,61**	**45,86**	**0,4**	**-2,78**	**Reference**	2,81
Crease resistance finishing	2,45	**47,33**	**-0,06**	**-4,23**	**2,11**	4,23
Water-oil-soil-repellent finish (fluorocarbon based repellents)	2,79	45,05	0,31	**-3,52**	**1,10**	3,53
1.1.7 Macro silicone softener (softening finish)	2,78	45,15	0,27	**-3,48**	**1,01**	3,49
Micro silicone softener (softening finish)	2,75	45,28	0,33	**-3,56**	0,97	3,58
Cationic softener (softening finish)	2,66	45,8	0,29	**-3,53**	0,76	3,54
Nano softener (softening finish)	2,67	45,62	0,2	**-3,26**	0,57	3,27
Nonionic fatty acid condensate softener (softening finish)	2,77	45,29	0,25	**-3,7**	**1,09**	3,71
Antifungal finish	2,70	45,58	0,27	**-3,54**	0,82	3,55
Antibacterial finish	2,66	45,88	0,19	**-3,57**	0,82	3,58
Odour finish	**3,19**	43,26	0,14	**-3,74**	**2,78**	3,74

When Table 9 is investigated, it is determined that finishes on grey dyed samples did not cause a significant change of colour strength, only the colour of odour finish applied grey sample (K/S değeri 3,194) became slightly darker compared with reference sample (K/S value of reference sample: 2,61). In addition to a* (red-green axis) value decreased for all the samples (especially, crease resistance finish applied sample has the lowest a* value and it is more green according to reference sample) and the colour became less red, b^* (blue-yellow axis) value also decreased and the colour became more blue (especially, crease resistance finish applied sample has the lowest b^* value). dE value is the highest in the odour finishes and crease resistance finishes are applied samples. All the samples's C^* values increased up to 2 point.

__Table 10:__ K/S values and color coordinates of beige dyed cotton samples

 **beige**	**Color Strength (K/S)**	***L****	**a^***	**b^***	**ΔE**	***C^****
Non-treated (before finishing)	**0,31**	**78,63**	**1,24**	**7,57**	**Reference**	**7,67**
Crease resistance finishing	0,29	78,96	1,05	7,12	0,59	7,20
Water-oil-soil-repellent finish (fluorocarbon based repellents)	0,32	78,47	1,15	7,49	0,20	7,58
1.1.8 Macro silicone softener (softening finish)	0,30	78,86	1,09	7,26	0,41	7,34
Micro silicone softener (softening finish)	0,30	79,15	1,13	7,24	0,62	7,33
Cationic softener (softening finish)	0,30	78,95	1,11	7,27	0,46	7,35
Nano softener (softening finish)	0,30	78,69	1,11	7,22	0,38	7,77
Nonionic fatty acid condensate softener (softening finish)	0,30	78,74	1,08	7,13	0,48	7,27
Antifungal finish	0,29	79,16	1,04	7,21	0,67	7,30
Antibacterial finish	0,30	78,95	1,18	7,17	0,52	7,21
Odour finish	0,33	78,06	0,97	7,71	0,65	7,28

It has been shown in Table 10, finishing processes applied mint coloured samples did not lead to a significant change on the colour strength, L^*, a^* and b^* values. dE value is under 1 point for all samples and C^* values of whole samples did not observed a major difference.

When Figure 1 and Figure 2 are observed detaily, All finishes of Navy dyed samples; all finishes of red dyed samples except nonionic fatty acid condensate softener (softening finish); nano softener (softening finish, cationic softener (softening finish) and odour finish applied fume dyed samples's colour difference is higher than 1 point according to reference sample (without finishes). Rest of the samples exhibit colour difference in the acceptable limits and the colour differences are small enough not to be noticed by naked eye.

When Figure 3 and Figure 4 are evaluated, the results show that there is a slightly difference of a* and b* values between before treatment and after treatment. These observed slight fluctuations of a* and b* values of the dyed and finished cotton fiber fabrics are in line with the aforementioned and discussed other colorimetric properties and also with the visual observation.

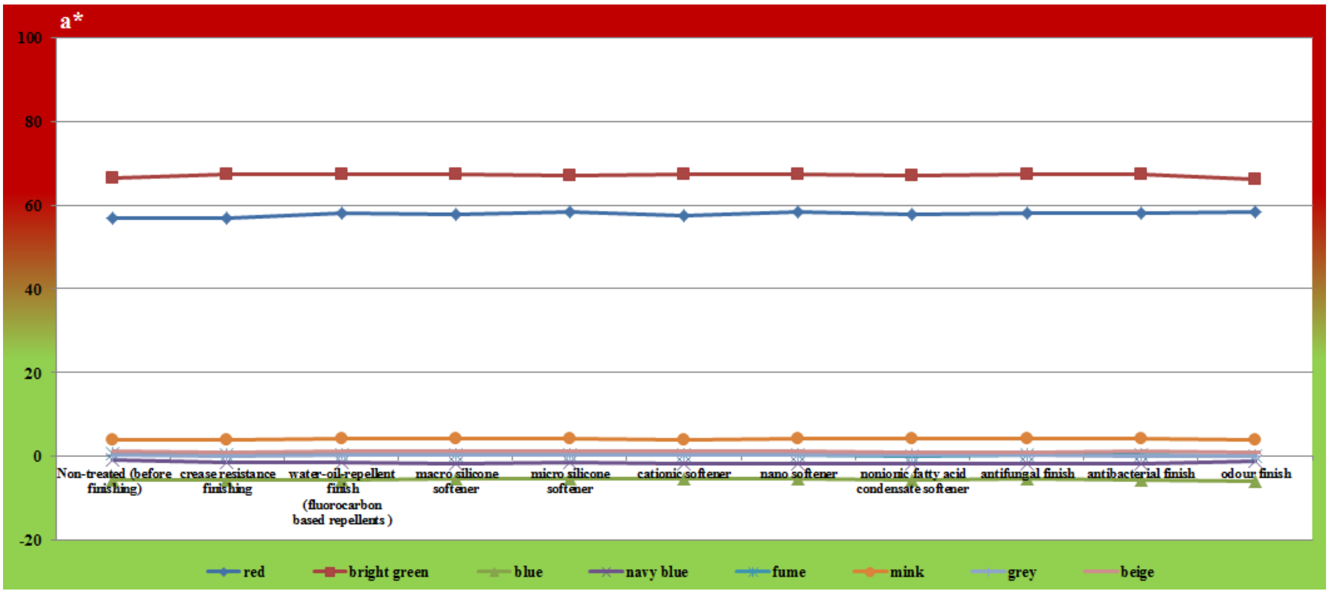


Figure 14: *Red-Green coordinates of the untreated and treated fabric cotton samples*

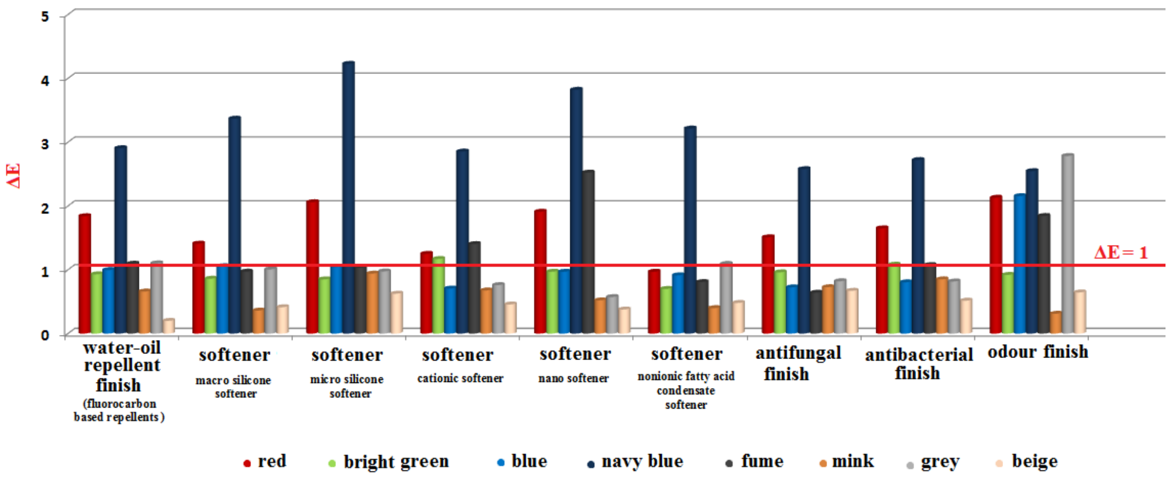


Figure 15: *Colour difference values (ΔE) of finished cotton fabrics dyed with reactive dyes according to finish type*

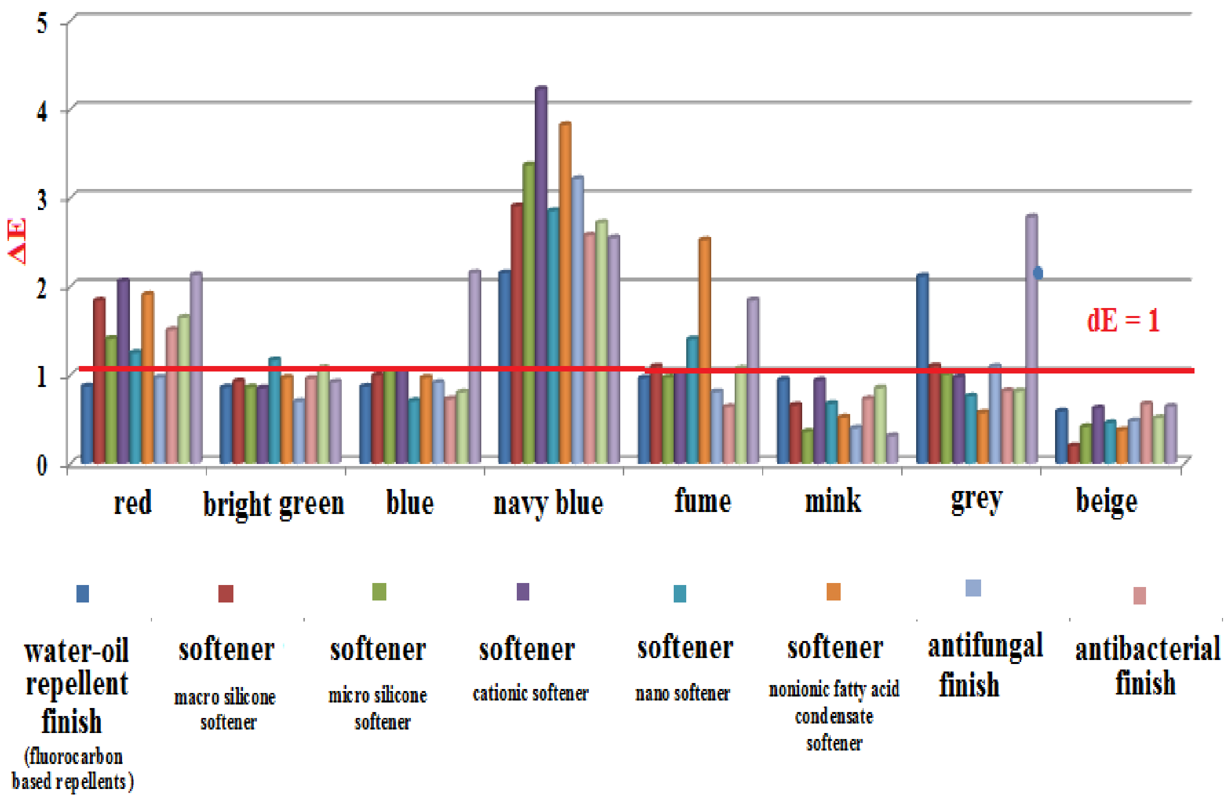


Figure 16: *Evauluation of colour difference values (ΔE) of finished fabrics according to color type of the dyed cotton fabric*

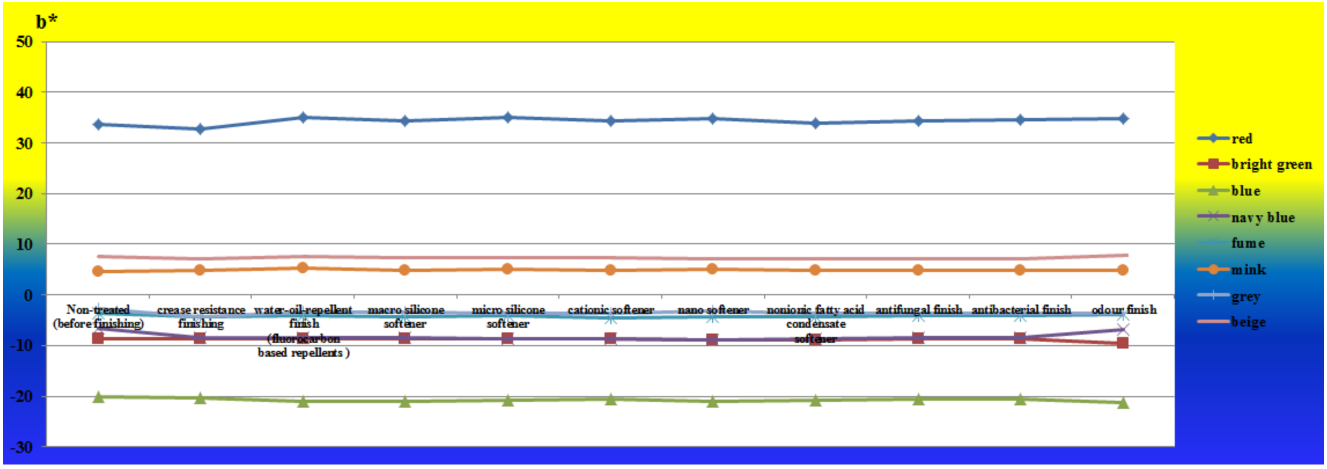


Figure 17: *Yellow-Blue coordinates of the untreated and treated fabric cotton samples*

Color Fastness Properties

Effects of Different Finishing Applications on Rub Fastness of dyed cotton fabrics

As a result of finishing treatments, it has been observed that wet and dry rubbing fastness values of red dyed samples decreased 0.25 to 0.50 point according to non-treated samples (Table 11). Also, light fastness values are kept same or improved 0.5 point. Rubbing fastness values can be changed depends on the colour depth of shade. It is determined that washing and rubbing fastness properties were slightly reduced after finishing in the literature (14). Decreasing of fastness values are related to dyes.

Table 11: *Red dyed samples's dry and wet rubbing fastness values*

 **red**	**Rub fastness** Dry	wet	**Light Fastness**	**Color Strength (K/S)**
Non-treated (before finishing)	4-4/5	2/3	4	**19,82**
Crease resistance finishing	4	2-2/3	4-5	21,26
Water-oil-soil-repellent finish (fluorocarbon based repellents)	3/4-4	2-2/3	4-5	22.72
1.1.9 Macro silicone softener (softening finish)	3/4-4	2/3-3	4	22.58
Micro silicone softener (softening finish)	4	2-2/3	4	**24.00**
Cationic softener (softening finish)	4-4/5	2/3-3	4	20.12
Nano softener (softening finish)	4/5	2/3	4	23.26
Nonionic fatty acid condensate softener (softening finish)	4/5	2/3-3	4	21.86
Antifungal finish	4-4/5	2-2/3	4	22.58
Antibacterial finish	4/5-5	2-2/3	4	22.14
Odour finish	4/5-5	2/3-3	4-5	22.86

Table 12: *Ligh green dyed samples's dry and wet rubbing fastness values*

 **bright green**	**Rub fastness**		**Light Fastness**	**Color Strength (K/S)**
	Dry	**wet**		
Non-treated (before finishing)	5	4/5-5	4-5	**0,84**
crease resistance finishing	5	4/5-5	4-5	0,81
water-oil-soil-repellent finish (fluorocarbon based repellents)	5	4/5-5	4-5	0,81
1.1.10 macro silicone softener (softening finish)	5	4/5-5	4-5	0,82
micro silicone softener (softening finish)	5	4/5-5	4-5	0,82
cationic softener (softening finish)	5	4/5-5	4-5	0,80
nano softener (softening finish)	5	4/5-5	4-5	0,82
nonionic fatty acid condensate softener (softening finish)	5	4/5-5	4-5	0,84
antifungal finish	5	4/5-5	4-5	0,81
antibacterial finish	5	4/5-5	4-5	0,81
odour finish	5	4/5	4-5	**0,92**

It is observed that finishing treatments of light green samples did not display a significant effect on wet and dry rub and light fastness properties (Figure 12).

Table 13: *Blue dyed samples's dry and wet rubbing fastness values*

 **blue**	**Rub fastness**		**Light Fastness**	**Color Strength (K/S)**
	Dry	**Wet**		
Non-treated (before finishing)	5	4-4/5	5	**4,35**
Crease resistance finishing	4/5-5	4-4/5	5	4,15
Water-oil-soil-repellent finish (fluorocarbon based repellents)	4/5-5	4-4/5	5	4,56
1.1.11 Macro silicone softener (softening finish)	4/5-5	4/5	5	4,39
Micro silicone softener (softening finish)	5	4-4/5	5	4,60
Cationic softener (softening finish)	5	4-4/5	5	4,32
Nano softener (softening finish)	4/5-5	4-4/5	5	4,38
Nonionic fatty acid condensate softener (softening finish)	4/5	4-4/5	5	4,35
Antifungal finish	5	4-4/5	5	4,29
Antibacterial finish	5	4-4/5	5	4,18
Odour finish	5	4-4/5	5	5,12

At the end of the applied fnishing processes, there isn't seen any important difference on wet and dry rubbing fastnesses of blue dyed samples (Table 13). There is only seen a decrease as 0.5 point on dry rubbing fastness of some finishihes. Light fastnesses of both finishing treated samples and finishing non-treated samples have same values.

Table 14: *Navy dyed samples's dry and wet rubbing fastness values*

 **navy blue**	**Rub fastness**		**Light Fastness**	**Color Strength (K/S)**
	Dry	**wet**		
Non-treated (before finishing)	4/5-5	2/3	5- 6	**23,35**
Crease resistance finishing	4/5-5	3/4	5- 6	**27,52**
Water-oil-soil-repellent finish (fluorocarbon based repellents)	4/5-5	3/4	5- 6	**32,59**
1.1.12 Macro silicone softener (softening finish)	4/5	4	5- 6	**34,87**
Micro silicone softener (softening finish)	4/5	4	5- 6	**38,86**
Cationic softener (softening finish)	4/5-5	4	5- 6	**31,85**
Nano softener (softening finish)	4/5-5	4	5- 6	**36,74**
Nonionic fatty acid condensate softener (softening finish)	4/5	3/4-4	5- 6	**33,72**
Antifungal finish	4/5-5	4	5- 6	**30,31**
Antibacterial finish	5	4/5	5- 6	**31,24**
Odour finish	5	4/5	6	**30,59**

After finishing treatments on navy samples, there is no observed remarkable difference between dry rubbing properties of non-treated samples and trated samples (Table 14). However, it is observed wet rubbing fastness values are improved after finishing treatments. According to early studies, softener finishing processes usually does not effect the fastness properties of samples, wheather it effects the fastness properties, softener finishes contributes to improve fastness performance (15). It is also determined colour fastness is not affected negatively from softener finishing processes (16).
Light fastness properties of navy dyed samples are propered to given information in literure, light fastness properties of navy dyed samples did not change, only odour finishes applied sample' light fastness is improved 0,25 point.

Table 15: *fume dyed samples's dry and wet rubbing fastness values*

 **fume**	**Rub fastness**		**Light Fastness**	**Color Strength (K/S)**
	Dry	**wet**		
Non-treated (before finishing)	5	3	5- 6	**10,738**
Crease resistance finishing	4/5-5	3/4-4	5- 6	10,279
Water-oil-soil-repellent finish (fluorocarbon based repellents)	4/5-5	3-3/4	5- 6	11,838
1.1.13 Macro silicone softener (softening finish)	4/5-5	4-4/5	5- 6	11,668
Micro silicone softener (softening finish)	4/5-5	4	6	11,776
Cationic softener (softening finish)	4/5-5	3/4-4	5- 6	11,995
Nano softener (softening finish)	4/5-5	4	5- 6	13,429
Nonionic fatty acid condensate softener (softening finish)	4/5	4	5- 6	11,25
Antifungal finish	4/5-5	4	6	11,233
Antibacterial finish	4/5	4	5- 6	11,713

Odour finish	5	4	6	12,358

Finishing agents applied fume dyed samples exhibit a slighlt difference on dry rubbing fastness. It is observed that dry rubbing fastness got worse up to 0,25-0,50 point according to non-treated sample rather wet rubbing fastness performance became better (Table 15). After finishing treatment, ligt fastness values measured same as non-treated dyed samples or slightly better (0.25 point).

Table 16: *Grey dyed samples's dry and wet rubbing fastness values*

 **grey**	**Rub fastness**		**Light Fastness**	**Color Strength (K/S)**
	Dry	**wet**		
Non-treated (before finishing)	5	4/5	4	**2,6149**
crease resistance finishing	5	4/5-5	4-5	2,4478
water-oil-soil-repellent finish (fluorocarbon based repellents)	5	4/5	4	2,7881
1.1.14 macro silicone softener (softening finish)	5	4/5-5	4	2,779
micro silicone softener (softening finish)	5	4/5-5	4	2,7511
cationic softener (softening finish)	5	4/5-5	4	2,6581
nano softener (softening finish)	5	4/5-5	4	2,6866
nonionic fatty acid condensate softener (softening finish)	5	4/5-5	4	2,7674
antifungal finish	5	4/5-5	4	2,701
antibacterial finish	5	4/5-5	4-5	2,655
odour finish	5	4/5-5	4-5	**3,194**

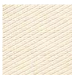
Table 16 shows that there is no changing on dry rubbing fastness values between treated and non-treated with finishing agents. It is also clear from Table 16, after finishing processes, wet rubbing fastness properties are enhanced; light fastness values are same as before treatmenr or improved 0.25 point.

Table 17: *Mink dyed samples's dry and wet rubbing fastness values*

 **mink**	**Rub fastness**		**Light Fastness**	**Color Strength (K/S)**
	Dry	**wet**		
Non-treated (before finishing)	5	4-4/5	4-5	**1,8032**
Crease resistance finishing	5	4-4/5	4-5	1,7091
Water-oil-soil-repellent finish (fluorocarbon based repellents)	5	4-4/5	4	1,7956
1.1.15 Macro silicone softener (softening finish)	5	4/5-5	4	1,7963
Micro silicone softener (softening finish)	5	4/5-5	4	1,7282
Cationic softener (softening finish)	5	4/5-5	4	1,7406
Nano softener (softening finish)	5	4/5-5	4	1,8618
Nonionic fatty acid condensate softener (softening finish)	5	4/5-5	4	1,7772
Antifungal finish	5	4/5-5	4	1,7278
Antibacterial finish	5	4/5-5	4	1,7121
Odour finish	5	4/5-5	4-5	1,8347

Fastness properties (wet and dry rubbing fastness) of mink dyed samples are evaluated so similar to non-treated mink dyed samples (Table 17). While light fastness values of crease resistance finishing and odour finishing agents applied samples retain their colour properties, other finishes decrease the light fastness values of samples 0,5 point.

Table 18: *Beige dyed samples's dry and wet rubbing fastness values*

 **beige**	**Rub fastness**		**Light Fastness**	**Color Strength (K/S)**
	Dry	**wet**		
Non-treated (before finishing)	5	4/5-5	4	**0,3118**
Crease resistance finishing	5	4/5-5	4	0,2947
Water-oil-soil-repellent finish (fluorocarbon based repellents)	5	4/5-5	4	0,3154
1.1.16 Macro silicone softener (softening finish)	5	4/5-5	4	0,3
Micro silicone softener (softening finish)	5	4/5-5	4	0,2919
Cationic softener (softening finish)	5	4/5-5	4	0,2985
Nano softener (softening finish)	5	4/5-5	4	0,3042
Nonionic fatty acid condensate softener (softening finish)	5	4/5-5	4	0,3017
Antifungal finish	5	4/5-5	4	0,2915
Antibacterial finish	5	4/5-5	4	0,2968
Odour finish	5	4/5-5	4	0,3316

The results show that beige coloured dyed samples and their fastness performance does not effect from finishing agents (Table 18). There is no difference in the fastness properties (wet and dry rubbing fastness, light fastness) of samples between treated and non-treated with finishing agents.

Effect of Finishing on Wash Fastness

There are many finishing treatments that effect the colorfastness of textile (resins) are used to enhance the durable press or wrinkle resistance of a textile structure. Resin treated textile materials are generally exhibited improved color retention to laundering (5). Also, nano-silicone softener treatment does not influence the colour fastness performance (drycleaning fastness, wet-dry rubbing fastness, washing fastness) of knitted textile materials (17). In our study, results are parallel to literature. Any of the fnishing treatmen effect to washing fastnesses. All the treated dyed samples exhibit high washing fastness performance, all the values are evaluated as 5.

Some studies determined that finishing treatments reduced or increases the colour strength of dyed material. However, it is totally depends on the used finishing agent and type of dyeing agent (14). Resin treated textile materials are usually helped to improve color retention and laundering. Softeners and resins have an important role in decreasing surface abrasion and therefore improved overall wash performance (5).

Effect of Finishing on Light Fastness

In a study that is investigated effect of softener finishes on fasteness properties of suphure dyed cotton textile materials, determine that softeners have an effect on the colour properties, light fastness and washing fastness. According to results, L^* value is decreased due to finishing proceses (18). Also, it is possible to have information from literature that DMDHEU does not affect the light fastness of reactive and direct dyed textile materials (19).

CONCLUSIONS

The results displayed that the final colorimetric values and color fastnesses of dyed and finished cotton fabrics are dependent on the color of the dyed cotton fabric, the type of finishing processes and the mutual interaction of used finish and dye. Mint and beige colored cotton fabrics did not exhibit significant difference on colorimetric and fastness properties in pursuit of all kind of finishing treatmeats studied. Color strength (K/S) values of red and navy blue colored cotton fabrics were increased after studied all finishing treatments. It is also observed that red dyed cotton samples became more red and more yellow after all finishing treatments according to measured a^* and b^* values. On the other hand, navy blue dyed cotton fabrics became greener and bluer. Furthermore, the colour strength (K/S) and a^* value of grey dyed cotton samples did not alter significantly after studied finishing processes, whereas similar applications resulted in slight differences on b^* values leading to bluer appearance. It is confirmed that finishing processes have effect on the colour strength and colorimetric parameters of cotton samples but these effects do not display specific trend. The results exhibited that the final colour strength and colorimetric values and color fastnesses of dyed and finished cotton fabrics are dependent on the color of the dyed cotton fabric, the type of finishing processes and the mutual interaction of used finish and dye. Finishing processes do not have a significant effect on the wash fastness performance of dyed cotton materials. It is observed that rub fastness of dyed cotton fabrics exhibited slight improvement differences, if any, after finishing treatments.

REFERENCES

1. Waring DR, Hallas G. The chemistry and application of dyes. New York: Springer Science & Business Media; 2013.
2. Troutman ER. Dyeing and Chemical Technology of Textile Fabrics. 5.th ed. London: Charles Griffin and Company Ltd; 1975.
3. Lawal A, Nnadiwa C. Evaluation of Wash and Light Fastness of Some Selected Printed Fabrics. IOSR Journal of Polymer and Textile Engineering (IOSR-JPTE).1(4):01-4.
4. Shore J. Cellulosics dyeing. England: Society of Dyers and Colourists; 1995.
5. Colorfastness of cotton textiles. Cotton Incorporated; 2002.
6. S.K.Chinta, Wane PP. Imparting Antimicrobial Finish By Microencapsulation Technique. International Journal of Innovative Research in Science, Engineering and Technology 2013;2(6).
7. Chinta S, Landage S, Swapnal J. Water repellency of textiles through nanotechnology. Int J Adv Res IT Eng. 2013;2(1):36-57.
8. Bajaj P. Finishing of textile materials. Journal of Applied Polymer Science. 2002;83(3):631-59.
9. Balci O. Farklı Bitim (Apre) İşlemlerinin Kumaş Rengine Olan Etkisinin İncelenmesi ve Uygun Tahmin Modellerinin Geliştirilmesi, . Adana: Çukurova Üniversitesi; 2008.

10. Saleemi S, Ejaz A, Almas R, uddin Tanwari A. sol-gel treatment of direct dyed cotton fabric with aerosil® 200 to enhance water repellency and fastness properties. SciInt(Lahore).25(4):823-7.
11. Pattanaik M, Ray S. A Study on the Effect of Crease Resistant Finish Treatment on Perspiration Fastness Property of Cotton Garments. International Journal of Textile Science. 2014;3(1):1-6.
12. Shakib N, Khoddami A, Ataeian A. an improvement in fluorocarbon chain re-orientation by reactive dyes. International Journal of Engineering. 2011;24(2):191.
13. Duran K. Tekstilde renk ölçümü ve reçete çıkarma. İzmir: Ege Üniversitesi; 2001.
14. Rajput R, Dorugade V. Effect of Finishing on Fastness properties of Reactive Dyes. International journal on Textile Engineering and Processes 2015;1(3).
15. Menceleoğlu Y. Tekstil Yumuşatma Maddelerinin Sararma Riskleri, Nedenleri ve Renk Haslıklarına Etkileri. TMMOB, Kimya Mühendisleri Odası, Tekstil Teknolojisi ve Kimyasındaki Son Gelişmeler Sempozyumu VII1999.
16. Toprakkaya D. Tekstil Terbiye İşlemlerinde Kullanılan Yumuşatıcı Maddeler. I Ulusal Tekstil Yardımcı Kimyasalları Kongresi Bildiri 2002.
17. Celik N, Degirmenci Z, Kaynak HK. Effect Of Nano-Silicone Softener On Abrasion And Pilling Resistance And Color Fastness Of Knitted Fabrics. Journal of Textile & Apparel/Tekstil ve Konfeksiyon. 2010;20(1):41.
18. Parvinzadeh M. The effects of softeners on the properties of sulfur-dyed cotton fibers. Journal of Surfactants and Detergents. 2007;10(4):219-23.
19. Cooke T, Weigmann H-D. The Chemistry of Formaldehyde Release From Durable Press Fabrics. Textile Chemist & Colorist. 1982;14(6).

THE EFFECTS OF REMNANT PRETREATMENT CHEMICALS ON THE REACTIVE PRINTING QUALITY OF COTTON FABRIC

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ABSTRACT

Fabric properties, ingredients, printing condition, pattern, printing paste properties, fixation conditions, etc. have significant roles on the printing quality of the textile substrate. These parameters affect the appearance of the printed fabric, colorimetric properties, penetration and color fastness performances. Especially, pretreatment processes determine the quality of printing if the reactive dye was used. In this study, the effects of remnant pretreatment chemicals left such as salts and alkaline on the cotton fabric on the reactive printing quality were investigated. Color strength values and rub fastness values of reactive printed cotton fabrics decreased and the backside penetration increased. Proper clearing and washing processes should be carried out to remove all possible pretreatment chemical remnants from the fabric to achieve desired printing quality.

Keywords: Reactive printing, color strength, penetration, pretreatment, electrolyte, rub fastness, cotton, remnant chemicals

INTRODUCTION

Reactive printing is one of the oldest printing methods and it is also one of the most preferred printing methods in the textile industry due to its reactivity towards cotton substrate (1). Today, cotton fiber is the most used natural fiber in the World and 75 % of print cotton materials are printed with reactive dyes (1). Vivid colors, good fastness properties, and high print durability can be obtained with reactive dye printing on the cotton fabric (1). Reactive dye stuff must be exhibit good properties such as high solubility, low affinity, high diffusion and high print paste stability that is important for printing quality (2). Natural fiber textile structures are usually treated with pretreatment processes before coloration because natural fibers have impurities. It is aimed with pretreatment process, removal of impurities from textile materials that cause yellowness and low absorbency performance without any strength lose. Also, chemical, energy and water requirements minimizations have an important role during pretreatment wet processes (3, 4).

Well pretreated fabric should be exhibit uniform properties such as whiteness, absorbency, chemical composition and low levels of impurities (4). On the contrary, dye uptake or absorbency of chemical agents will not be uniform during dyeing or printing processes hence coloration will be non-uniform (4). Many of the inherent foreign substances of natural fibers such as cotton wax do not absorb the dye. Pectin is dyed a different color from the main color of fiber. Lignin impairs the clarity of the color and stability of the material. So that, a well doing pretreatment process has a great importance for efficiency of next processes.

The dye absorption is considerably impaired from poor wetting properties of fabric and retaining sizing agents on the fabric surface. Especially, pretreatment must be carried out carefully for cellulosic fiber materials when reactive dyes are used (5).

If the textile material structure is a woven fabric, fabric must be thoroughly desized as reaction with size under hot alkaline conditions in presence of reducing end groups. Mercerization or semi-mercerization of natural fabrics such as cotton fabric is also recommended before following wet treatments like coloration (5).

Printing paste is a significant importance on the appearance and quality of printing as much as fabric quality and uniformity during printing process (6) whereas viscosity of printing paste is effective on contour sharpness, penetration effects, the depth of shade and hue (6). Ultimate color fastness levels can be affected from foreign matters, impurities, fixation conditions and inadequate clearing and washing cycles (6). It is possible encounter with various problems during printing process but many of these problem cause former wrong or inadequate applied processes. Problem is usually found in pretreatment. Caustic (sodium hydroxide) is the most used alkali during pretreatment processes and it is a powerful chemical can be easily reacted. Even small amount of sodium hydroxide is retained on the fabric, sodium hydroxide reacts with the carbon dioxide of air and produces sodium carbonate. After pretreatment processes, all the chemicals must be removed from the fiber structure with multiple washings. This step has an importance as much as well doing pretreatment. On the contrary, fabric will be retained various neutral salts and alkali chemical. In this study, the effects of remnant pretreatment chemicals left such as salts and alkaline on the cotton fabric (due to inadequate clearing) on the reactive printing quality such as color, fastness and printing penetration were investigated.

MATERIAL METHOD

In this study, a plain woven 100% cotton fiber fabric with the following characteristics: fabric weight 140 g/m^2, whiteness degree: 77.85 (Stensby). After pretreatment process, there will be some salt and alkali residues on the fabric surface if neutralization washing can be applied effectively. For investigation of the effects of these residues on the printing quality, different concentrated sodium sulfate, sodium acetate, sodium chloride and sodium carbonate solutions are prepared (0.5, 1, 3, 5, 10 g/kg) (Figure 1). Cotton fabrics are treated with these solutions by using pad-batched method (A_F %80). Following that, pad-batched cotton fabrics are printed with Novacron Red P 4B reactive dye (Table 1). Finally, color strength of printed fabrics, whiteness degrees of non-printed areas in the printed fabrics, penetration degrees and rub fastness properties are evaluated.

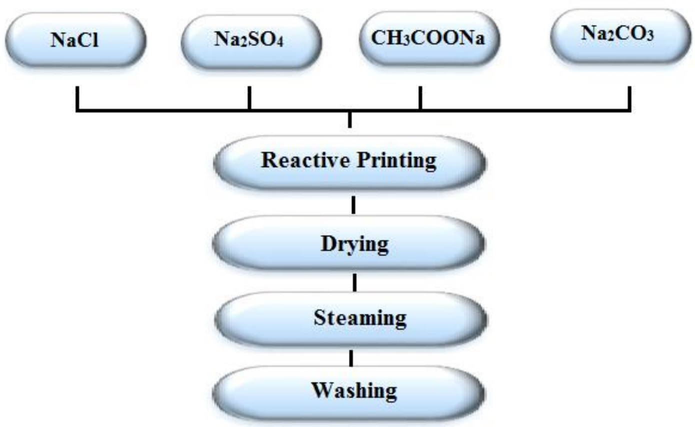


Figure 1: Treatment steps

Table 1 Reactive printing recipe

Reactive printing recipe		
Novacron Red P -4B	20	g
Lamiteks L 10 (%8) (Sodium alginate, low viscosity)	195	g
Lamiteks S (%6, Sodium alginate, high viscosity)	195	g
Urea	100	g
Sodium bicarbonate	25	g
Sodium m-nitrobenzenesulphonate	10	g
Water	~	
Total	**1000**	**g**

Viscosity degree of printing paste was measured degree 50 poise as a base with a spindle (No.5) using a Brookfield viscometer (20 Rpm). Cotton fabrics were printed at 6 m/minutes at pres 4 on J. Zimmer MDK laboratory type printing machine with 70 Nr PES gauze and a doctor blade 8 mm in diameter in laboratory conditions. After printing, cotton fabrics were dried in a laboratory type Rapid Drying machine at 100°C for 3 minutes and the printed cotton fabrics were steamed for 10 minutes at 102°C with a laboratory-type steamer (Mathis) for the dye fixation. In pursuit of fixation, fabrics were firstly cold rinse for 10 minutes, hot rinse for 5 minutes, hot washing for 5 minutes, cold rinse for 5 minutes and then dried at room temperature. Colorimetric properties (whiteness degrees and color values) of cotton fabric are measured by Minolta Cm-3600d spectrophotometer as former printing and after printing. Rub fastness of reactive printed cotton fabric is applied and evaluated according to ISO 105-X12, respectively. Cotton fabric Printed with printing paste without alkali and electrolyte additive is admitted as reference.

RESULTS AND DISCUSSION

In this study, it is aimed that to determine the effects of alkali and neutral salts on the cotton fabrics during reactive printing. For this reason, cotton fabrics are firstly padded using pad-mangle in solutions with different conductivity; sodium chloride, sodium sulphide, sodium acetate and sodium carbonate and then dried. Padding solutions and their conductivity levels can be seen from Table 2. Conductivity of solutions is measured with WTW brand LF 330 SET conductometer. Then all these pretreated cotton fabrics with printed with reactive dyes. In other way of saying, reactive printing paste was applied by printing on the cotton fabrics which were padded with alkali or neutral salt solutions previously.

Table 2: Padded pretreatment chemical solutions and their conductivity values

Pretreat. chemical concent.	**sodium chloride ($NaCl$)**		**sodium sulfate (Na_2SO_4)**		**sodium acetate (CH_3COONa)**		**sodium carbonate (Na_2CO_3)**	
	pH	**conductivity**	**pH**	**conductivity**	**pH**	**conductivity**	**pH**	**conductivity**
0,5 g/kg	7,04	1803 µS/cm	7,35	1524 µS/cm	7,30	1231 µS/cm	10,11	1686 µS/cm
1 g/kg	7,33	2,81 mS/cm	7,22	2,31 mS/cm	7,30	1780 µ S/cm	10,46	2,26 mS/cm
3 g/kg	7,28	6,96 mS/cm	7,24	5,18 mS/cm	7,37	3,79 mS/cm	10,97	6,14 mS/cm
5 g/kg	7,24	10,86 mS/cm	7,24	7,85 mS/cm	7,39	5,50 mS/cm	11,19	9,25 mS/cm
10 g/kg	7,14	20,2 mS/cm	7,26	13,99 mS/cm	7,24	10,10 mS/cm	11,43	16,32mS/cm

Sodium chloride and sodium sulphate exhibit high conductivity since completely ionized. Sodium acetate display low conductivity due to its slight ionizable character. pH values of sodium chloride, sodium sulphate and sodium acetate solutions did not have a significant difference depend on the concentration increasing. However, pH value of sodium carbonate solutions raised up based on concentration increasing (Table 2).

***Table 3:** Color strength (K/S) and whiteness levels of cotton fabrics printed with reactive dye*

		Whiteness Degree (Stensby)			
Applied concentrations of pretreatment chemicals		**sodium chloride (NaCl)**	**sodium sulfate (Na_2SO_4)**	**sodium acetate (CH_3COONa)**	**sodium carbonate (Na_2CO_3)**
Whiteness degree of greige fabric	**77,85**				
0,5 g/kg		77,26	77,13	77,68	76,39
1 g/kg		77,10	76,50	77,24	75,94
3 g/kg		76,84	76,77	76,31	75,44
5 g/kg		76,47	75,60	76,25	74,80
10 g/kg		75,36	75,61	73,00	73,90

Increasing amounts of sodium chloride, sodium sulphate, sodium acetate and sodium carbonate cause decreasing of whiteness degree according to reference cotton fabric (Table 3). Whereas, whiteness degree of reference fabric is 77.8, whiteness degree of cotton fabrics padded with sodium acetate and sodium carbonate solutions and then dried was decreasing until 73 (Figure 2).

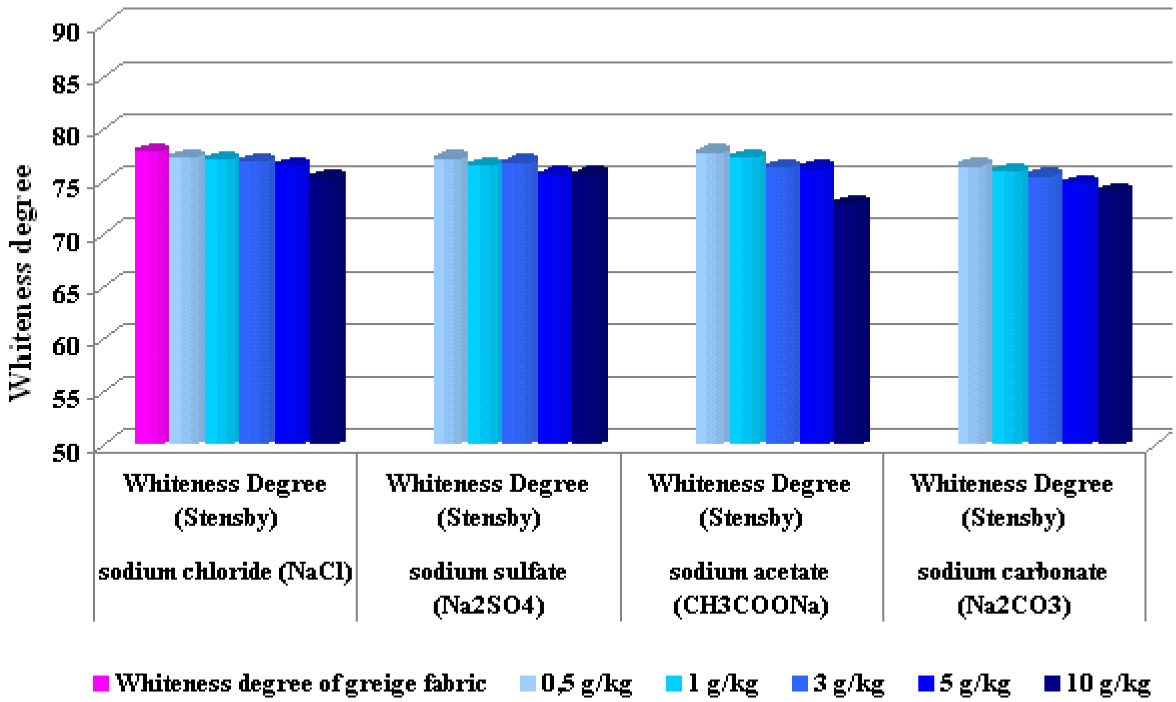


Figure 2: Whiteness degrees of cotton fabrics padded with different pretreatment chemicals with varied concentrations

When Table 4 and Figure 3 is examined, it is observed that color strength values (K/S) of sodium chloride, sodium sulphate, sodium acetate and sodium carbonate existed cotton printed fabrics was lower than reference cotton fabric' color strength value (K/S value 15,144). K/S value decreasing is directly affected from amount of sodium chloride, sodium sulphate, sodium acetate and sodium carbonate.

Table 4: *Color strength values (K/S) of cotton fabric printed with reactive dye*

Applied concentrations of pretreatment chemicals		Color strength (K/S) Sodium chloride (NaCl)	Sodium sulfate (Na_2SO_4)	Sodium acetate (CH_3COONa)	Sodium carbonate (Na_2CO_3)
Color strength of greige fabric (K/S)	**15,144**				
0,5 g/kg		14,872	14,51	14,922	13,637
1 g/kg		14,369	14,246	14,496	12,605
3 g/kg		14,076	14,056	14,464	11,829
5 g/kg		13,249	13,894	14,322	11,742
10 g/kg		11,796	12,936	13,795	11,861

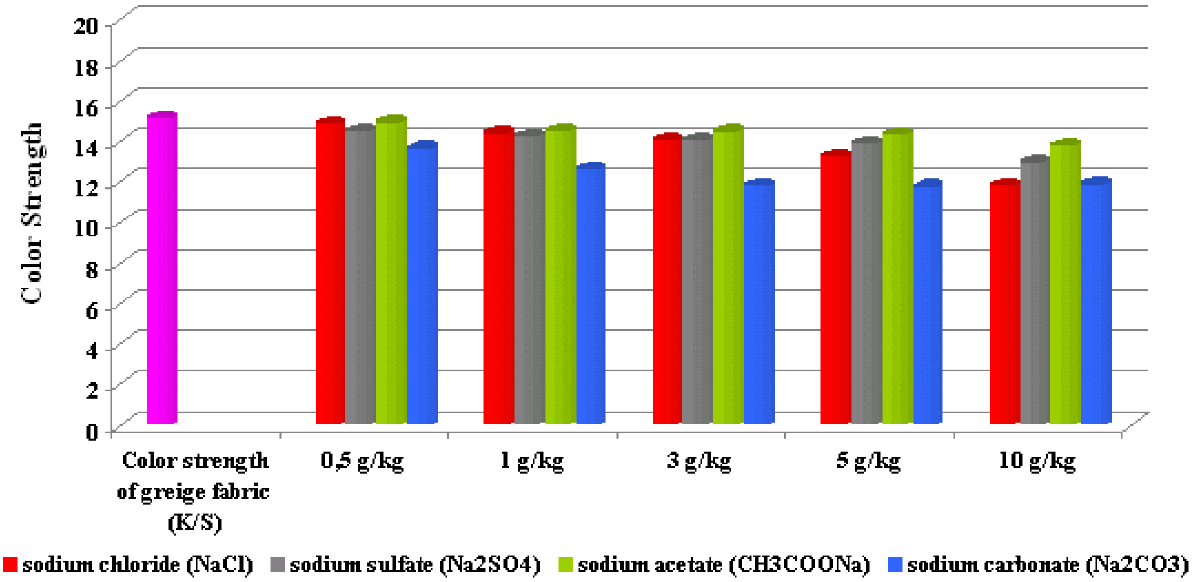


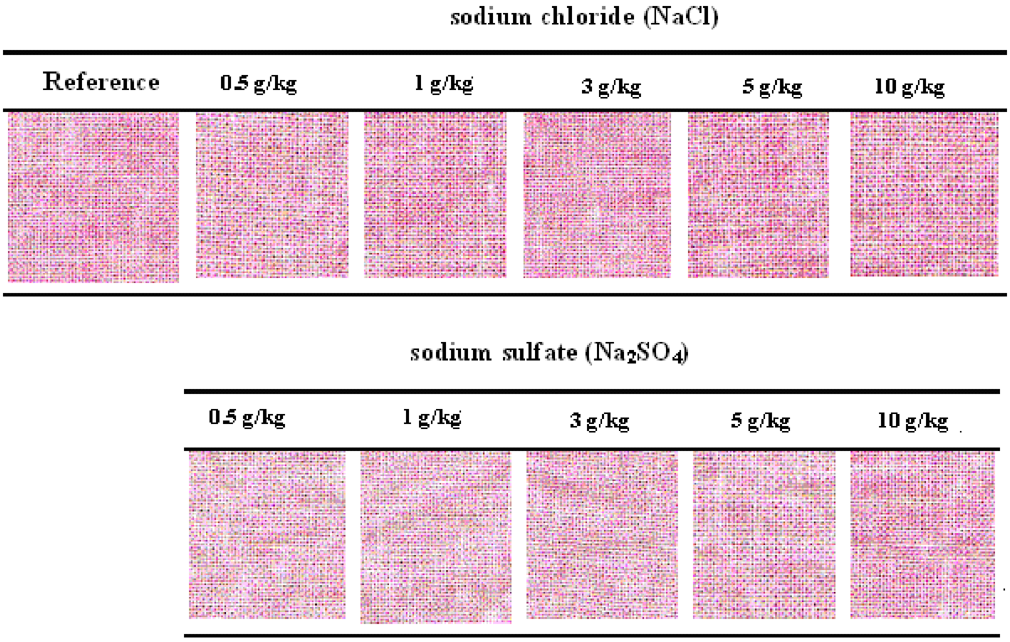
Figure 4: *Color strength values (K/S) of all printed cotton fabrics*

Table 5: *Rub fastness values of cotton fabrics printed with reactive dye*

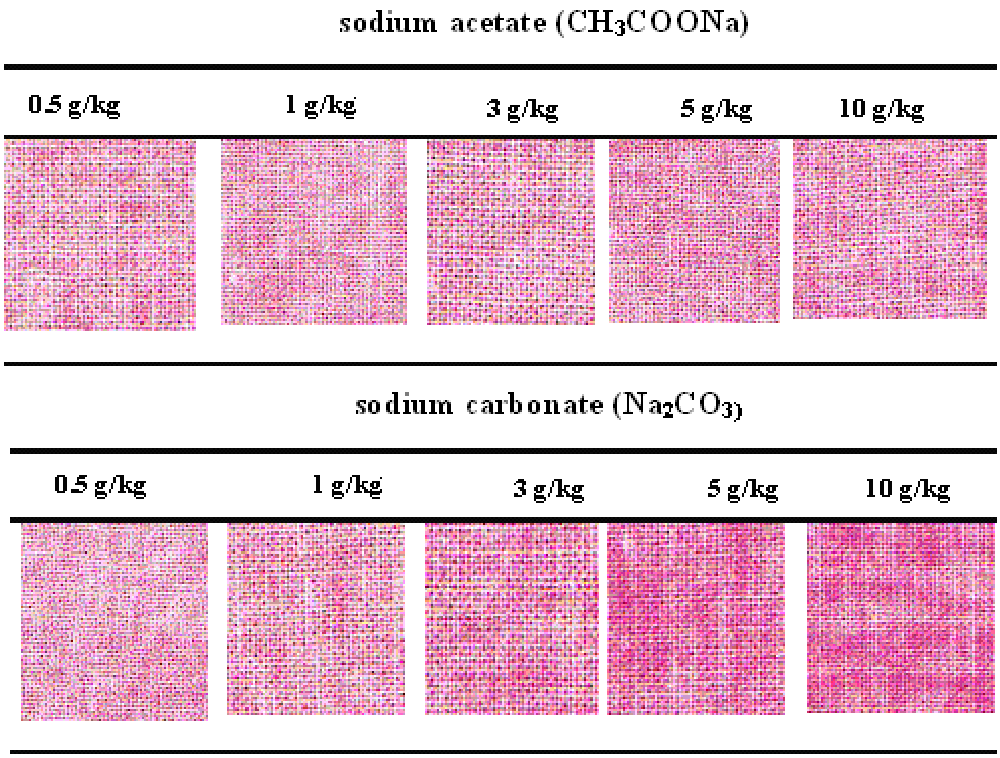
Rub fastness		Dry	Wet			Dry	Wet
Greige fabric		**5**	**3-4**				
sodium acetate	**0,5 g/kg**	5	**2**	**sodium chloride**	**0,5 g/kg**	5	3-4
	1 g/kg	5	**2**		**1 g/kg**	5	3-4
	3 g/kg	5	**2**		**3 g/kg**	5	3-4
	5 g/kg	5	**2**		**5 g/kg**	4-5	3-4
	10 g/kg	5	**2**		**10 g/kg**	4-5	3-4
sodium sulfate	**0,5 g/kg**	5	3-4	**sodium carbonate**	**0,5 g/kg**	5	**4**
	1 g/kg	5	3-4		**1 g/kg**	5	**4**
	3 g/kg	5	3-4		**3 g/kg**	5	**4**
	5 g/kg	5	3-4		**5 g/kg**	5	**4**
	10 g/kg	5	3-4		**10 g/kg**	5	**4**

When the rub fastness properties of cotton fabric printed with reactive dye is evaluated, different results were obtained related with type of the padded solution. Existing sodium acetate on the fabric is decreased wet rub fastness value up to 1,5 point according to reference fabric. On the other hand, if the cotton fabric padded with sodium carbonate, its wet rub fastness value increased half point.

Although, color strength (K/S) of reference cotton fabric measured as 15,144, color strength (K/S) of reactive printed cotton sample exist sodium acetate 11.86. It has been thought that, increasing in rub fastness properties of printed cotton fabrics contain sodium carbonate is caused as a result of decreasing on the color strength of printed cotton fabric (Table 4). It can be seen from Table 2, sodium acetate solution exhibited the lowest conductivity. Cotton fabrics pretreated with sodium acetate solution exhibited the highest color strength values after the printing on the contrary of the color strength of cotton fabrics padded with other pretreatment solutions. In this situation, penetration increased in parallel with the conductivity increase. Penetration of reactive printed cotton fabric previously padded with various pretreatment chemical solutions is shown visually in Figure 5.



a) *Penetration of reactive printed cotton fabric previously padded with NaCl and Na_2SO_4 solutions (backside appearance)*



b) Penetration of reactive printed cotton fabric previously padded with CH_3COONa and Na_2CO_3 solutions (back side appearance)

Figure 5: *Penetration of reactive printed cotton fabric previously padded with various pretreatment chemical solutions (back side appearance)*

CONCLUSION

Material based differences have an important role on the appearance and the quality of the end-product. The main reason of many problems, that are seen in the coloration processes such as dyeing or printing, is caused from pretreatment problems. If some electrolyte substances found on the fabric surface, this is due to the possible remnant chemicals left on the fabric after the pretreatment process. In this study, the effects of remnant pretreatment chemicals left such as salts and alkaline on the cotton fabric on the reactive printing quality were investigated. Color strength values and rub fastness values of reactive printed cotton fabrics decreased and the backside penetration increased. Alkali substances, left on the cotton fabric surface after the pretreatment processing, lead to yellowness effect so the whiteness degree of the cotton fabric was decreased. Color strength values of all printed cotton fabrics decreased according to the initial reference cotton fabric. It is determined that some rub fastness properties preserved their values but rub fastness values of some cotton fabrics decreased again according to the pretreatment chemical type and concentration. It is obvious that proper clearing and washing processes should be carried out to remove all possible pretreatment chemical remnants from the fabric to achieve desired printing quality.

REFERENCES

[1] Chintan R. Madhu. Nanotechnology to improve Printing of Cotton with Reactive Dye. Indian Journal of Applied Research. 2013;3(5).

[2] El Hamaky YH, Tawfeek S, Ibrahim DF, Maamoun D, Gaber S. Printing cotton fabrics with reactive dyes of high reactivity from an acidic printing paste. Coloration Technology. 2007;123(6):365-73.

[3] K armakar SR. Chemical technology in the pre-treatment processes of textiles. Amsterdam: Elsevier; 1999.

[4] HAMZAH MA, Fan L, Shu W, Shao L, Xin-Yue X, Li-Na L, et al. Conventional and Single-step Pretreatment Process of Cotton Woven Fabric. International Conference on Material Science and Application (ICMSA 2015)2015. p. 585-91.

[5] Miles C, Leslie W. Textile Printing: Revised Second Edition2010.

[6] CHT. Technical Bulletin. 1993.

REDUCTIVE BLEACHING OF CASEIN FIBERS

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ABSTRACT

Casein (milk) fiber was the first regenerated protein fiber which was created via dissolving the casein protein of milk in diluted alkaline and then extruding this dope into acidic-formaldehite coagulation bath via wet spinning. Casein fiber even can be produced from sour milk. Casein fibers possess many nice textile advantages such as ease of coloration and bright colors attainment, ecological benefits, wearing comfort and healthy nature for body skin due to its compatible pH value with the human body. In this study, bleaching of 100% casein (milk) fibers with some reductive bleaching agents was studied. The effects of various reductive bleaching processes on the whiteness, yellowness and bursting strength properties of casein fiber fabrics were investigated and compared. Some reducing agents caused whiteness increase whereas some of them affect oppositely leading to yellowness increase instead of whiteness rise. Morever, hydropilicity level of milk fiber fabric was improved after reductive bleaching with decrolin with faster water absorption. Reductive bleaching processes with optimum bleaching conditions studied did not cause a significant damage on the milk fabric properties. The optimum bleaching pH and optimum reducing agent concentration (optimum bleaching recipe) for casein fiber bleaching should be selected according to their preliminary trials.

Keywords: Casein fiber, milk fiber, bleaching, whiteness index, reductive bleaching

INTRODUCTION

Casein (milk) fiber is not only the first regenerated protein fiber but also the most commony known regenerated protein fiber (Susich ve Zagieboylo 1953). German chemist Todtenhaupt was produced casein fiber in 1904 for the first time (Cook 2001[b], Brooks 2009). However, first produced casein fibers did not have the necessary flexibility and strength and moreover they possess fragile structure (Cook 2001[b]). In 1935, flexible casein fiber which has many similar properties to wool fiber was produced succesfully (Moncrieff 1954). The longitidunal views of milk, cotton and wool fiber are shown on Figure 1.

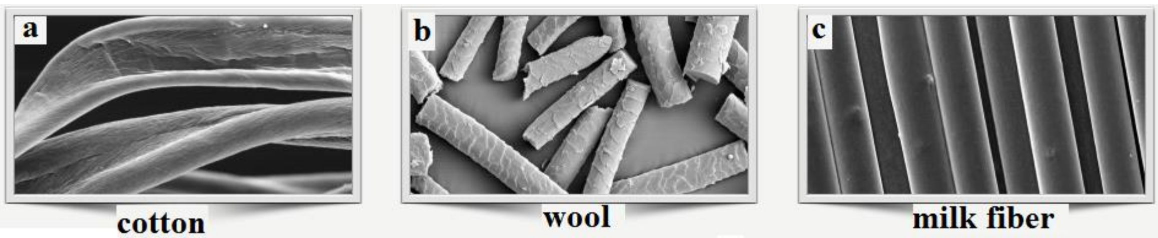

Figure 1 *SEM micrographs of cotton, wool and casein fibers (Qmilk 2015)*

Casein fibers exhibit silky handle, gentle luster, perfect abrasion resistance, good moisture management performances (Yang 2012). They are durable to weak acids but when it compared with wool, they exhibit more sensitivity to acids (Diamond ve Wormmell 1939, Başer 2002). Weak alkalines such as sodium bicarbonate and disodium hydrogen phosphate have very little effect on milk fiber especially at low temperatures. Strong alkalines such as sodium hydroxide result in fiber swelling which may lead to fiber fracture (Cook 2001b). Milk fiber, its yarn and a shirt made from milk fiber are shown on Figure 2 (Swicofil 2016, Slideshare 2013).

***Figure 2** Milk fiber and shirt from the Milk fiber (Swicofil 2016, Slideshare 2013)*

The bleaching of protein fibers, such as wool and casein, can be carried out by either oxidation or reduction processes. Some of traditional textile reducing agents are hydosulphite, thiourea, tiourea dioxide, formamidine sulphinic acid, zinc formaldehyde sulphoxylate and sodium formaldehyde sulphoxylate (Yılmazer and Kanik, 2009). Wool fibers can be bleached using reducing agents without fiber damage when applied at mild conditions. In this study, 100% casein regenerated protein fiber (milk fiber) is bleached using some reductive bleaching agents. Then the effects of various reductive bleaching processes on the whiteness, yellowness and bursting strength of casein fiber fabrics were investigated and compared.

EXPERIMENTAL

Substrate

100% casein milk fiber yarn (32/1 Ne) single jersey knitted fabric (140 g/m^2) is used in this study. The whiteness degree of greige un-treated casein milk fiber fabric was 56.91 Stensby.

Methods

Scouring process, at 40°C for 10 minutes, was applied to greige milk fabrics twice before any bleaching operations in order to remove any possible impurities which could be found on the surface of the fabric. Conventional reductive bleaching operations were applied to casein (milk) fabrics using Ataç Lab Dye HT IR sample dyeing machine via exhaustion process. Milk fibers were reductive bleached with different commercial reducing agents at various reducing agent concentrations, bleaching times and different pHs. The used bleaching agents and their application recipes are given in Table 1. In this study following commercial reducing agents were used as bleaching agents for milk fibers; Genred OX (Genkim, acidic reducing agent), Isopon ERC (Bozzetto, alkyl aril sulphonate and aldols, without sulphur and bor presence), Decrolin (BASF, zinc salt of hydroxymethanesulphinic acid), *Redulit WOL* (hydroxyl amine derivative) and Blankit IN (BASF, stabilized hydrosulphite). In all bleaching processes, 0.5 g/l nonionic wetting agent was added to the bleaching bath.

***Table 1** Commercial reducing agents used for casein fiber bleaching and their processing detail*

Reductive agent	Temperature (°C)	Time (min)	Concentration (g/l)	pH
Genred OX	90	30	1-5-10-20-30-40-60	5 , 8.5-10
Isopon ERC	90	30	1-5-10-20-30	5, 10
Blankit IN	60, 90	60, 30	1-5-10-20-30-40-60	7
Decrolin	90	30	1-5-10-20-30-40-60	5, 7
Redulit WOL	90	30	0,5-1-5-10-20	5, 7, 10

Following various abovementioned bleaching treatments, the whiteness (Stensby value) and yellowness (E313 YI) of the casein fiber fabrics were determined using a Datacolor 600 spectrophotometer. Each sample was measured from four different areas, twice on each side of the fabric for consistency, and the average value was calculated. The hydrophilicity property of bleached and untreated control casein milk fiber fabrics was measured as the time, in seconds, of water absorption of the specimen according to TS 866 standard. Moreover, bursting strength properties of bleached milk knitted fabric was carried out in accordance with ISO 13938-2, using an SDL Atlas M229P bursting tester, under the standard laboratory conditions (20±2 C; 65±2% relative humidity).

RESULTS AND DISCUSSION

Bleaching with reducing agents is generally recommended for wool, silk and nylon fibers.
Hydrosulphide (sodium dithionite) exhibits fast deterioration with elevated temperature and oxygen content in the bleaching apparatus. Therefore, stabilized hydrosulphide is more commonly used as a reducing agent instead of solely usage of hydrosulphide. Moreover, stable stabilized hydrosulphite compounds can be applied at higher bleaching temperatures, too.

Bleaching of Milk fibers with *Genred OX* (Reducing agent for acidic baths)

The whiteness and yellowness properties of milk fiber bleached with Genred OX (reducing agent for acidic baths) reducing agent at pH 5 and pH 8.5-10 are shown in Table 2 and Figure 3. Genred OX reducing agent is applied with its own pH of pH 8.5-10 without altering the pH of the bleaching bath. Although there is a slight increase on whiteness levels of milk fiber fabrics with the increased Genred OX concentration, the whiteness degree increase was low, from 56.91 to 59.49 Stenssby, even after 60 g/l Genred OX reducing agent usage for reductive bleaching (Table 2). That is why higher concentrations had not been tried further.

Table 2 *The whiteness and yellowness properties of milk fiber bleached with Genred OX reducing agent at pH 5 and pH 8.5-10*

Genred OX				
	pH 5		pH 8.5-10	
Concentration	Whiteness Degree (Stensby)	Yellowness Index (E313 YI)	Whiteness Degree (Stensby)	Yellowness Index (E313 YI)
1 g/l	52,17	21,75	51,60	22,49
5 g/l	58,85	15,65	54,49	19,25
10 g/l	61,90	13,90	57,96	16,31
20 g/l	62,18	12,87	58,21	15,25
30 g/l	63,07	12,20	58,38	15,74
40 g/l	63,37	11,74	58,71	16,84
60 g/l	63,58	10,98	59,49	14,59

Higher whiteness and lower yellowness degrees were obtained on milk fiber fabrics after acidic reductive bleaching at pH 5 with Genred OX, as expected, in comparison with the alkaline reductive bleaching at pH 8.5-10 with Genred OX (Table 2 and Figure 3). For example bleaching with 30 g/l Genred OX at pH 5 led to 63.07 Stensby and 12.2 yellowness index (Table 2). Although Genred OX reducing agent is suitable to work on alkaline conditions, the higher measured whiteness values after acidic reductive bleaching at pH 5 could be due to the possible slight milk fiber yellowness under the alkaline bleaching conditions (pH 8.5-10). The highest whiteness value, 63.58 Stensby, of milk fabric was obtained after bleaching with 60 g/l Genred OX at pH 5 and 90°C for 30 minutes (Table 2).

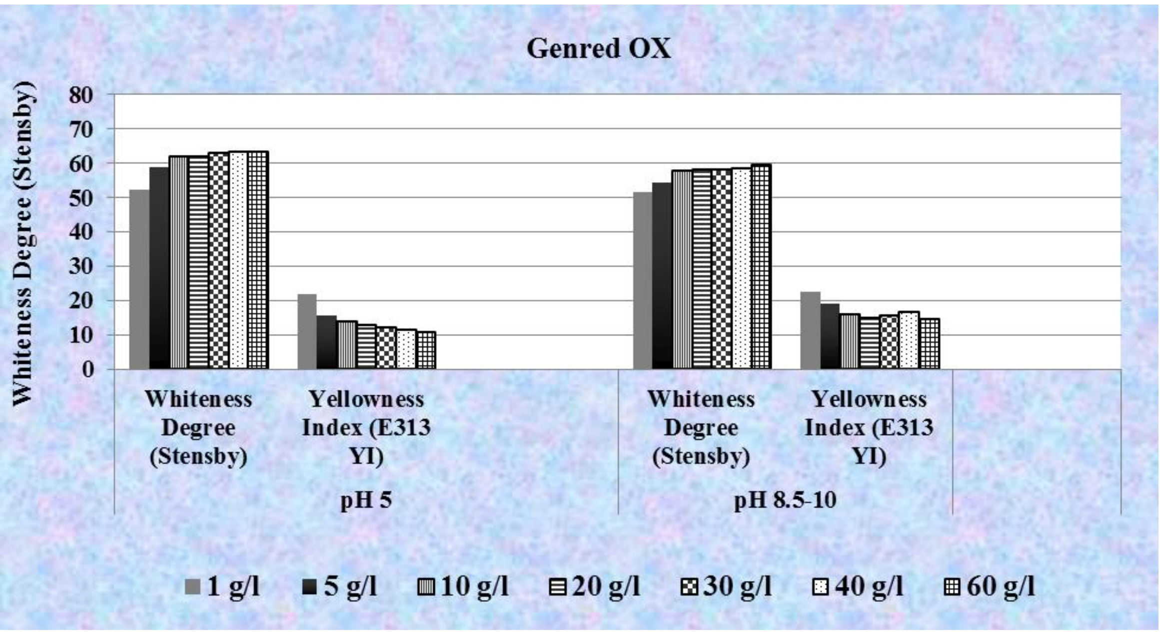

Figure 3 *The whiteness and yellowness properties of milk fiber bleached with Genred OX commercial reducing agent at different bleaching pHs*

Bleaching of Milk fibers with *Isopon ERC*

The whiteness and yellowness properties of milk fiber bleached with *Isopon ERC* (alkyl aril sulphonate and aldols, without sulphur and bor presence) reducing agent at pH 5 and pH 10 are shown in Table 3 and Figure 4.

Table 3 *The whiteness and yellowness properties of milk fiber bleached with Isopon ERC reducing agent at pH 5 and pH 10*

ISOPON ERC				
	pH 5		pH 10	
Concentration	Whiteness Degree (Stensby)	Yellowness Index (E313 YI)	Whiteness Degree (Stensby)	Yellowness Index (E313 YI)
1 g/l	53,64	20,34	54,76	21,02
5 g/l	53,74	20,97	53,34	22,51
10 g/l	53,79	21,16	43,37	29,33
20 g/l	53,91	20,55	42,92	29,39
30 g/l	54,27	20,98	42,85	31,50

It is important to remind that the whiteness degree of greige un-treated casein milk fiber fabric was 56.91 Stensby. The whiteness degrees of milk fabric bleached with Isopon ERC at both acidic pH (pH 5) and alkaline pH (pH 10) conditions were lower than the greige un-treated milk fiber (Table 3 and Figure 4). It seems that this reducing agent yellows the milk fiber not whitens (Table 3). The higher the concentration of this reducing agent is the yellower (with higher yellowness index) the milk fabric especially for alkaline pH condition (pH 10) (Table 3 and Figure 4).

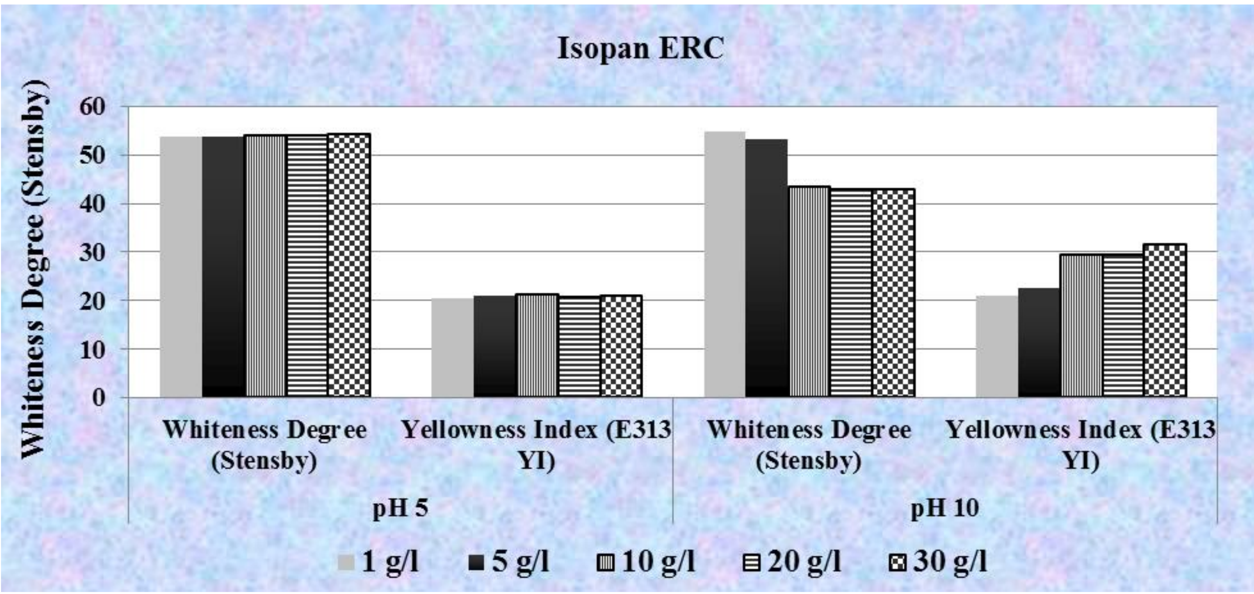

Figure 4 *The whiteness and yellowness properties of milk fiber bleached with Isopon ERC commercial reducing agent at different bleaching pHs*

Bleaching of Milk fibers with *Blankit IN* (stabilized hydrosulphite)

The whiteness and yellowness properties of milk fiber bleached with *Blankit IN* (stabilized hydrosulphite) reducing agent at pH 7 are shown in Table 4 and Figure 5.

Table 4 *The whiteness and yellowness properties of milk fiber bleached with Blankit IN reducing agent at pH 7*

Blankit IN, pH 7				
	60°C 60 minutes		90 °C 30 minutes	
Concentration	Whiteness Degree (Stensby)	Yellowness Index (E313 YI)	Whiteness Degree (Stensby)	Yellowness Index (E313 YI)
1 g/l	57,19	18,42	55,30	20,98
5 g/l	58,09	17,57	56,83	19,08
10 g/l	59,54	16,43	59,15	16,67
20 g/l	60,38	15,27	61,90	13,35
30 g/l	61,59	14,70	63,27	12,42
40 g/l	61,88	13,85	63,71	12,23
60 g/l	62,03	15,05	63,92	11,33

Higher whiteness and lower yellowness degrees were obtained on milk fiber fabrics after neutral reductive bleaching at pH 7 with Blankit IN with increasing reducing agent concentration (Table 4 and Figure 5).

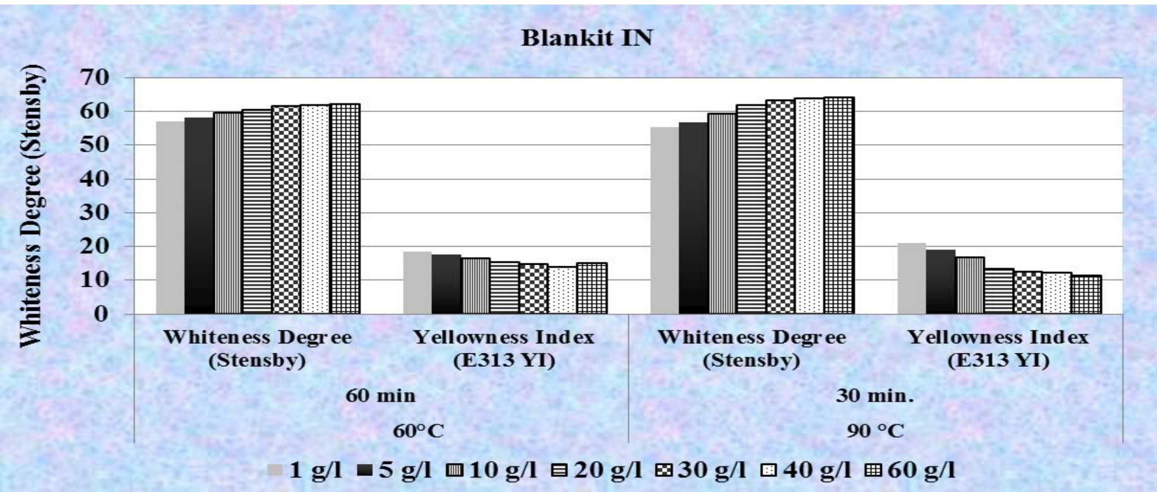

Figure 5 *The whiteness and yellowness properties of milk fiber bleached with Blankit IN commercial reducing agent at neutral pH 7*

Although there is a gradual slight increase on whiteness levels of milk fiber fabrics with the increased Blankit IN concentration, the whiteness degree increase was low, from 56.91 to 62.03 Stenssby, even after 60 g/l Blankit IN reducing agent usage for reductive bleaching at 60°C for 60 minutes (Table 4). The whiteness levels of milk fabrics treated with Blankit IN at 90°C for 30 minutes were slightly higher than those of milk fabrics treated with Blankit IN at 60°C for 60 minutes, especically for 30 g/l and/or more Blankit IN concentrations (Table 4). The higher the whiteness degree is the lower the yellowness value, as expected (Figure 5). The highest whiteness value, 63.92 Stensby, of milk fabric was obtained after bleaching with 60 g/l Blankit IN at pH 7 and 90°C for 30 minutes (Table 4). Although bleaching with the higher Blankit IN concentration led to higher whiteness, the whiteness difference between bleached milk fabric samples was not significantly high especially at high reducing agent applications such as 30-40-60 g/l concentrations.

Bleaching of Milk fibers with *Decrolin* (Zinc salt of hydroxymethanesulphinic acid)

The whiteness and yellowness properties of milk fiber bleached with Decrolin (zinc salt of hydroxymethanesulphinic acid) reducing agent at pH 5 and pH 7 are shown in Table 5 and Figure 6. Zinc salt of hydroxymethanesulphinic acid based products such as Decrolin are not affected from air oxygen at low application temperatures and bleaching with these products can also be carried out at acidic conditions. If one wants to make and effective bleaching at short time, the bleaching temperature should not exceed 90°C. Otherwise, bleaching application time should be prolonged.

Table 5 *The whiteness and yellowness properties of milk fiber bleached with Decrolin reducing agent at pH 5 and pH 7*

	Decrolin			
	pH 5		pH 7	
	Whiteness Degree (Stensby)	Yellowness Index (E313 YI)	Whiteness Degree (Stensby)	Yellowness Index (E313 YI)
1 g/l	57,44	17,67	56,89	18,29
5 g/l	63,74	13,84	59,04	15,34
10 g/l	63,70	12,76	58,90	15,30
20 g/l	64,02	11,94	59,11	15,39
30 g/l	64,37	11,35	59,24	14,92
40 g/l	65,35	11,78	59,33	15,27
60 g/l	65,56	12,55	60,26	14,92

As it can be clearly seen from Table 5 and Figure 6, acidic reductive bleaching at pH 5 with Decrolin resulted in higher whiteness and lower yellowness than its neutral reductive bleaching counterpart at pH 7 for each studied reducing agent concentration (Table 5 and Figure 6). The highest whiteness value, 65.56 Stensby, of milk fabric was obtained after bleaching with 60 g/l Decrolin at pH 5 and 90ºC for 30 minutes (Table 5). Although bleaching with the higher Decrolin concentration led to higher whiteness, the whiteness difference between bleached milk fabric samples was not significantly high. In other words, there was not significant whiteness increase in parallel with bleaching agent concentration increase. Therefore, optimum Decrolin concentration can be chosen as 5 g/l when less chemical consumption taking into consideration.

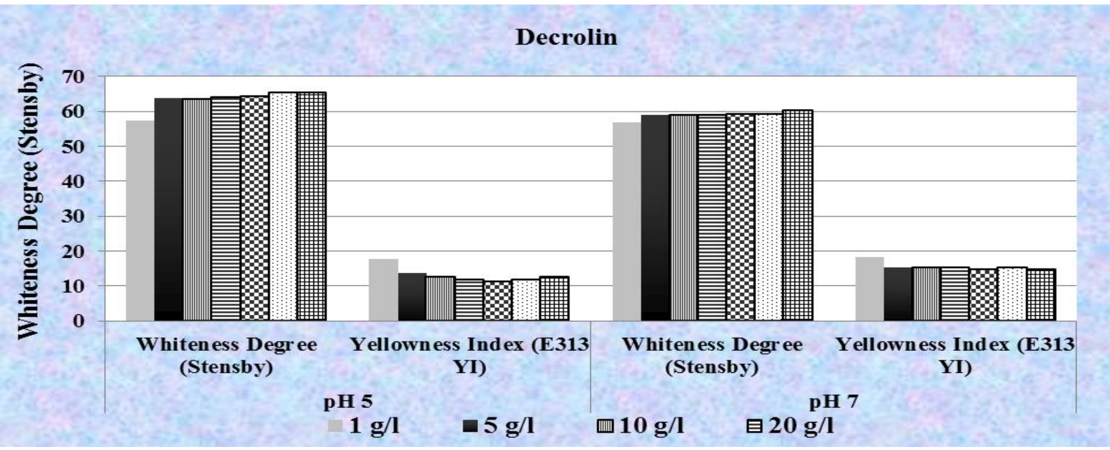

Figure 6 *The whiteness and yellowness properties of milk fiber bleached with Decrolin commercial reducing agent at different bleaching pHs*

Bleaching of Milk fibers with *Redulit WOL* (Hydroxyl amine derivative)

The whiteness and yellowness properties of milk fiber bleached with Redulit WOL (hydroxyl amine derivative) reducing agent at pH 5, pH 7 and pH 10 are shown in Table 6 and Figure 7.

Table 6 *The whiteness and yellowness properties of milk fiber bleached with Redulit WOL reducing agent at pH 5, pH 7 and pH 10*

Redulit WOL						
	pH 5		pH 7		pH 10	
	Whiteness Degree (Stensby)	Yellowness Index (E313 YI)	Whiteness Degree (Stensby)	Yellowness Index (E313 YI)	Whiteness Degree (Stensby)	Yellowness Index (E313 YI)
0,5 g/l	49,90	23,90	46,76	25,48	12,87	48,75
1 g/l	50,94	23,32	46,12	26,53	2,98	55,29
5 g/l	52,82	21,89	44,76	27,52	-5,49	77,46
10 g/l	52,49	23,47	24,03	39,55	-16,14	90,56
20 g/l	52,74	22,79	5,32	51,59	-16,35	99,78

Bleaching pH when bleached with Redulit WOL has a significant effect on the whiteness and yellowness levels of milk fiber fabric (Table 6 and Figure 7). The highest whiteness was attained at acidic bleaching pH condition (pH 5). In bleaching with Redulit WOL at pH 7 and pH 10, the higher Redulit WOL concentrations resulted in significantly lower whiteness degrees due to yellowing effect (Figure 7).

Nontheless, the whiteness degrees of milk fabric bleached with Redulit WOL at acidic pH (pH 5), neutral pH (pH 7) and alkaline pH (pH 10) conditions were lower than the greige un-treated milk fiber (Table 6 and Figure 7). As similarly observed in Isopon ERC case, it seems that this reducing agent also yellows the milk fiber not whitens (Table 3).

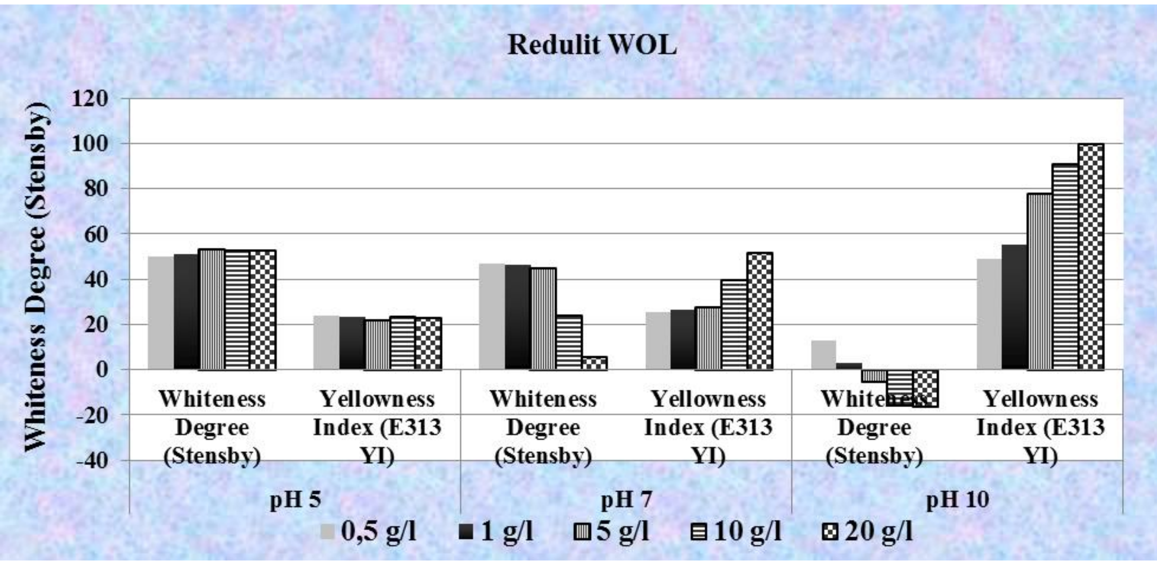

Figure 7 *The whiteness and yellowness properties of milk fiber bleached with Redulit WOL commercial reducing agent at different bleaching pHs*

Optimum reductive bleaching conditions chosen for casein fiber bleaching

From all above whiteness and yellowness results of milk fabrics bleached with various reducing agents, optimum reductive bleaching conditions were chosen for casein fibers according to the best whiteness results and least chemical consumption combination and they are shown on Table 7. It can be said that optimum pH and optimum reducing agent concentration (optimum bleaching recipe) for casein fiber bleaching should be selected after their preliminary trials. Since, some reducing agents could lead to whiteness increase whereas some of them affect oppositely leading to yellowness increase instead of whiteness rise.

Table 7 *Optimum reductive bleaching conditions chosen for casein fibers*

Reductive agent	Concentration	pH	Temperature (°C)	Time (min.)	Whiteness Degree (Stensby)	Yellowness Index (E313 YI)
Greige fabric					56,91	19,21
Genred OX	60 g/l	5	90	30	63,58	10,98
Isopon ERC	1 g/l	10	90	30	54,76	21,02
Blankit IN	60 g/l	7	90	30	63,92	11,33
Decrolin	5 g/l	5	90	30	63,74	13,84
Redulit WOL	5 g/l	5	90	30	52,82	21,89

Burst Strength Properties of Bleached Casein (Milk) Fiber Fabrics

It is known that bleaching operations could cause some damage or deterioration to the textile fibers. Therefore, the highest whiteness degrees obtained after various reductive bleaching processes with optimum bleaching conditions by means of the lowest chemical consumption (Table 7) were chosen for bursting strength examination. So, the best whiteness values with the least reducing agent consumption combinations were chosen and tested (Table 8).

Table 8 The burst strength properties of milk fiber fabrics after optimum reductive bleaching operations

Bleaching Type	Whiteness Degree (Stensby)	Bursting Strength (kPa)	Hydrophilicity (seconds)
Greige (untreated) fabric	56,91	290,2	90
Decrolin (5 g/l Decrolin at pH 5, 90 °C for 30 min.)	63,74	289,4	42
Blankit IN (60 g/l Blankit IN at pH 7, 90 °C for 30 min.)	63,92	287.1	-

After reductive bleaching with Decrolin and Blankit IN reducing agents, the bursting strength of milk fiber fabric slightly decreased (Table 8). However, these observed strength decreases were not significant. Milk fiber fabric weights were measured before and after bleaching processes at 90°C for 30 minutes. The weight of greige untreated milk fiber fabric was 140 g/m^2 as earlier stated. After aforementioned bleaching operation, the weight of milk fiber fabric was 180 g/m^2. This means that the milk fiber fabric exhibited fabric shrinkage during this bleaching operation at high temperature. Tighter fabric structure may lead to higher bursting strength results. Although the milk fiber fabric shrinked after bleaching process at at 90°C for 30 minutes, the measured bursting strength values were slightly lower than untreated milk fiber fabric. Nonetheless, the strength difference of milk fabric before and after bleaching operation was not significantly high. Morever, as it can be seen from Table 8, hydropilicity level of milk fiber fabric was improved after reductive bleaching with decrolin with faster water absorption (Table 8).

CONCLUSIONS

In this research, 100% casein regenerated protein fiber (milk fiber) is bleached using some reductive bleaching agents in order to determine the optimum bleaching conditions of these studied reducing agents (*Redulit WOL, Isopon ERC, Decrolin, Blankit IN, Genred OX)*. Then the effects of various reductive bleaching processes on the whiteness, yellowness, bursting strength and hydrophilicity performances of casein fiber fabrics were investigated and compared. The optimum bleaching pH and optimum reducing agent concentration (optimum bleaching recipe) for casein fiber bleaching should be selected after their preliminary trials. Since, some reducing agents caused whiteness increase (Decrolin, *Genred OX*, Blankit IN) whereas some of them affect oppositely leading to yellowness increase (*Redulit WOL, Isopan ERC*) instead of whiteness rise. For example,
The whiteness degrees of milk fabric bleached with Redulit WOL (hydroxyl amine derivative) at acidic pH (pH 5), neutral pH (pH 7) and alkaline pH (pH 10) conditions were lower than the greige un-treated milk fiber leading to yellowness effect. Similar phenomenon was observed in the case of Isopon ERC (alkyl aril sulphonate and aldols, without sulphur and bor presence). Milk fiber fabric exhibited fabric shrinkage during the bleaching operation at high temperature. Therefore, milk fabrics should be tested for fabric shrinkage preliminary bleaching trials.

After reductive bleaching with Decrolin and Blankit IN reducing agents, the bursting strength of milk fiber fabric slightly decreased. Nevertheless, these observed strength decreases were not significant. Morever, hydropilicity level of milk fiber fabric was improved after reductive bleaching with decrolin with faster water absorption. Reductive bleaching processes with optimum bleaching conditions studied did not cause a significant damage on the milk fabric properties.

ACKNOWLEDGMENT

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REFERENCES

[1] Brooks, M M, “Regenerated protein fibres a preliminary review”, (eds: S.J. Eichborn, W.S.Hearle, M. Jaffe, T. Kikutani), *Handbook of Textile Fibre Structure Vol 2: Natural, Regenerated, Inorganic and Specialist Fibres*, Cambridge: Woodhead Publishing Limited, 234-265, (2009).
[2] Cook, J.G., *Handbook of Textile Fibres: Man-Made Fibres*, Vol II, England: Woodhead Publishing Ltd, (2001b).
[3] Diamond, C. and Wormmell, R.L., “The manufacture and properties of casein fibre”, *Journal of the Textile Institute Proceedings*, 30,7, 224-228, (1939).
[4] Duygu Yilmazer, , Mehmet Kanik, Bleaching of Wool with Sodium Borohydride, Journal of Engineered Fibers and Fabrics http://www.jeffjournal.org Volume 4, Issue 3 – 2009, p 45-50.
[5] http://de.qmilk.eu/produkte/die-faser/ , 2015
[6] http://www.swicofil.com/products/212milk_fiber_casein.htm
[7] http://www.slideshare.net/GaldeMerkline/kpmg-milk-fiber-innovation-study-may-2013
[8] Moncrieff, R.W., *Artificial Fibres*, London: National Trade Press Limited, (1954).
Audic, J.L. Chaufer, B. and Daufin, G., “Non-food applications of milk components and dairy co-products: A review”, *Lait 83*, 417-438, (2003).
[9] Susich, G. and Zagieboylo, W., “The tensile behavior of some protein fibers”, *The Office of Technical Services, U.S., Deparment of Commerce*, Research and Development Report no 80, USA, (1953).
[10] Yang, Y. and Reddy, N., “Properties and potential medical applications of regenerated casein fibers crosslinked with citric acid”, *International Journal of Biological Macromolecules*, 51, 37-44, (2012).
[11] Yang, Q., “The mechanical property of milk protein fiber”, *Advanced Materials Research*, 496, 431-434, (2012).

DESIGN OF THE TRACKSUIT AND COMPUTER SIMULATION OF PROTOTYPE

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ABSTRACT

In this study, was made a new design for the tracksuit using the Optitex system. Using the Optitex system it is done construction, modeling and grading patterns. 3D simulation of prototype was done, where it showed how would be look design on the human. Before preproduction it showed how would look like, is it comfortable or not. With this system we can predict a possible mistakes in design, modeling, grading, draping, style, visual effects, and etc.

Keywords: design, comfort, tracksuit, Optitex system

INTRODUCTION

For designing new products in the fashion industries, could doing on many ways using new hardver, software and service products from various companies. Today, designers using different technics for making new products. The development of new products includes a variety of activities from the development of product conception, development of the product itself and its processes, production launching products on the market [1]. Technology development has been changed, it is still in development and progress. Engineering Graphics over the past ten years has changed, where he switched from 2D to 3D production [2]. Today, many CAD softwares can show in advance possible errors, which may improve before making the garment. It believes that the solution for the future must be sought in technological processes, the change of mentality, organizational structure, modern design, computer integrated manufacturing and business, a flexible labor force, distribution, sales and integrated system of quality [1]. Clothing which is designed for any kind of sports activity, should meet the requirements utilized. Under such requirement doesn't mean only the technical or fashion aspects, but also at physiological comfort. Based on that is developed a new design of the tracksuit. For making a new product were used all methods for obtaining a good and quality product.

DESIGN AND COMFORT

Design has been always connected with our contemporary intellectual endeavour including art, science and philosophy [3]. The word "design" originates from the English word design and loosely translated means: drawing, systematic project, the patter and similarly[4]. Design is now clearly a high professional activity for some people, and the very best designers are greatly valued and we admire what they do enormously. The engineer's process seems to us to be relatively precise, systematic and even mechanical, where as fashion design seems more imaginative, unpredictable and spontaneous. The engineers know more or less what is required from the outset [3]. Phase design defines the product, which is still evolving and further detailed before entering production. It consists of planning and product marketing, detailed engineering, material specification and others [1]. For good products and also profit, the most important thing is good design. For design the last and very important factor is physical conditions of a person, which include age, condition of health of person, body structure, physiological response of body, activity level, etc [5]. Good designer must to know products and technologie for easier work.

Also he need to know all requirements of costumers all ages, to follow new trends, research market and to know the market. Besides that he need to know physical and mechanical behavior of the materials, construction fabrics and clothes, modeling and all the rest processes of production.

According Zafirova, a good design must have two basic components:

- Knows a needs and desires of consumers,
- Appealing to the senses and the intellect of consumer [1].

Except the design, very important factor is comfort of the garment. Today, consumers want clothing which not only good design but also they want to feel comfortable. According F.S. Kilinc-Balci, understading and meeting consumers' needs and expectations towards products have become essential for the long-term survival of any enterprise in the competitive textile and apparel market [6].
Comfort is a fundamental and universal need of a human being [7]. Confort can be considered as the consistency of the clothing with the human surroundings or enviroment derermined by human pleasantness or relief [8]. Although it is difficult to describe comfort positively, discomfort can be easily described in such terms as prickle, itch, hot and cold[7]. Consumers are now allowing touch, smell, inuition and emotion to infuence their decision on clothing selection more that their aesthetic sense [7]. Human comfort is complex and subjective and this affect on the psychology and physiology of clothing, also and environmental conditions [9]. Psychological comfort affects a lot to the feeling of comfort, Bartles says the most influence is from fashion and attitude to the brand, color, pattern, textile material and production [10].

Comfort has been defined by many researchers in different ways, A. Das, R. Alagirusamy specify some of the most basic definitions:

- Comfort is influenced by the physiological reaction of the wearer.
- Comfort is temperature regulation of the body.
- Comfort is the absence of unpleasantness or discomfort.
- Comfort is a state of pleasant psychological, physiological and physical harmony between a human being and the environment. All three aspects are equally important, since people feel uncomfortable if any one of them is absent [5].

Based on the above, we can conclude the definition of comfort is almost impossible, each person (human being) is different and because of it subjective and psyshological factors are different and they affect on comfort. The most important element of today's good production is the clothing of good design and good wearing comfort. Designer has to have some form of communication with customers or potential carriers of their clothing.

OPTITEX SYSTEM

Since 1988, Optitex is a leading manufacturer for 2D and 3D solutions for textiles, industrial fabrics, apparel, upholstery, transportation, composites, home furniture and other sewing products. Optitex making its mark in the global textile industry to provide digital software solutions for state development patterns, simulation and optimization of processes.

Optitex's products are sold and supported around the world through certified distributors and OEM. Optitex's Fashion Design Software solutions are available for more than 20 languages. Optitex's 3D Suite of Tools produce realistic 3D presentation of material to look at the simulation of 2D patterns.

3D simulation has demonstration how would look at real life, which allows visualization of draping garments, according to the movement of 3D models.

This allows designers to create, correct and adjust compelling designs before the first piece of material before cutting, giving a new dimension such like the virtual model real. 3D simulation takes into account all the basic physical characterstics of the material like weight, bending, stretching, friction.

BASIC TOOLS

Optitex software provide various sollutions for clothing. He offers lot of options, commands and tools to use. Standard alats are select tool, new file, open file, save file, zoom by rectangle, undo, rendo, cut, copy, paste, replace old, measure tool, join pieces, build piece, add point on contour tool, notch tool, seam tool, move piece tool, move point, rotate piece tool, extend parallel tool, grade proportional tool, 3D properties, fabric editor, and etc.

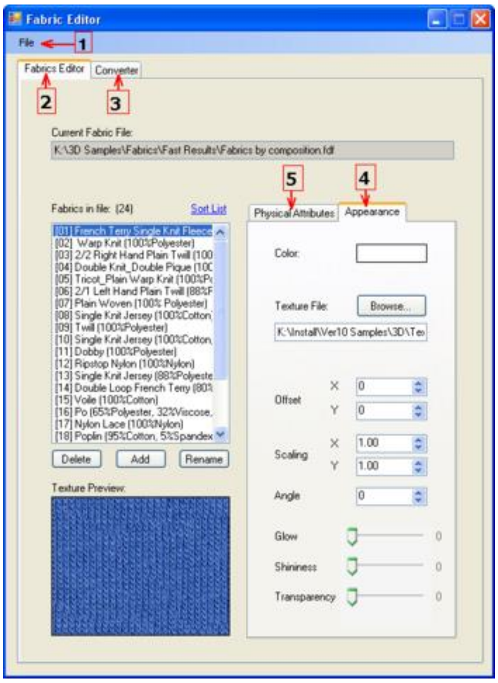

FIGURE 1. Fabric Editor [1]

Fabric Editor is for convert real fabric charasteristics tested in industry laboratories into Optitex cloth parameters (figure 1). The Fabric Editor supports Kawabata (KES) and Fast industry standards and automatically converts KES and FAST results into Optitex cloth parameters [11]. Data from FAST system entries from FAST Control Chart for Tailorability like extensibility, bending rigidity, shear rigidity, surface thickness, weight (figure 2).

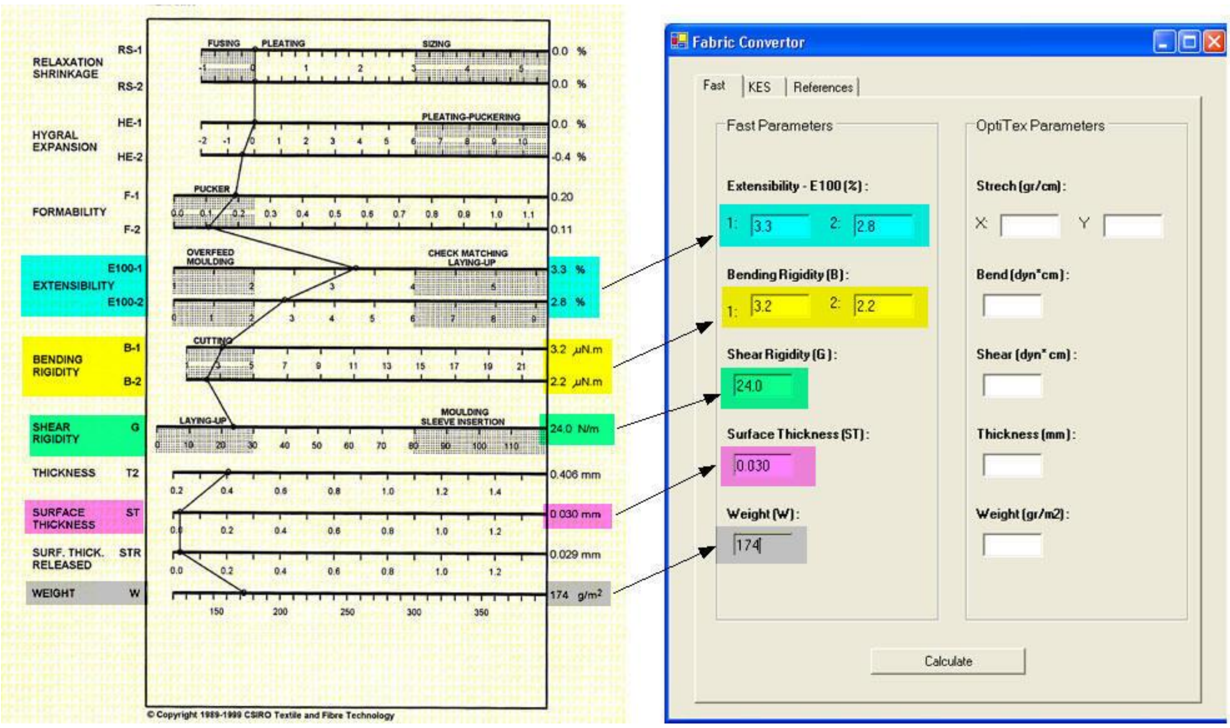

FIGURE 2. Example for convert data [1]

Stitch tool is important for 3D simulation. It is very important that all seams be connected correctly. If they are wrong connected, 3D simulation of the model will be bad with deformations.

Simulate draping is the last tool for 3D simulation. Process of simulation is on the figures 3, 4 and 5.

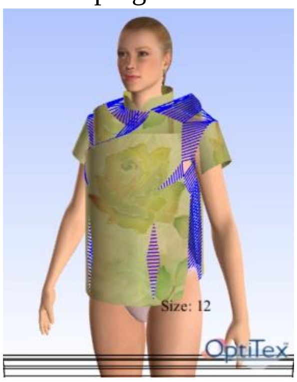

FIGURE 3. Beginning of simulation *2.Simulating* *3. Simulation Complete*

RESULTS

The first was done sketches (figure 4) and one of them has been chosen for research (figure 5). Technical sketch is on figure 6. Women's tracksuit is from two parts, sweatshirt and pants. Sweatshirt has a zipper in the middle, a collar and long sleeves. The back is from one piece and he is of navy knit. The sleeves are from three parts of two different materials, the front part is in white colour knit and he is shorter, the rest of sleeves are in navy colour knit and he is visible on the front of the sleeve. The shoulder seam front and back part is lowered from the front of 4 cm, excatly back par is extended to 4 cm from the shoulder seam and that amount is reduced to the front. The front of sweatshirt is in white colour knit. The front part of the design has a kangaroo pockets. The kangaroo pockets are from white knit and on the edge of pocket is piping from the navy knit (width 7mm). Inner of the collar is from white navy.

The collar is widht 4cm. Sweatpants are straight from navy knit and waist is from the white knit with rubber. Waist is from one piece. The sweatpants have one piece, one sweatpants is from one piece (one seam).

FIGURE 4. Sketches

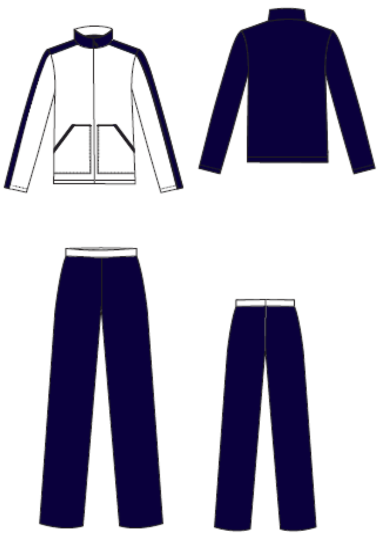

FIGURE 5. Sketch for research

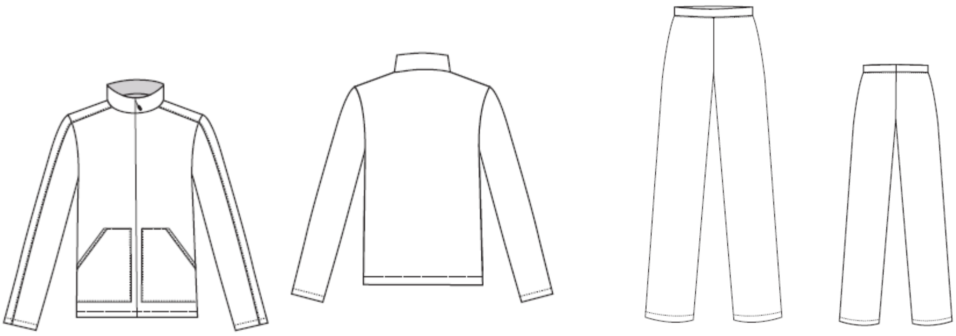

FIGURE 6. Technical sketch

Construction, modeling, grading were done in Optitex system in Maribor University. Base size was 36. Base of the construction of tracksuit is on the figure 7. Base was change, because she needed for the next step, for better and easier modeling. New base of the construction is on the figure 8 with one piece for pants.

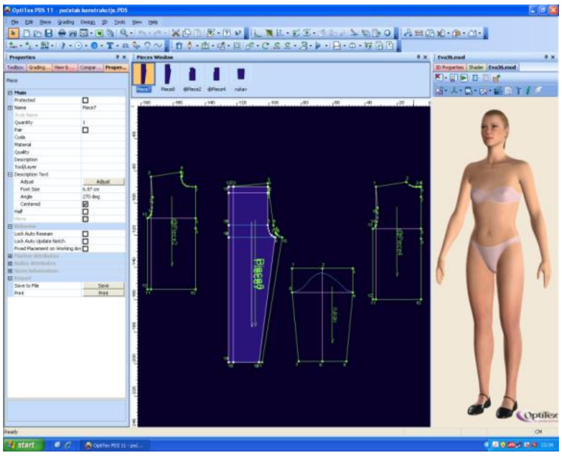

FIGURE 7. Base construction

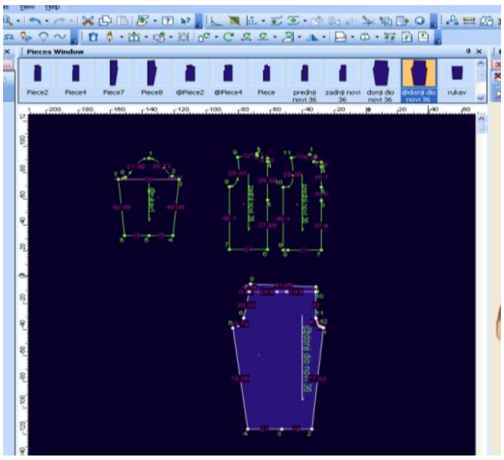

FIGURE 8. New base

With modeling we've got a new pattern for our design with all necessary pieces (figure 9). On the figure 10 are all patterns with seams. Grading pieces of the tracksuit are on the figure 11. Grading is from size 36 to 42.

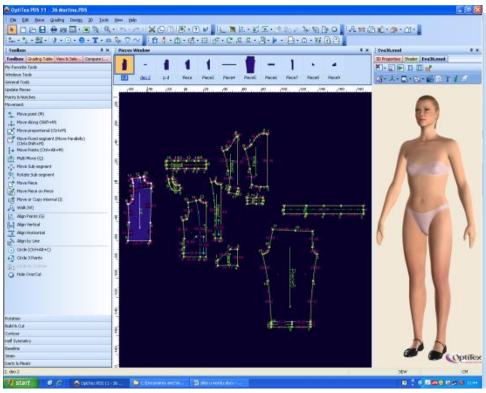

FIGURE 9. Modeling

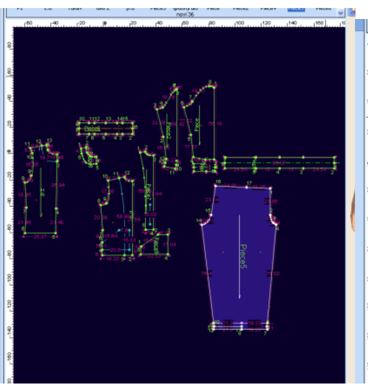

FIGURE 10. Patterns with seams

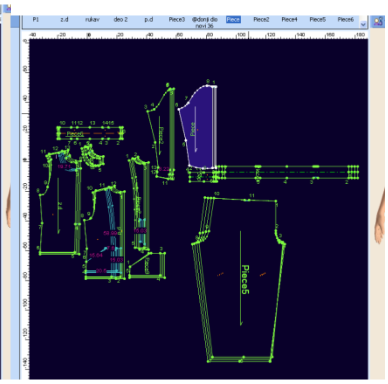

FIGURE 11. Grading

For 3D simulation are necessary data from the FAST Control Chart for Tailorability. Results for white knit and for navy knit were put in the Fabric Convertor. With that on 3D simulation showed how draping is, how it fit on the model and etc. Before simulation it showed all seams what spouse to be merged during sewing (figure12). After simulation, it showed how would look the desing on the model (figure 13).

FIGURE 12. Before simulation

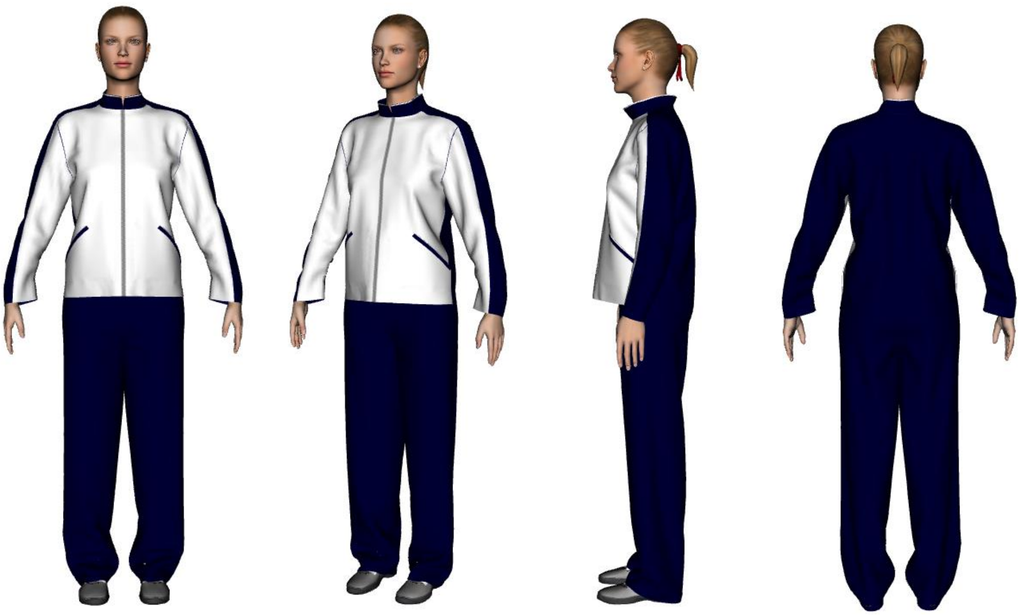

FIGURE 13. After simulation – 3D model

CONCLUSIONS

In this research, was showed Optitex system and making a new design. This system is very good for preproduction because it showed all possible mistakes, problems and also showed how would look like on the human before cutting materials. The first thing are sketches, they are the base of any part making clothes. When it found good design, construction, modeling and grading were done. The Optitex system is very easy for use. After it is done patterns, 3D simulation can started. Very important thing for stimulation, if we want good and quality simulation, it is necessary FAST results.

With them draping, fitting are possible to see on the model. On 3D model, after simulation it showed that model is good, draping is good, shape also. With this model, it made new design which is comfortable for wearing. It showed it fits nice, design is good, patterns are good for preproduction. This is absolutely good system for preproduction, which gave future for mass production.

REFERENCE

[1] K. Zafirova, *Integralni dizajn tekstilnih proizvoda*, Tehnološki metalurški fakultet, Institut tekstilnog inženjerstva, Stručni rad 677.074.11, Skopje, Makedonija, 2004
[2] G. Marunić, V. Glažar, G.Gregov, *3D Solid Modelling Inclusion in Engineering Graphics Course*, Strojarstvo 51, Rijeka, Hrvatska, 2009
[3] B. Lawson, „How Designers Think“, Great Britain, 2005
[4] M. Fruht, M. Rakić, I. Rakić, *"Grafički dizajn, Kreacije za tržište*", Beograd, 2004
[5] A. Das, R. Alagirusamy, *"Science in Clothing Comfort",* Woodheed Publishing India Pvt. Ltd., India, 2010
[6] F.S. Kilinic-Balci, Testing, *analyzing and predicting the comfort properties of textile*, Improving Comfort in Clothing, Woodhead Publishing Series In Textiles, U.S., 2011
[7] A. K. Roy Choudhury, P. K. Majumdar, C. Datta, *Factors affecting comfort: human physiology and the role of clothing*, Improving Comfort in Clothing, Woodhead Publishing Series In Textiles, U.S., 2011
[8] S. A. Hosseini Ravandi, M. Valizadeh, *Properties of fibers and fabrics that contribute to human comfort*, Improving Comfort in Clothing, Woodhead Publishing Series In Textiles, U.S., 2011
[9] G. Song, Preface, Improving Comfort in Clothing, Woodhead Publishing Series In Textiles, U.S., 2011
[10] V.T. Bartels, Improving comfort in sports and leisure wear, Improving Comfort in Clothing, Woodhead Publishing Series In Textiles, U.S., 2011
[11] www.optitex.com , 22.08.2015

FIGURES:

[1] www.optitex.com , 22.08.2015

DYEING OF SOYBEAN FIBERS WITH ECOLOGICAL NATURAL RED CABBAGE (*Brassica oleracea var. capitata f. rubra*) JUICE

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ABSTRACT

In this study, soybean fiber fabrics were dyed with the juice of red cabbage (Brassica oleracea var. capitata f. rubra) using exhaustion technique at various pHs. The gallnut was used for a natural, sustainable and renewable mordant. The effects of different dyeing pH levels (pH 5, 7, 9 and 11) on color strength levels of dyed soybean fiber fabrics were also studied. Moreover, the color fastness performance, colorimetric properties, fabric thickness and fabric density of dyed samples were measured and compared. Dyed soybean fiber fabrics exhibited different shades of blueish purple, beige and greyish color. The highest color strength values were observed on dyeing at pH 9 with and without mordant existence. However, the color fastness, fabric thickness and fabric density properties weren't affected from dyeing pH unlike color strength values. Consequently, pH 9 can be selected as an optimum dyeing pH value for soybean fiber fabrics dyeing with red cabbage juice, especially from the color point of view.

Key Words: red cabbage, Brassica oleracea var. capitata f. rubra, soybean, natural dyeing, gallnut

INTRODUCTION

In the textile industry, there are many synthetic dyes and dyeing auxiliary agents are used for textile dyeing. The manufacturing steps of these chemicals and their usage in textile dyeing may cause many undesirable effects on human health and environment. Natural dyeing has a great importance from the economic point of view as well as their applicability for textile industry (Samanta and Agarwal, 2009). *Brassica oleracea var. capitata f. rubra*, called commonly red or purple cabbage (Figure 1), is a member of Cruciferae family. Red cabbage is a plant which is rich in anthocyanins (Wiki, 2013; Yen et al., 2012). Color of the red cabbage leaves can be dark red or purple according to the pH value of the soil. Its color shade can change according to its anthocyanins content in the plant. For instance, the leaves grow more reddish in acidic soil, more purple in neutral soil and finally greenish yellow in alkaline soil (Wiki, 2013).

Figure 1: Type of anthocyanin in red cabbage (Wiki, 2013)

Anthocyanins, provided red, orange, blue or purple colours, are water soluble pigments found in fruit and vegetables (Wiczkowski et al., 2013; Webexhibits, 2016). The type of anthocyanin in red cabbage is cyanidin (Figure 1) (Webexhibits, 2016). The chemical structure of red cabbage can be seen on Figure 2.

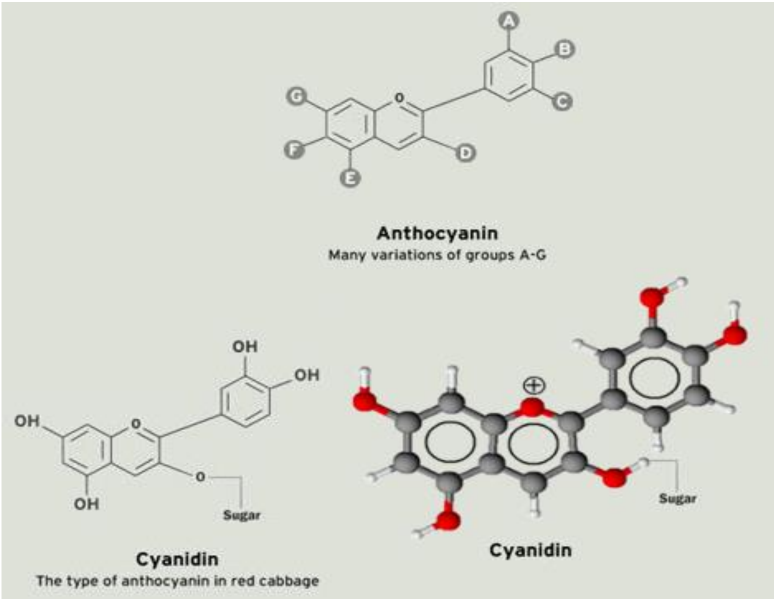


Figure 2: Type of anthocyanin found in red cabbage (Webexhibits 2016; Wiki 2, 2016)

Generally red cabbage are used in cooking. However, it also can be used as a pH indicator thanks to the presence of anthocyanins presence (Figure 3). And, red cabbage plant contain twice as much iron as green cabbage and 10 times more A vitamin (Wiki, 2013). Moreover, red cabbage were also previously used in textile dyeing and printing (Yildirim et. al., 2014; Sevgisunar et. al., 2013; Yen et al., 2012; Singh and Grover, 2009; Tezel, 2009). However, these studies are very limited.

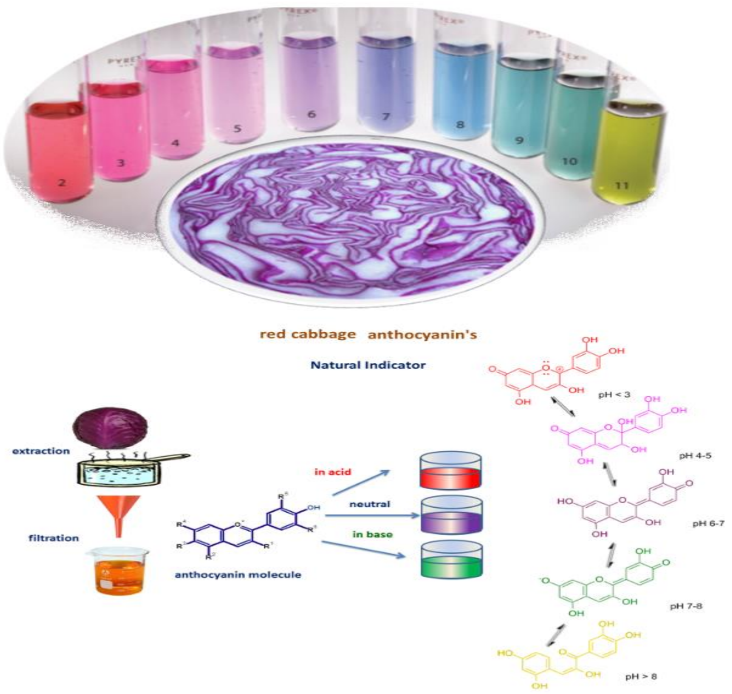


Figure 3: Usage of red cabbage as a pH indicator and its anthocyanins (Wiki 3, 2016; Catalog, 2016; Bushtuckerchem, 2016)

In this research, soybean fiber fabrics are dyed with natural red cabbage juice in company with natural gallnut mordant. Color, fabric thickness, fabric density and overall fastness properties of dyed samples are examined.

MATERIALS AND METHODS

Materials

In this study, 100% soybean fiber knitted fabrics were used. The red cabbage juice was used as a natural colorant and gallnut was used as a mordant. The juice of red cabbage wastes were extracted using Arzum AR 164 Mela Plus Whole Fruit Juicer. The natural dyeing process was carried out using exhaustion dyeing method with simultaneous mordanting. The mordant was added for procuring good fastness performance.

Exhaustion Dyeing Procedure

The red cabbage juice extract was used for dyeing soybean fabrics via simultaneous mordanting technique. Dyeing process with red cabbage extract was carried out in Atac Lab-Dye HT machine at a liqour ratio of 40:1 at various pH values (pH 5, 7, 9, 11). 1:1 extract/water rate was used for each dyeing process. The gallnut mordant powder, which is obtained via milling operation of gallnut, was used in concentration 20%. The natural dyeing was started at room temperature and reached to 100 ^oC by increasing the dyeing temperature by 4 ^oC per minute. The dyeing process at boil carried out for 60 minutes and then the dyeing baths were cooled down to 50 ^oC. After dyeing, the samples were removed and rinsed under running tap water. Then, all samples were flat-air-dried. Afterwards, the samples were washed at 40 ^oC for 10 minutes with water and flat-air-dried again before any testing.

Colorimetric Measurements

The CIE Lab L^*, a^*, b^*, C^*, and h^o values of dyed soybean fiber fabric samples were measured with using a DataColor SpectraFlash 600 (Datacolor International, Lawrenceville, NJ, USA), spectrophotometer under illuminant D65, using 10^o Standard observer for each dyed samples. The colour strength value K/S is calculated by using the Kubelka-Munk equation. The equation of *K/S, Eq. (1)* is given at below:

$$K/S = (1-R)^2/2R \qquad (1)$$

Color Fastness and Fabric Thickness and Density Properties

Both dry and wet rub fastness testing were performed with the ISO 105: X12 protocol. Both acidic and alkaline perspiration fastness test were performed with ISO 105: E04 standard. Wash-fastness test was carried out in a M228 Rotawash machine (SDL ATLAS, UK) at 40^{o}C according to ISO 105:C06 A2S test. Overall fastness properties were determined using ISO grey scales.

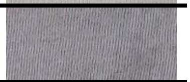
Warp and weft densities of knitted soybean fabrics were measured with 1*1 cm^2 textile loop. And finally, fabric thickness measurements were performed in Automatic Micrometer Louis Schopper Leipzig equipment, Germany.

RESULTS AND DISCUSSION

Color Properties

Color strength values, CIELAB color values and the obtained shades of dyed soybean fabric samples are shown on Table 1. Moreover, colorimetic values of naturally dyed fabrics are shown in Figures 3-6.

Table 1: Color strength, CIELAB color values of naturally dyed samples

Dyed fabric samples	*L**	*a**	*b**	*C**	*h°*	*K/S*	**Appearance**
Natural dyed at pH 5, mordanted with gallnut	64,38	5,82	13,9	15,02	67,2	2,2	
Natural dyed at pH 7, mordanted with gallnut	63,88	5,99	12,9	14,23	65,1	2,2	
Natural dyed at pH 9, mordanted with gallnut	62,07	5,36	14,2	15,17	69,3	2,5	
Natural dyed at pH 11, mordanted with gallnut	64,53	4,58	17,6	18,19	75,4	2,3	
Natural dyed at pH 5, unmordanted	63,89	4,5	11,9	12,73	69,3	2,0	
Natural dyed at pH 7, unmordanted	64,55	3,26	11,4	11,86	74,1	1,9	
Natural dyed at pH 9, unmordanted	55,5	2,93	5,27	6,03	60,9	2,7	
Natural dyed at pH 11, unmordanted	70,29	2,2	13,8	14	81	1,5	

Dyed samples displayed blueish purple, beige and greyish color shades. In earlier literature, it is reported that bluish color shades were obtained from red cabbage extract on cotton fibers (Tarafder, 2009) (Table 1). The highest color strength value (2,7) was observed on soybean fabric dyed with red cabbage juice extract at pH 9 without mordant usage. Generally, but not a rule, mordanted samples exhibited higher color strength values than those of unmordanted samples. The only exception was the observed case on dyeing at pH 9. In contrast to the other dyeing results, dyed soybean fabric with red cabbage extract at pH 9 without mordant usage exhibited higher color strength than that of dyed sample at pH 9 with mordant. Mordants can change the color shades of the natural dyes. Further, in the polygenetic natural dyes, the use of different mordants with same dye can shift the color shade (Samanta and Konar, 2011). Therefore, soybean fabrics dyed with red cabbage extract in the presence of natural gallnut mordant displayed slightly different color shades than the ones dyed in the absance of mordant existence.

All mordanted samples exhibited more or less akin color shades. However, unmordanted samples, dyed at different pH values, showed slightly different color shades. The color shade differences of these dyeings can result from the presence of anthocyanins in the red cabbage (Yen et al, 2012). As it is well known, the anthocyanins are sensitive to pH and temperature. On the other hand, the observed color shade differences of dyed samples were not extreme. The highest color strentgh values are observed on soybean fabrics dyed at pH 9 with and without mordant existence. Accordinly, pH 9 can be recommended for soybean fibre fabric dyeing with red cabbage extract.

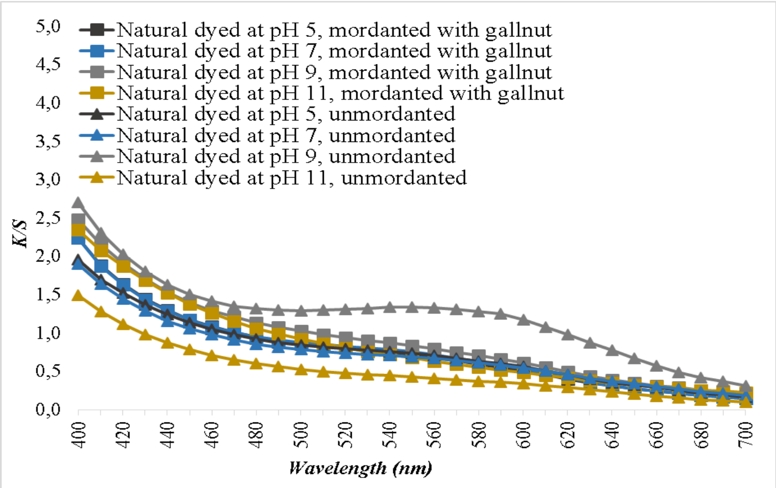


Figure 3: Color strength (K/S) –wavelength (nm) spectra

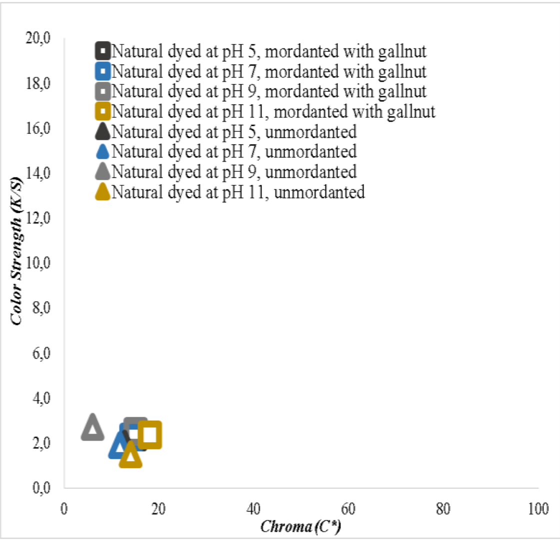


Figure 4: Color Strength (K/S)- Chroma (C*) plots*

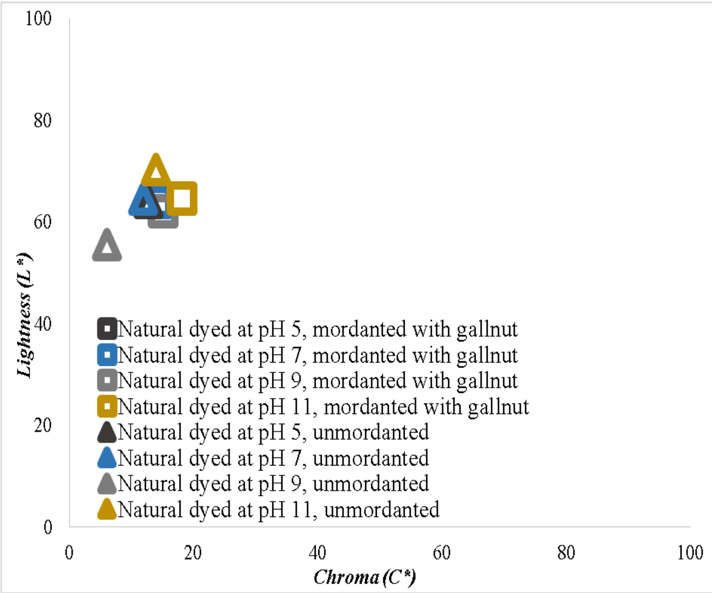


Figure 5: Lightness (L)-Chroma (C*) plots*

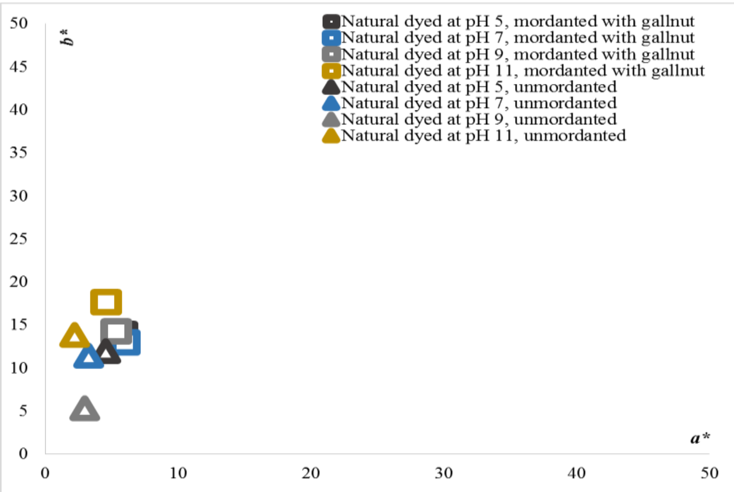


Figure 6: Redness (a)- Yellowness (b*) plots*

Table 1 and Figures 3-6 shows that soybean samples generally exhibit the highest *L** values leading to weakest colors. As it can be seen from all plots, all dyed samples exhibited close colorimetric values to each other with the one exception. This exception was the soybean fabric dyed at pH 9 without mordant usage. This sample displayed highest color strength, darkest and dullest appearance according to the color strength-chroma and lightness-chroma plots (Figures 4 and 5).

Color fastness, Fabric Density and Fabric Thickness properties of dyed fabrics

Color fastness properties of dyed soybean fiber fabrics are shown on Table 2-4.

Table 2: Wash and rub fastness values of dyed samples

Dyed Samples	***Washing Fastness ISO 105:C06 A2S***							***Rub Fastness ISO 105: X12***	
	K/S	***AC***	***CO***	***N6.6***	***PES***	***PC***	***WO***	***Dry***	***Wet***
Natural dyed at pH 5, mordanted with gallnut	2,2	5	4/5	5	5	5	5	4/5	4/5
Natural dyed at pH 7, mordanted with gallnut	2,2	5	4/5	5	5	5	5	4/5	4/5
Natural dyed at pH 9, mordanted with gallnut	2,5	5	4/5	5	5	5	5	4/5	5
Natural dyed at pH 11, mordanted with gallnut	2,3	5	4/5	5	5	5	5	5	5
Natural dyed at pH 5, unmordanted	2,0	5	5	5	5	5	5	4/5	4/5
Natural dyed at pH 7, unmordanted	1,9	5	5	5	5	5	5	5	4/5
Natural dyed at pH 9, unmordanted	2,7	5	5	5	5	5	5	5	5
Natural dyed at pH 11, unmordanted	1,5	5	5	5	5	5	5	5	5

*4/5 indicates 4,75 gray scale rating

As seen on Table 2, wash fastness values of all dyed soybean samples were in the range of 4/5-5 gray scale rating. Similarly, all soybean fabrics exhibited high rub fastness values which are again in the range of 4/5-5 values. It seems that unmordanted samples exhibited slightly higher wash fastness values than mordanted samples. All wash and rub fastness values of dyed sample exhibited good to excellent fastness values leading to commercially acceptance color fastness levels.

Table 3: Alkaline perspiration fastness values of dyed samples

Dyed Samples	***Alkaline Perspiration Fastness ISO 105: E04***						
	K/S	***AC***	***CO***	***N6.6***	***PES***	***PC***	***WO***
Natural dyed at pH 5, mordanted with gallnut	2,2	5	4/5	5	5	5	4/5
Natural dyed at pH 7, mordanted with gallnut	2,2	5	4/5	5	5	5	4/5
Natural dyed at pH 9, mordanted with gallnut	2,5	5	4/5	5	5	5	4/5
Natural dyed at pH 11, mordanted with gallnut	2,3	5	4/5	5	5	5	5
Natural dyed at pH 5, unmordanted	2,0	5	4/5	5	5	5	5
Natural dyed at pH 7, unmordanted	1,9	5	4/5	5	5	5	5
Natural dyed at pH 9, unmordanted	2,7	5	4/5	5	5	5	5
Natural dyed at pH 11, unmordanted	1,5	5	4/5	5	5	5	5

*4/5 indicates 4,75 gray scale rating

All alkaline perspiration fastness values ranged between 4/5 and 5. And therefore, all alkaline perspiration results were excellent and commercially acceptable. As can be seen from Table 4, All acidic perspiration fastness values were also in the range of 4/5 and 5 leading to commercially acceptable levels once again. Higher dye content, leading to higher color strength values, seems to cause slightly lower acidic perspiration fastness values. Nevertheless, all wash, rub (dry and wet) and perspiration (alkaline and acidic) fastness values of dyed soybean fabrics were quite high and commercially acceptable.

Table 4: Acidic perspiration fastness values of dyed samples

Dyed Samples	***Acidic Perspiration Fastness ISO 105: E04***						
	K/S	***AC***	***CO***	***N6.6***	***PES***	***PC***	***WO***
Natural dyed at pH 5, mordanted with gallnut	2,2	4/5	4/5	4/5	4/5	4/5	4/5
Natural dyed at pH 7, mordanted with gallnut	2,2	4/5	4/5	4/5	4/5	4/5	4/5
Natural dyed at pH 9, mordanted with gallnut	2,5	4/5	4/5	5	5	5	4/5
Natural dyed at pH 11, mordanted with gallnut	2,3	4/5	4/5	4/5	4/5	4/5	4/5
Natural dyed at pH 5, unmordanted	2,0	5	4/5	5	5	5	5
Natural dyed at pH 7, unmordanted	1,9	5	4/5	5	5	5	5
Natural dyed at pH 9, unmordanted	2,7	4/5	4/5	4/5	4/5	4/5	4/5
Natural dyed at pH 11, unmordanted	1,5	5	5	5	5	5	5

*4/5 indicates 4,75 gray scale rating

It is clear that dyeing pH had no significant effect on the color fastness properties. Fabric densities and fabric thickness of all dyed soybean fabric samples are shown on Table 5 and Figures 7-10.

Table 5: Warp and Weft Densities and Fabric Thickness of red cabbage dyed soybean fabrics at various pH values

Dyed Samples	***Densities***		***Thickness (mm)***
	Warp Direction	***Weft Direction***	
Greige Fabric	13	18	0,42
Natural dyed at pH 5, mordanted with gallnut	14,5	20,5	0,54
Natural dyed at pH 7, mordanted with gallnut	15	20,5	0,55
Natural dyed at pH 9, mordanted with gallnut	13,5	19,5	0,53
Natural dyed at pH 11, mordanted with gallnut	13,5	19,5	0,51
Natural dyed at pH 5, unmordanted	13	19,5	0,52
Natural dyed at pH 7, unmordanted	14	19,5	0,51
Natural dyed at pH 9, unmordanted	14	19	0,53
Natural dyed at pH 11, unmordanted	13,5	19,5	0,53

As can be seen from Table 5 and Figures 7-10, soybean fiber fabrics shrinkaged after dyeing at boil for each dyeing pH. The warp and weft densities of the all dyed samples were higher than those of greige (undyed) soybean fabric (Figures 7 and 9). Therefore, the fabric thickness increased after dyeing as a result of fabric shrinkage (Figures 8 and 10).

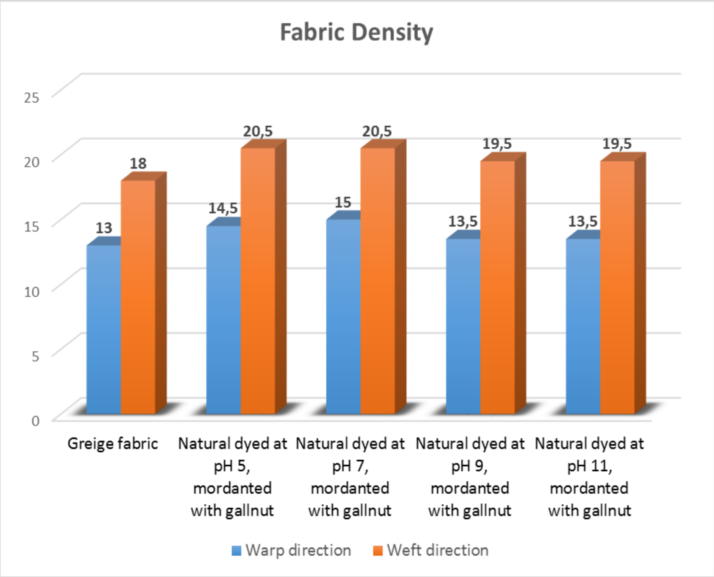


Figure 7: Warp and Weft density values of dyed soybean fabrics at various pH values via mordant

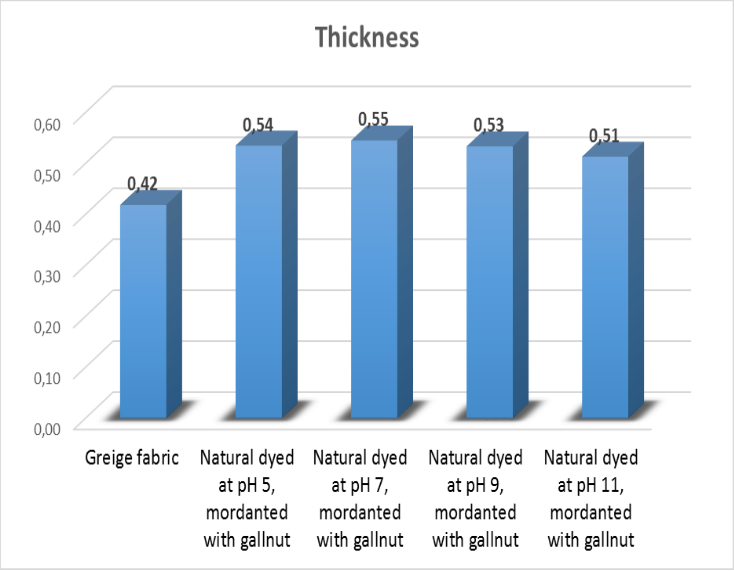


Figure 8: Fabric thickness values of dyed soybean fabrics at various pH values via mordant

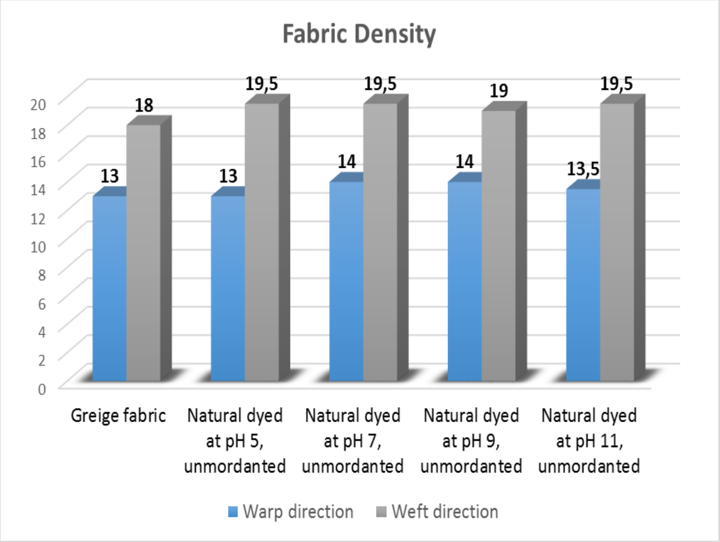


Figure 9: Warp and Weft density values of dyed soybean fabrics at various pH values without mordant

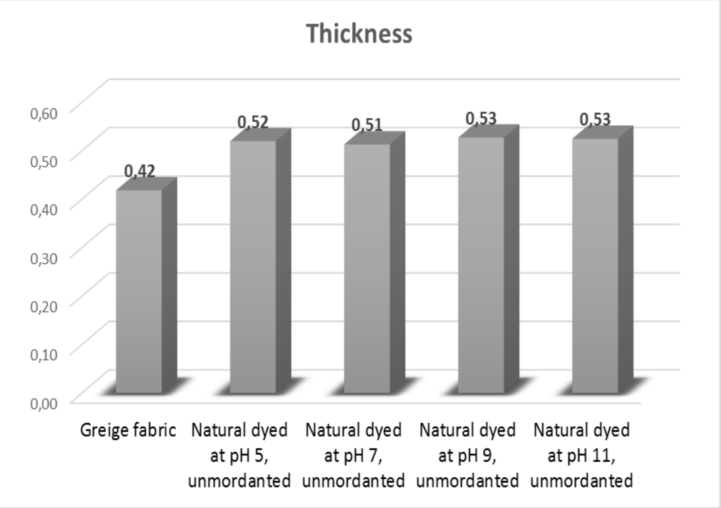


Figure 10: Fabric thickness values of dyed soybean fabrics at various pH values without mordant

After dyeing, mordanted soybean fiber fabrics generally, but not a rule, exhibited slightly more shrinkage (according to fabric density and fabric thickness values) than unmordanted soybean fiber fabrics. However, these differences were not significantly big. It seems that dyeing pH had no significant effect on the fabric density and fabric thickness properties.

CONCLUSION

Soybean fiber fabrics dyed with red cabbage juice extract exhibited bluish purple, beige and greyish color shades. In general, when sustainable, renewable and natural gallnut is used as a simultaneous mordanting material during natural dyeing, deeper color shades with higher chroma levels were observed. However, the highest color strength values in this study were observed on soybean fabrics dyed at pH 9 for both with and without mordant presence.

Dyeing with the juice of red cabbage *(Brassica oleracea var. capitata f. rubra)* led to good to excellent wash, rub and perspiration fastness values. All measured color fastness values were above 4/5 gray scale rating and commercially acceptable. Besides, thickness and warp & weft fabric density values of all dyed soybean fabrics demonstrated that soybean fabric exhibited fabric shrinkage during dyeing at boil. Since, the warp & weft densities and fabric thickness of the all dyed samples were higher than those of greige (undyed) soybean fabric due to fabric shrinkage. None the less, the amount of shrinkage was not affected from dyeing pH. For all dyeing pH's, the amount of shrinkage was more or less similar. It seems that natural dyeing pH had no significant effect on the color fastness, fabric density and fabric thickness properties of dyed soybean fabrics. Consequently, overall, pH 9 can be selected as an optimum dyeing pH value for soybean fiber fabrics dyeing with red cabbage juice, especially from the color point of view.

REFERENCES

Önal and Subasar, Önal, A., & Subasar, F. D. Kırmızı lahana'dan (Brassica oleracea var. capitata f. rubra) elde edilen doğal boya ile yün, pamuk ve keten kumaşların boyanması.

Samanta and Konar, Samanta A.S. and Konar A., (2011), "Dyeing of Textiles with Natural Dyes" in *Naturla dyes*, Kumbasar P.A., Intech, 2011

Yen C.-K., Peng L.-Y., Wang C.-X., Chen Y.-Y., (2012), Dyeing of degummed silk fibers with anthocyanins in red cabbage, *Advanced Materials Research*, Vol 418-420, pp.585-588.

Samanta and Agarwal, Ashis Kumar Samanta & Priti Agarwal, (2009), Application of natural dyes on textiles, Indian Journal of Fibre & Textile Research, Vol. 34, December 2009, pp. 384–399

Wiki, http://en.wikipedia.org/wiki/Red_cabbage, reviewed on 26/01/2013.

Wiczkowski et. Al., Wiczkowski W., Szawara-Nowak D., Topolska J., (2013), Red cabbage anthocyanins: Profile, isolation, identification, and antioxidant activity, *Food Research International*, Vol 51, issue 1, pp. 303-309.

Tarafder, Tarafder N., (2009), Eco safe natural dyes and application on textile materials, *Man-made textiles in India*, 355-361

Webexhibits, http://www.webexhibits.org/causesofcolor/7G.html, 10.04.2016

Wiki 2, https://commons.wikimedia.org/wiki/File:Cyanidin_structure_3D.png, 10.04.2016

Yildirim et. Al, F.Filiz Yıldırım, Arzu Yavaş, O.Ozan Avinç ve O.Yemiş, (2014), "Pigment Printing Of Wool And Soybean Fabrics With Black Carrot (Daucus Carota L.) And Red Cabbage (Brassica oleracea var. capitata f. rubra)", 6th International Scientific – Professional Conference Textıle Scıence And Economy Proceedings, Zrenjanin, Serbia, 28-30th, Sn; 19-27, 2014.

Sevgisunar et. Al, H.G. Sevgisunar[1], A. Yavaş*[1], O.O.Avinc[1], And O. Yemis, (2013), Eco-Printing Of Wool, Soybean And Silk Fibers With Red Cabbage (Brassica Oleracea Var. Capitata F. Rubra) Juice, International Conference, Textile Science and Economy V, 5th International Scientific-Professional Conference, November 05-06th, Zrenjanin, Serbia, Sn 57-62, 2013

Yen et. al, Yen C.-K., Peng L.-Y., Wang C.-X., Chen Y.-Y., (2012), Dyeing of degummed silk fibers with anthocyanins in red cabbage, *Advanced Materials Research*, Vol 418-420, pp.585-588.

Singh and Grover, Singh, C., & Grover, E. (2009). Red Cabbage-A natural dye for silk. *Man-Made Textiles in India*, *52*(5).

Tezel, Tezel, Z. (2009). Yazmacılık sanatında desenleme teknikleri (Kalıp tekniğiyle ağaç baskı uygulama örneği). *Gazi Üniversitesi Endüstriyel Sanatlar Eğitim Fakültesi Dergisi*, *25*, 27-40.

Wiki 3, https://commons.wikimedia.org/wiki/File:Rotkohl-Indikator-Reaktionen.png, 10.04.2016

Catalog, http://catalog.flatworldknowledge.com/bookhub/reader/26669?e=averill_1.0-ch16_s05, 10.04.2016

Bushtuckerchem, https://bushtuckerchem.wordpress.com/natural-indicators/, 10.04.2016

THE EFFECT OF pH ON ECOLOGICAL DYEING OF SOYBEAN FIBRES WITH HORSE CHESTNUT (*Aesculus hippocastanum*) SHELLS

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ABSTRACT

Horse chestnut is a tree growing in many countries that have temperate climatic conditions. Although the horse chestnut is generally known as a medicinal plant, there are also other usage areas in industry. The extract of horse chestnut can be used in textile dyeing. In this study, renewable, sustainable and ecological soybean fiber fabrics were dyed at various pH values (pH 4, 7, 10) with the powder extract of renewable, sustainable and natural horse chestnut shells, obtained via soxhlet extraction technique, using exhaustion dyeing method. Dye baths were prepared with or without mordant. The overall color fastness and color properties of dyed samples were evaluated and compared. Additionally, the physical properties (fabric stiffness, thickness and air permeability) of dyed samples were evaluated. Dyed soybean fabric samples exhibited dark beige, greyish and brownish color shades. All mordanted samples exhibited higher color strength (*K/S*) values than un-mordanted samples. Moreover, dyeing with horse chestnut shell powder led to good wash, rub, perspiration and water fastness levels. From the color and physical properties of dyed soybean fiber fabrics, dyeing at pH 4 can be selected as an optimum dyeing pH for natural dyeing of soybean fiber fabric with the extract of horse chestnut shells.

Key Words: Horse chestnut, *Aesculus hippocastanum,* soybean, natural dyeing, sustainable

INTRODUCTION

Figure 1. *(wiki1, 2016)*

Aesculus hippocastanum, which is commonly known as horse chestnut or conker tree, is a member of Hippo-castanaceae family (Figure 1) (Bellini and Nin, 2005). The horse chestnut tree grows up to 36 metres (25 to 36 metres) and the tree is a flowering plant. Flowers of tree are usually white with a small red or yellow spots. They produce panicles in spring and approximately 20-50 flowers are located on each panicle; however, only 1-5 fruit develop on each panicle. The fruits have green and spiky capsule called conkers or horsechestnut (Figure 2). The horsechestnut tree, needs temperate climatic conditions, can also be cultivated in parks and streets (Wiki1, 2016; Bellini and Nin, 2005).

Figure 2. Aesculus hippocastanum tree and Horse chestnut fruit (wiki1, 2016; wiki2, 2016; wiki3, 2016; wiki4, 2016; wiki5, 2016)

They grow successfully in the UK, New Zeland, Canada, Ireland, Iceland, Norway and Turkey. In Ireland and Britan, the seeds are used for children's games (Wiki1, 2016; Bellini and Nin, 2005). The seeds, mostly contain alkaloid saponoins (called aescin), flavonoids, condensed tannins, quinines, and glucosides, are slightly poisonous. Even though seeds are not dangerous for touching, they cause sickness when eaten (Wiki1, 2016; Sigmaaldrich, 2016; Bellini and Nin, 2005).

Horse Chestnut is classified as an unsafe herb by FDA (US Food and Drug Administration). However, seed extracts (including 20% aescin) are used for its venotic effect, vascular protection, free radical scavenging, antioxidant and anti-inflammatory properties (Wiki1, 2016; Sigmaaldrich, 2016). The toxicity of the horsechestnut leaf, bark, seed and flower are resulted from its aescin existence (Wiki1, 2016; Sigmaaldrich, 2016; Bellini and Nin, 2005).

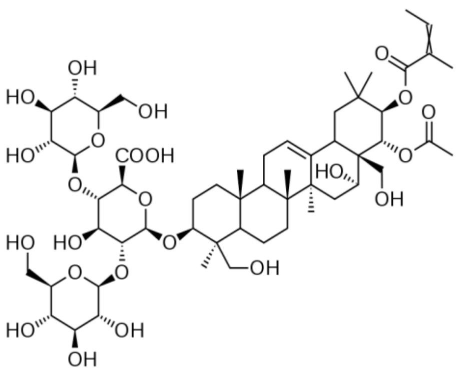

Figure 3. β-Aescin (wiki6, 2016; Ramos and Braga, 2015)

Aescin (Figure 3), is the one of the main active ingredients of horse chestnut, acts on capillary membranes to normalize vascular permeability (Wiki1, 2016; Sigmaaldrich, 2016; Bellini and Nin, 2005).

The horse chestnut is widely known as a medicinal plant in many different countries. Apart from the potential usage areas via its medical properties, the horse chestnut has various other uses (*such as domestic uses*). Horse chestnut can be used in soap production, for removing earthworms, to combat moths, in cosmetics (in bath foams, tonics, shampoos. Etc.), in furnitures and in animal nutrients e.g. (Bellini and Nin, 2005).

Taking into account of the industrial and technological point of views, the horse chestnut can be used as a glue through its dextrin content, the seed powder serve as a foaming agent for extinguishers, also their seeds can be used as anti-prasitic and insecticidal agents. Additionally, the extract of the bark is used for wool dyeing and mordanting, and for fur dyeing (Bellini and Nin, 2005; Onal 1995). In addition to the usage of its bark, outer shells of the horse chestnut may also be used for dyeing. Aesculin (6,7-dihydroxy coumarin) is a substance which is isolated from outer shell of chestnut and used in dyeing. It is reported that aesculin has three auxchrome groups (Onal, 1995).

In the recent years, new dyeing and finishing techniques have been explored and investigated by many different researchers instead of traditional dyeing and finishing processes. For example, cosmeto-textile applications can be implemented to textile materials with new techniques. Cosmeto-textiles have been used in the treatment of chronic venous insufficiency in legs via elastic bandages. The elastic bandages were produced by recharging aescin (which is derived from horse chestnut) formulations (*and other extracts*) to the β-cyclodextrin grafted fabrics (Cravotto et. al, 2011; Ramos and Braga, 2015; Ramos and Braga, 2015b).

As explained above, the horse chestnut extract was applied to the textile materials; however, there are very few studies about its application on fabrics. In this study, ecological, biodegradable, renewable soybean knitted fiber fabrics were dyed with natural dye powder of horse chestnut at various pH's with or without any mordant existence. Color, physical and overall fastness properties of dyed soybean fabrics are examined.

MATERIALS AND METHODS

Materials

100% soybean fiber knitted fabrics were used for this study. The natural dyeing process was carried out using exhaustion dyeing method. Soybean fabrics were dyed with horse chestnut shell extract in powder form in company with gallnut mordant or without any mordant usage existence. The horse chestnut shell extract in powder form is obtained via soxhlet extraction technique from the shells of horse chestnut. The natural gallnut mordant, in powder form via milling, was added to impart better fastness and bonding properties.

Dyeing Process

Natural dyeing of soybean fabrics with horse chestnut shell powder was carried out in Atac Lab-Dye HT machine at a liquor ratio of 40:1 at various pH values (pH 4, 7, 10). 10% horse chestnut powder was used for natural dyeing with and without mordant. In the mordant dyeing, 20% gallnut mordant concentration was used during the dyeing process as a mordant. The natural dyeing was started at room temperature and the dyeing temperature was increased for 4 ^{o}C per minute and reached to 100 ^{o}C.

The dyeing process performed at boil for 60 minutes and then the baths were cooled down to 50 ^{o}C. After dyeing, the fabric samples were rinsed in tap water to clear the remaining unfixed dyes on the fabric surfaces for 5 minutes. Then, the samples were flat-air-dried. Afterwards, the samples were washed at 40 ^{o}C for 10 minutes with water and flat-air-dried again.

Colorimetric Measurements

The CIE Lab *L**, *a**, *b**, *C**, and h^o values were measured with using a DataColor SpectraFlash 600 (Datacolor International, Lawrenceville, NJ, USA), spectrophotometer under illuminant D65, using 10º Standard observer for each dyed samples. The colour strength value K/S is calculated by using the Kubelka-Munk equation. The equation of *K/S, Eq. (1)* is given at below:

$$K/S = (1-R)^2/2R \qquad (1)$$

Physical and Comfort Properties

Air permeability values of dyed fabrics were measured in air permeability tester Textest FX 33000 according to TS 391 EN ISO 9237 test at under pressure 200 Pa and with 5 cm^2 test head. Thickness measurements were performed in Automatic Micrometer Louis Schopper Leipzig equipment. Fabric stiffness test was carried out in Prowhite Stiffness tester according to ASTM D4032 test standard.

Fastness Properties

Both dry and wet rub fastness testing were performed with the ISO 105: X12 protocol. Wash-fastness test was carried out in a M228 Rotawash machine (SDLATLAS, UK) at 40ºC according to ISO 105:C06 A2S test. The water fastness test was carried out in accordance with ISO 105: E01 protocol. Both acidic and alkaline perspiration fastness test were performed with ISO 105: E04 standard. Overall fastness properties were determined using ISO grey scales.

RESULTS AND DISCUSSION

Color Properties

The color strength, CIELAB values and appearance of the dyed samples are shown on Table 1. Moreover, color properties of dyed soybean fiber fabrics are shown on Figures 4-7.

Table 1: Color strength, CIELAB color values of horsechestnut dyed soybean fabrics at various pH values

Natural dyed fabric samples	*L**	*a**	*b**	*C**	*h^o^*	*K/S*	Appearance
Natural dyed at pH 4, mordanted with gallnut	51,92	8,21	20,8	22,4	68,5	7,6	
Natural dyed at pH 4, unmordanted	55,37	9,8	15,8	18,6	58,2	3,4	
Natural dyed at pH 7, mordanted with gallnut	52,88	7,65	19	20,46	68	6,1	
Natural dyed at pH 7, unmordanted	56,53	10,5	14,7	18,07	54,5	2,9	
Natural dyed at pH 10, mordanted with gallnut	58,92	7,98	12,9	15,15	58,2	2,6	
Natural dyed at pH 10, unmordanted	65,74	7,69	14,8	16,64	62,5	1,7	

All dyed fabrics samples displayed dark beige, greyish and brownish color shades. In the earlier studies, it is reported that horse chestnut provided brown color shades on wool fibres (Onal, 1995; Arlı et. al. 1993). Soybean fibers can be dyed at each studied pH value which is in the range of pH 4 and pH 10. As seen on Table 1, the highest color strength value (K/S 7,1) is observed on soybean fabric dyed at pH 4 in company with gallnut mordant. Moreover, the results indicated that mordant usage enhanced the color strength values. Unmordanted samples displayed lower color strength values in comparison with those of mordanted samples.

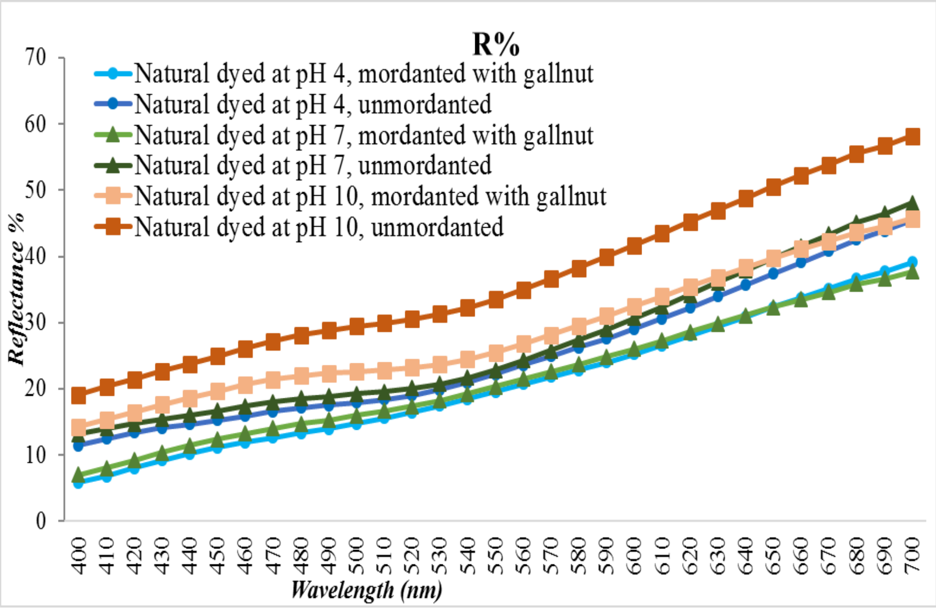

Figure 4: Reflectance (R%)-wavelength(nm) spectra of dyed soybean fabrics at various pH values

Reflectance-wavelength graphic (see also Figure 4) and Table 2 results show that unmordanted soybean samples led to lighter color shades than the mordanted soybean samples.

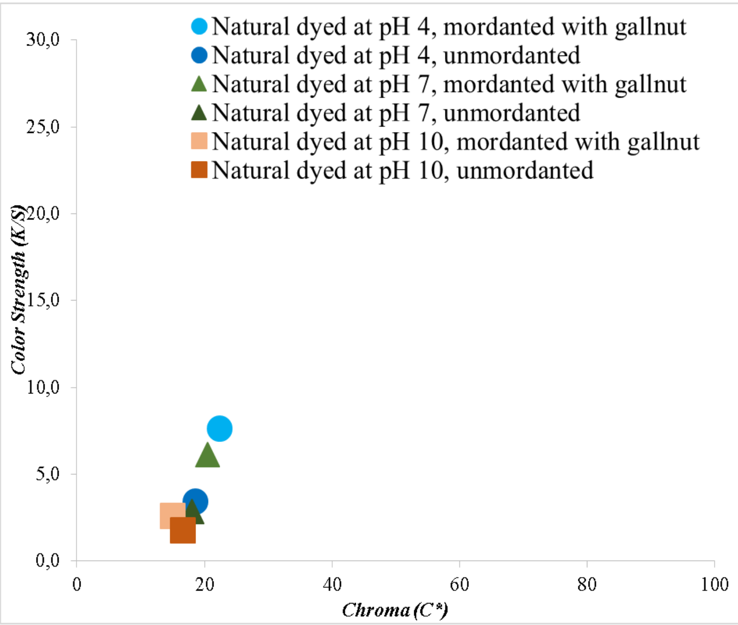

Figure 5: Color strength (K/S)-Chroma (C)*plots of dyed soybean fabrics at various pH values*

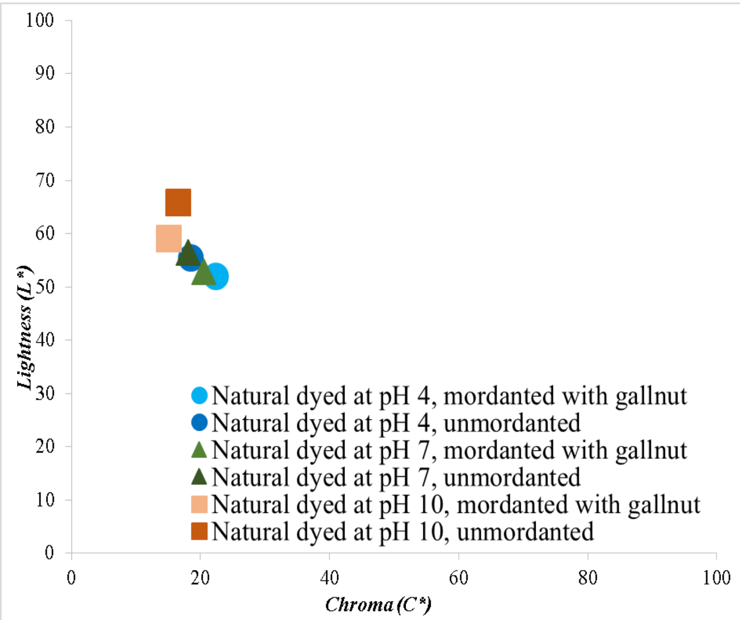

Figure 6: Lightness (L)- Chroma (C)* plots of dyed soybean fabrics at various pH values*

The color strength and chroma (Figure 5) values enhanced with mordanting. The highest color strength and chroma (22,4) values are obtained from natural dyeing at pH 4 via mordant. As seen on lightness-chroma graph (Figure 6), lightness values increased with increasing dyeing pH leading to lower color strength. Lower lightness values point out darker color shades. Thus, dyeing with horse chestnut dye can be carried out at the range of pH 4-7 via mordant usage.

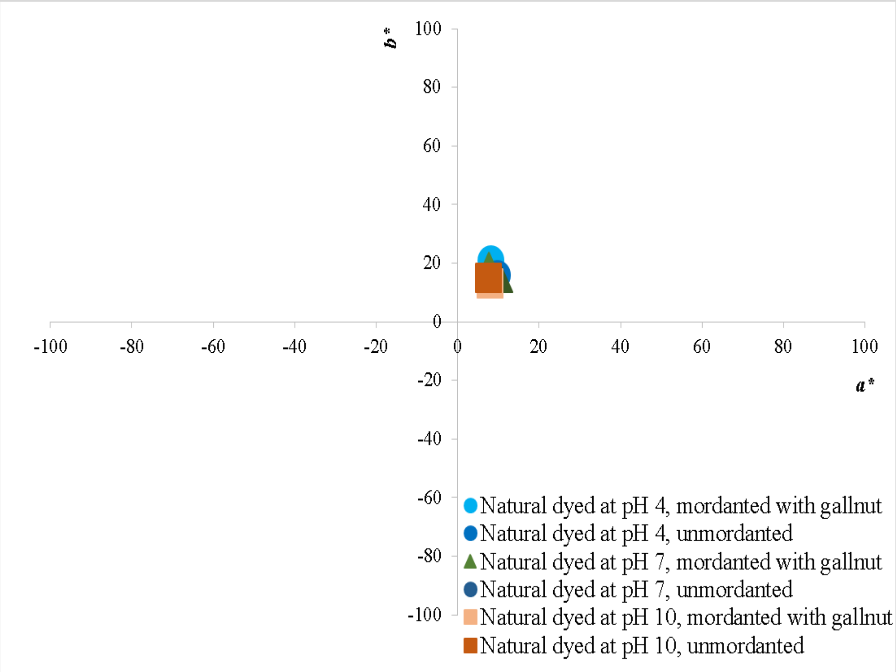

Figure 7: Redness (a)- Yellowness (b*) plots of dyed soybean fabrics at various pH's*

All dyed samples exhibited dark beige and brownish shades and displayed similar redness-yellowness values, as seen on figure 7. Overall from the color point of view, pH 4 can be selected as a optimum horse chestnut natural dyeing pH for soybean fiber fabrics leading to highest color strength levels achieved when compared with their counterparts.

Physical properties

Air permeability, thickness and stiffness values of dyed soybean fiber fabrics are shown on Table 2 and Figures 8-10.

Table 2: Physical properties of dyed soybean fabrics at various pH values

Dyed Soybean Fabric Samples	***Stiffness (CN)***	***Air permeability ($l/m^2.sn$)***	***Thickness (mm)***
Greige Fabric (Undyed)	19,63	2380	0,42
Natural dyed at pH 4, mordanted with gallnut	28,57	1880	0,47
Natural dyed at pH 4, unmordanted	27,50	2025	0,46
Natural dyed at pH 7, mordanted with gallnut	28,50	1640	0,49
Natural dyed at pH 7, unmordanted	27,00	2100	0,46
Natural dyed at pH 10, mordanted with gallnut	28,25	1970	0,47
Natural dyed at pH 10, unmordanted	27,50	2325	0,44

The higher the stiffness value is the stiffer the fabric. The greige soybean fabric exhibited lower stiffness value than those of dyed fabrics (Table 2 and Figure 8). It means that the greige soybean fabric is softer than dyed soybean fabrics or in other way of saying dyeing process at boil resulted in slightly stiffer handle. This could be due to the shrinkage problem during dyeing process. What is more, in terms of dyed fabrics, the mordanted samples exhibited slightly higher stiffness values than unmordanted samples.

This result actually overlaps with the previous experience of some mordants which could lead to harsh handle on some fabrics (Samanta and Konar, 2011). However, it is important to state that these stiffness level differences between mordanted and unmordanted fabrics are not significant variations (Figure 8). Moreover, the dyeing pH was not effective on stiffness levels of soybean fiber fabrics.

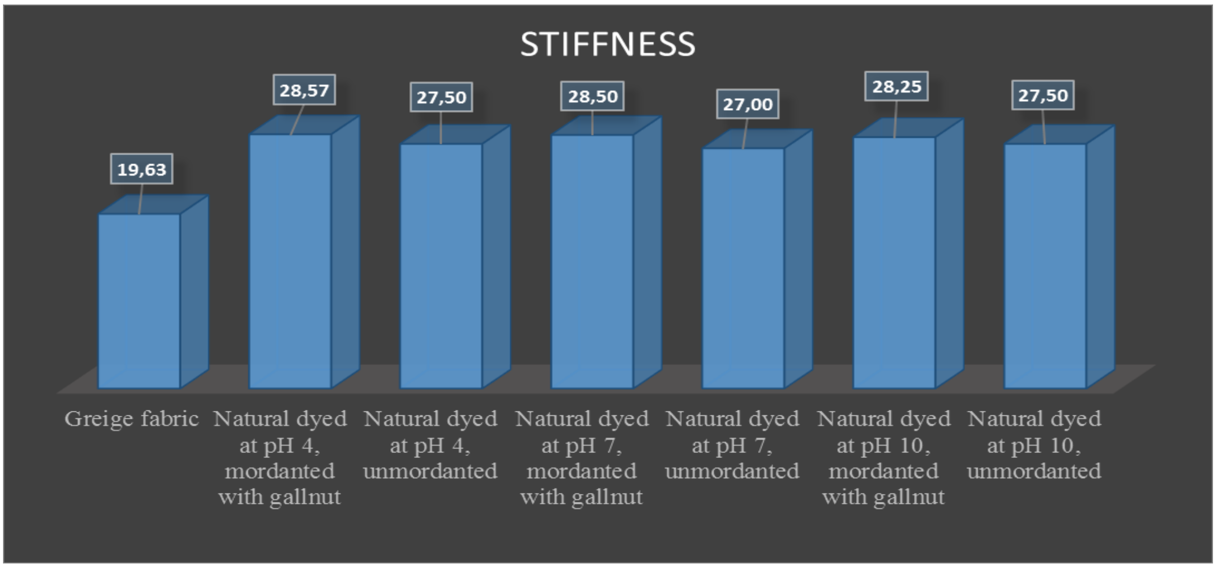

Figure 8; Stiffness values of dyed soybean fabrics at various pH values

Thickness values of dyed soybean fiber fabrics were higher than that of greige fabric (Table 2 and Figure 9). This means that dyeing soybean fibers at 100^{o}C led to slight shrinkage due to high temperature aquatic application. Furthermore, thickness values of mordanted fabrics are slightly higher than those of unmordanted samples. All these measured results are in parallel with the measured thickness levels of the soybean fabrics.

The thicker fabric is the stiffer fabric due to higher yarn content available in the measured part of the fabric. Indeed air permeability results validate this inference (Table 2 and Figure 10). The highest air permeability value was measured for undyed greige soybean fiber fabric (Figure 10). Dyeing at boil resulted in less air permeability levels due to shrinkage during the dyeing operation leading to also thicker fabric. When only the air permeability values of dyed fabrics are examined, it is clearly visible that mordanted samples exhibited lower air permeability values than unmordanted samples.

This is an expected result, since the higher thickness values resulted in tighter fabric due to shrinkage at boil leading to slight decrease on air permeability properties.

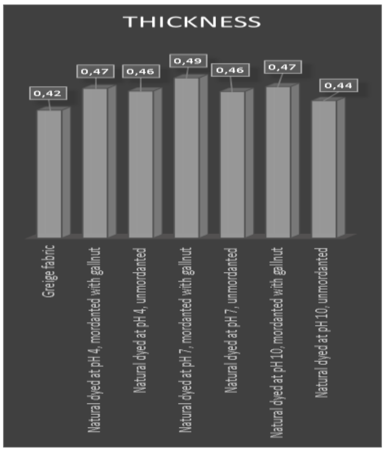

Figure 9: Thickness values of dyed soybean fabrics at various pH values

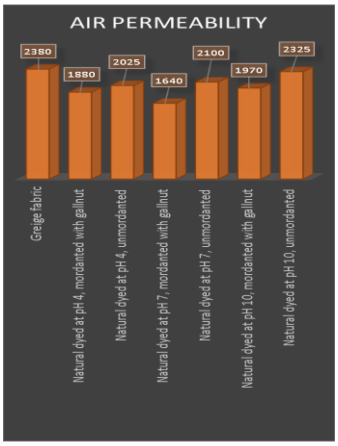

Figure 10: Airpermeability values of dyed soybean fabrics at various pH values

The highest thickness value (0,49 mm) and the lowest air permeability value (1640 l/m^2.sn) observed in mordanted natural dyeing at pH 7. So from color properties and physical properties of dyed soybean fiber fabrics, dyeing at pH 4 seems to be an optimum dyeing pH for horse chestnut natural dyeing of soybean. However before finalizing this comment, color fastness values are needed to be disclosed.

Fastness properties

Color fastness properties of soybean fabrics dyed with horse chestnut are shown on Table 3 (wash fastness, dry and wet rub fastness), Table 4 (alkaline perspiration fastness), Table 5 (acidic perspiration fastness) and Table 6 (water fastness).

Table 3: Wash and rub fastness values of dyed soybean samples

Dyed Samples	***Washing Fastness ISO 105:C06 A2S***							***Rub Fastness ISO 105: X12***	
	K/S	***AC***	***CO***	***N6.6***	***PES***	***PC***	***WO***	***Dry***	***Wet***
Natural dyed at pH 4, mordanted with gallnut	7,6	5	4/5	5	5	5	4/5	5	4/5
Natural dyed at pH 4, unmordanted	3,4	5	5	5	5	5	5	5	4/5
Natural dyed at pH 7, mordanted with gallnut	6,1	5	4/5	5	5	5	5	5	4/5
Natural dyed at pH 7, unmordanted	2,9	5	5	5	5	5	5	5	4/5
Natural dyed at pH 10, mordanted with gallnut	2,6	5	5	5	5	5	5	5	4/5
Natural dyed at pH 10, unmordanted	1,7	5	5	5	5	5	5	5	4/5
****4/5 indicates 4,75 gray scale rating***									

As seen on Table 3, washing fastness values of all dyed samples were between 4/5 and 5 gray scale rating. 4/5 washing fastness values were observed on natural dyed fabrics at pH 4 and 7 via gallnut mordant accompany. This could be explained due to their higher color strength value leading to higher dye content in the fiber available to stain the adjacent multifiber fabric. All rub fastness values were in the range of 4/5-5 gray scale levels.And, wet rub fastness values were slightly lower than those of dry rub fastness. All dyed soybean samples exhibited good to excellent wash and rub fastness levels leading commercially accepted fastness levels

Table 4: Alkaline perspiration fastness values of dyed soybean samples

Dyed Samples	Alkaline Perspiration Fastness ISO 105: E04						
	K/S	AC	CO	N6.6	PES	PC	WO
Natural dyed at pH 4, mordanted with gallnut	7,6	4	4	4	4/5	4/5	4
Natural dyed at pH 4, unmordanted	3,4	5	5	5	5	5	4/5
Natural dyed at pH 7, mordanted with gallnut	6,1	4/5	4/5	4/5	4/5	4/5	4/5
Natural dyed at pH 7, unmordanted	2,9	5	5	5	5	5	5
Natural dyed at pH 10, mordanted with gallnut	2,6	5	5	5	5	5	5
Natural dyed at pH 10, unmordanted	1,7	5	5	5	5	5	5
*4/5 indicates 4,75 gray scale rating							

All alkaline perspiration fastness values ranged between 4 and 5. The lowest alkaline perspiration values were observed on natural dyeing at pH 4 via mordant. As a result of high color strength values, more reachable horse chestnut dyes were located on fiber surface leading to higher staining levels. Although the fastness values of soybean fabrics dyed at pH 4 and 7 with mordant usage were slightly lower than other dyed fabrics, it is important to mention that even these slightly lower results are still good and commercially acceptable which is equal to or more than gray scale rating of 4.

Table 5: Acidic perspiration fastness values of dyed soybean samples

Dyed Samples	Acidic Perspiration Fastness ISO 105: E04						
	K/S	AC	CO	N6.6	PES	PC	WO
Natural dyed at pH 4, mordanted with gallnut	7,6	4/5	4/5	4/5	5	5	4/5
Natural dyed at pH 4, unmordanted	3,4	5	5	5	5	5	5
Natural dyed at pH 7, mordanted with gallnut	6,1	4/5	4/5	4/5	5	5	4/5
Natural dyed at pH 7, unmordanted	2,9	5	5	5	5	5	5
Natural dyed at pH 10, mordanted with gallnut	2,6	5	5	5	5	5	5
Natural dyed at pH 10, unmordanted	1,7	5	5	5	5	5	5
*4/5 indicates 4,75 gray scale rating							

Table 6: Water fastness values of dyed soybean samples

Dyed Samples	Water Fastness ISO 105: E01						
	K/S	AC	CO	N6.6	PES	PC	WO
Natural dyed at pH 4, mordanted with gallnut	7,6	4/5	4/5	4/5	4/5	4/5	4/5
Natural dyed at pH 4, unmordanted	3,4	5	5	5	5	5	5
Natural dyed at pH 7, mordanted with gallnut	6,1	5	4/5	5	5	5	4/5
Natural dyed at pH 7, unmordanted	2,9	5	5	5	5	5	5
Natural dyed at pH 10, mordanted with gallnut	2,6	5	5	5	5	5	5
Natural dyed at pH 10, unmordanted	1,7	5	5	5	5	5	5
*4/5 indicates 4,75 gray scale rating							

As seen above (Tables 5 and 6), acidic perspiration fastness and water fastness values of dyed samples were in the range of 4/5-5 gray scale levels and they are all commercially acceptable. So overall, dyed soybean fiber fabrics exhibited quite good, high and commercially acceptable color fastness (wash, rub, perspiration and water fastness) levels for each dyeing pH regardless of mordant usage. So from the color properties and physical properties of dyed soybean fiber fabrics, dyeing at pH 4 can be selected as an optimum dyeing pH for horse chestnut shell natural dyeing of soybean fiber fabric.

CONCLUSION

In this study, renewable, sustainable and ecological soybean fiber fabrics were dyed with renewable, sustainable and natural horse chestnut powder at various pH values in the presence of again renewable, sustainable and natural gallnut mordant. Dyed soybean fabric samples exhibited dark beige, greyish and brownish color shades. When gallnut mordant was used for dyeing at pH 4 to 7, deeper and stronger color shades and color strength values were obtained. Additionally, all mordanted samples exhibited higher color strength (*K/S*) values than their un-mordanted counterparts. The highest color strength value (K/S value of 7,1) was obtained with dyeing soybean fibers at pH 4 in the presence of gallnut mordant. The stiffness, air permeability and thickness values of dyed fabrics were also examined. Dyeing at boil resulted in slight increase on the thickness of soybean fiber fabric due to shrinkage at boil leading to slightly stiffer handle and less-air-permeable fabric structure. Dyeing with horse chestnut powder at each dyeing pH studied (pH 4, 7 and 10) led to good to excellent washing, rub, perspiration and water fastness values. Overall, from the color properties and physical properties of dyed soybean fiber fabrics, dyeing at pH 4 can be selected as an optimum dyeing pH for horse chestnut shell natural dyeing of soybean fiber fabric.

REFERENCES

Wiki1, https://en.wikipedia.org/wiki/Aesculus_hippocastanum. 07.04.2016
Sigmaaldrich, http://www.sigmaaldrich.com/lifescience/nutritionresearch/learningcenter/plantprofiler/aesculushippocastanum.html, 07.04.2016
Bellini and Nin, E. Bellini & S. Nin (2005) Horse Chestnut: Cultivation for Ornamental Purposes and Non-Food Crop Production, Journal of Herbs, Spices & Medicinal Plants, 11:1-2, 93-120,DOI:10.1300/J044v11n01_04
Onal, Onal A., (1995), At kestanesinden boyarmadde ekstraksiyonu ve kürk boyama, Erciyes Üniv. Fen Bil. Dergisi, 11, 1-2, 73-77
Wiki 2, https://en.wikipedia.org/wiki/File:Horse-chestnut_800.jpg, 08.04.2016
Wiki 3, https://en.wikipedia.org/wiki/File:Aesculus_hippocastanum-1.jpg, 08.04.2016
Wiki 4, https://en.wikipedia.org/wiki/File:Ka%C5%A1tan_1.jpg, 08.04.2016
Wiki 5, https://en.wikipedia.org/wiki/File:2010.05.09_Horse_chestnut_blossom,_Kyiv,_Ukraine_001c.jpg, 08.04.2016
Wiki 6, https://commons.wikimedia.org/wiki/File:Beta-Aescin.svg, 08.04.2016
Cravatto et. al., Cravotto G[1], Beltramo L, Sapino S, Binello A, Carlotti ME, (2011), A new cyclodextrin-grafted viscose loaded with aescin formulations for a cosmeto-textile approach to chronic venous insufficiency, J Mater Sci Mater Med. 2011 Oct;22(10):2387-95. doi: 10.1007/s10856-011-4399-z.
Ramos and Braga, Ramos A. And Braga S. S., (2015), NMR Studies On The Nanoencapsulation Of Aescin By The Native Β- And Γ-Cyclodextrins, Conference Paper · SEPTEMBER 2015 *With* 35 READS, Conference: Nanospectroscopy For Two-Dimensional Materials, At Technische Universität Chemnitz, Chemnitz, Germany
Ramos and Braga b, Ramos A. And Braga S. S., (2015), Inclusion of aescin into beta and gamma cyclodextrins, Conference: HINT Training School - “Bottom-up Approaches of Hybrid Materials: Preparation and Design”, At Ljubljana
Arlı et. al., Arlı M., Kayabaşı N., and Ilgaz F., (1993), El Dokuması Halıcılıkta Bitkisel Boya Kullanımının Önemi, Tekstil ve Mühendis, Yıl 7, Sayı 38
Yildirim et. al, F.Filiz Yıldırım, O.Ozan Avinç ve Arzu Yavaş, (2012), Eco-Friendly plant based regenerated protein fiber: soybean, Poster Presentation”, Strutex 19 th International Conference: Structure and Structural mechanics of textiles, TU Liberec, Czech Republic, 2012
Samanta and Konar, Samanta A.S. and Konar A., (2011), “Dyeing of Textiles with Natural Dyes” in *Naturla dyes,* Kumbasar P.A., Intech, 201

MECHANICAL PROPERTIES OF 1X1 RIB KNITTED FABRICS

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ABSTRACT

The geometrical dimensions of 1 X 1 rib knitted fabric made from the yarns with different raw material and different length of the loop and their effect on the mechanical and tensile properties of these fabrics are discussed. Tests show that the change of cam setting, the raw material and the state of the relaxation (dry and finished relaxation) of the knitted fabrics caused changes in the structural characteristics, which are directly upon their mechanical properties. Tensile properties of the knitted fabrics are significantly influenced by the mode of the deformation, actually the load, the explore time and the stretching direction. The most significant influence on the total and residual elongation on the rib knitted fabrics has had the loop length. The influence of the raw materials comes to expression especially upon the elasticity and slowly recoverable elongation as well their share related breaking elongation.

Key words: rib knitted fabric, mechanical properties, statistical methods, structural characteristics, the kinetic of the relaxation on the deformation for knitted fabrics

INTRODUCTION

The knitted fabric is often used ready made clothing industry. During the exploitation knitted fabric are subjected to load. The forces that act on the fabric during exploitation surely of smaller magnitude than compared to the forces that causes fabric breakage. However these forces, with act periodically, damage the knitted fabric and garment construction.
Hence, the evaluation of fabric behaviour in the load - unload -rest cycles is significant for evaluation of fabric stability during exploitation.
The characteristics of fabrics depend on many factors, of which the most important are [1-5]:

- The characteristic of the raw materials;
- The quality characteristics of the yarn
- The geometrical structure of the knitted fabrics
- The parameters of the machine;
- The parameters of the finishing process.

The coordination of the mentioned factors and keeping them in proper relation, makes the product of the knitted fabrics with good quality.

In this work the geometrical dimensions of 1 X 1 rib knitted fabric made from various yarn raw material, different length of the loop and different state of relaxation (dry and finished) and their effect on the physical and mechanical properties of these fabric are discussed.

METHODOLOGY

The rib knitted fabric samples were prepared from yarn of 25 tex X 2 with approximately same twist of 641 m^{-1} + 7 % and different raw material: 100 % cotton, 46 % cotton / 54 % PES and 100 % PES on a circular one bad knitting hosiery machine E - 14 gauge (diameter of 95,2 cm, needles 168 and systems 2). By adjusting the cam setting, as much as possible on same gauge of machine, five different length of the loop were taken.
Samples were prepared for studying the dimensional and mechanical properties of the knitted fabrics in different states of relaxation: dry and finished. Dry relaxation: fabric samples were placed free from constrains, on a flat surface and allowed to condition for a least 24 hours in a standard atmosphere. Finished relaxation: Knitted samples were bleached and softened according to the standard methods in relate to the raw materials.

Methods of testing

Fabric dimensions were measured in term of courses and wales per centimetre and stitch density. Physical and mechanical properties like weight unit area, thickness, loop length, loop shape factor, breaking strength and elongation were tested at various state of relaxation in standard atmosphere conditions of temperature and relative humidity by standard test methods.
Tensile properties of these fabrics such as their ability to recover their original size and shape after the removal of the deforming stress, slowly recoverable and residual elongation at constant stretching load with 5 % of the breaking load were also tested.

The effect of the structure of the knitted fabrics and the type of the raw materials was analysed by long-term mode of the deformation (expose time - 3 hours and time of the relaxation - 24 hours).
The statistic methods, such as correlation and regression analysis have been used to determine depends on the properties of the knitted fabrics and their length of loop. Using analysis of variance [6] the importance of the effect of the different factors on the properties of the knitted fabrics was relieved.

RESULTS AND DISCUSION

Structural parameters of the knitted fabrics

Structural parameters of the knitted fabrics have important effect on the psychical and mechanical properties of the knitted fabrics.

Increasing of the length of the loop, area density, tightness factor, thickness and weight unit area reduced. Also, the loop shape factor, the linear, so as area modulus and the bulking of dry relaxed knitted fabrics increased. After the finishing the loop length is reduced and the change is depend on the type of the raw material (figure 1).

Structural parameters of the rib knitted fabrics significantly influenced by the type of the raw materials and cam setting, but theirs changes were more expressed by changing of the cam setting especially upon dry relaxed fabrics. The influence of the raw materials comes to expression especially after finishing.

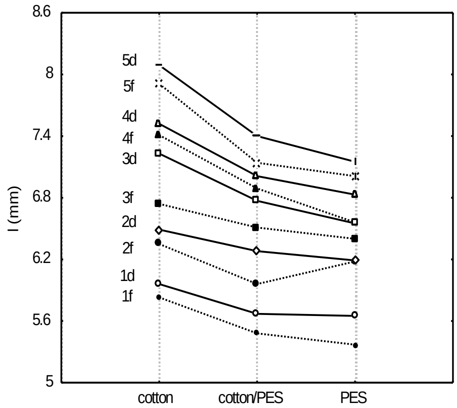

Figure 1: Variance of the length of the loop with variation of cam setting and type of the raw material (1,2,3,4,5 - cam setting; f-finished, d-dry relaxed)

Mechanical properties of the knitted fabrics

In purpose to determine the effect of the change of structural parameters of the tested knitted fabrics on mechanical properties the finished knitted fabrics were stretched in direction of courses and wales until breaking. Using the results of the breaking strength, breaking elongation and "strength - extension" curves, other mechanical characteristic important for the exploitation of the knitted fabrics were determined.

Increasing the length of the loop breaking strength in both directions decreased. All fabrics have shown higher breaking strength and lower elongation when they are stretched in direction of wales than in the course direction. The greatest decrease in breaking strength in direction of courses was noticed in cotton fabrics (42,4 %), then in cotton / PES (31,8 %) and the smallest in PES fabrics (20,1 %) (table 1).

Table 1: Breaking strength Fa (N) and elongation ε (%) for finished knitted fabric made from various raw material

Cam setting		**1**	**2**	**3**	**4**	**5**	$r_{l,x}^*$
Knitted fabric	**Direction of wales**						
Cotton	*Fa(N)*	117,90	103,70	86,55	81,93	67,90	**-0,97**
	Cv(%)	*4,19*	*11,6*	*12,7*	*10,2*	*9,8*	
	ε(%)	447,5	480,0	475,5	454,7	483,5	
	Cv(%)	*10,3*	*5,4*	*5,2*	*8,5*	*9,9*	
PES/cotton	*Fa(N*	145,27	141,33	123,00	99,00	101,50	**-0,96**
	Cv(%)	*2,53*	*2,55*	*6,46*	*11,20*	*9,4*	
	ε(%)	456,0	485,3	504,5	462,7	507,3	
	Cv(%)	*10,1*	*11,6*	*9,1*	*10,8*	*6,2*	
PES	*Fa(N*	187,0	182,64	163,05	140,40	149,35	**-0,82**
	Cv(%)	*10,4*	*7,8*	*6,26*	*10,2*	*7,63*	
	ε(%)	536,0	622,8	571.0	581,5	599,0	
	Cv(%)	*4,6*	*5,2*	*5,6*	*4,1*	*5,5*	
	Direction of course						
Cotton	*Fa(N*	294,0	264,0	202,0	220,67	194,0	**-0,87**
	Cv(%)	*8,84*	*10,15*	*6,93*	*7,13*	*10,23*	
	ε(%)	107,0	128,0	138,0	122,0	123,2	
	Cv(%)	*11,9*	*10,9*	*7,25*	*12,7*	*6,4*	

PES/cotton	*Fa(N* Cv(%) ε(%) Cv(%)	397,0 *12,7* 121,5 *5,4*	355,3 *14,1* 116,7 *9,3*	382,8 *3,0* 126,0 *4,4*	320,0 *8,2* 102,7 *3,8*	353,8 *5,3* 120,0 *5,4*	**-0,66**
PES	*Fa(N* Cv(%) ε(%) Cv(%)	539,1 *4,64* 157,5 *5,2*	527,5 *6,13* 160,8 *4,9*	500,8 *11,7* 140,8 *6,0*	431,7 *10,5* 130,8 *9,5*	459,6 *11,2* 127,5 *8,4*	**-0,78**

*$r_{l,x}$ –correlation coefficient of length of the loop (l) and the breaking strength; Cv (%) –coefficient of variance

The extension of the fabrics is expressed through "z" - extension, determined as extension in field from origin of the "strength-extension" graph to point where the curve deflects from the apices, ε_o (%) like as the extension of the 1 N/mm^2 tensile and ε_1 (%) - the extension of the 5 N/mm^2 tensile.

Tested fabrics shown a high value a "z" extension in direction of wales (from 14,8 to 42,0 % of the breaking elongation) and it was smaller in direction of courses smaller (from 16 to 36 % of the breaking elongation) and its share was from 11,9 to 30 % of the breaking elongation.

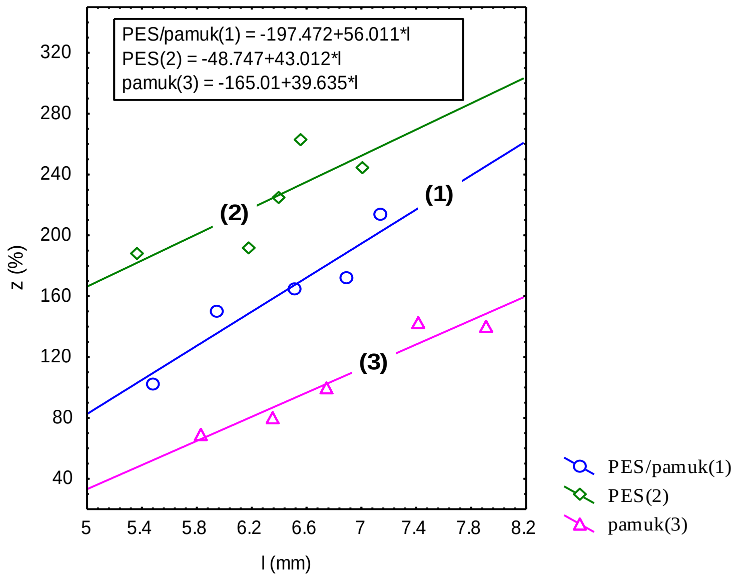

Figure 2. Relationship between z-extension and length of the loop l (mm) of finished knitted fabrics in direction of wales

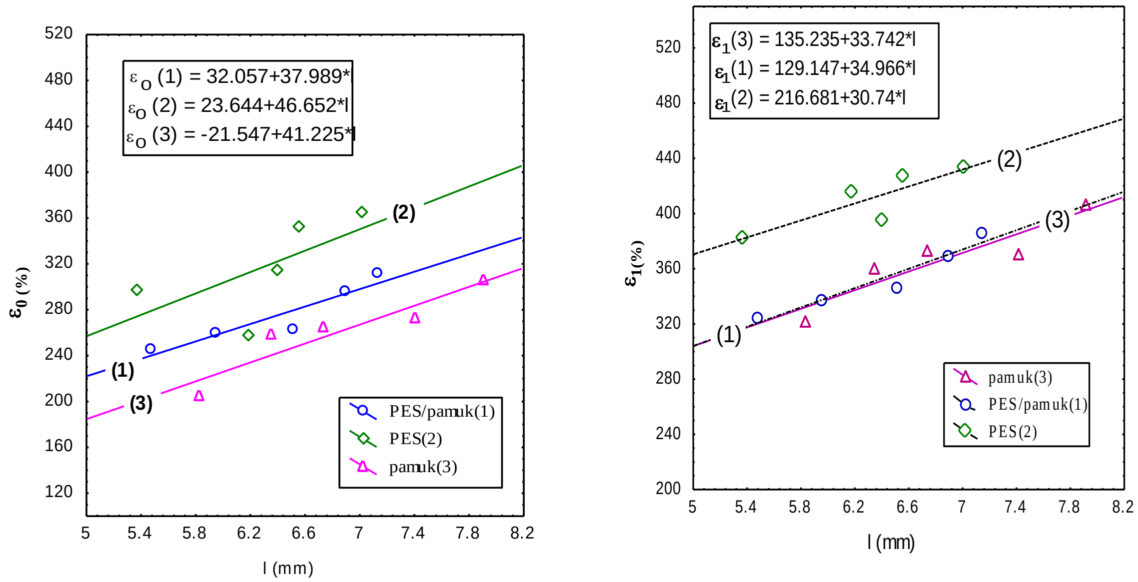

Figure 3: Relationship between ε_o and ε_1-extension and length of the loop l (mm) of finished knitted fabrics in direction of wales

The extension, as well as share in both direction increased almost linearly (coefficient of linear correlation of 0,96-0,98) against the length of the loop.
The structure of the knitted fabric and type of the raw materials has effect on the tensile properties of the knitted fabrics. Total elongation, ε_v (%), elasticity ε_e (%), slowly recoverable elongation ε_{ze} (%) and residual elongation ε_o (%) using the curves of the kinetics of the relaxation on the deformation for knitted fabrics during the loading (stretching) and unloading were determined.

Tables 2, 3 and 4 gives the linear regression equations and correlation coefficients for relationship between total elongation, as well as share of the elasticity upon the total elongation and residual elongation and length of the loop for the rib knitted fabrics which had been produced from yarns of different fibre types and had been relaxed on different way (dry and finished) (figure 4-7).
Table 2: Linear regression equations and correlation coefficients for relationship between total elongation, ε_v (%) and the length of the loop of the tested knitted fabrics in dry and finished state of relaxation

The raw material	**Dry relaxation state**	**Finished relaxation state**
Cotton	ε_v= - 704,15 +162,14*l **(r = 0,97)**	ε_v = -52,34 + 51,59*l **(r = 0,99)**
cotton / PES	ε_v = 22,95 + 52,68*l **(r = 0,98)**	ε_v = 131,54 +39,82*l **(r= 0,92)**
PES	ε_v = 81,04 + 47,75*l **(r = 0,90)**	ε_v = 86,99 +52,59*l **(r = 0,98)**

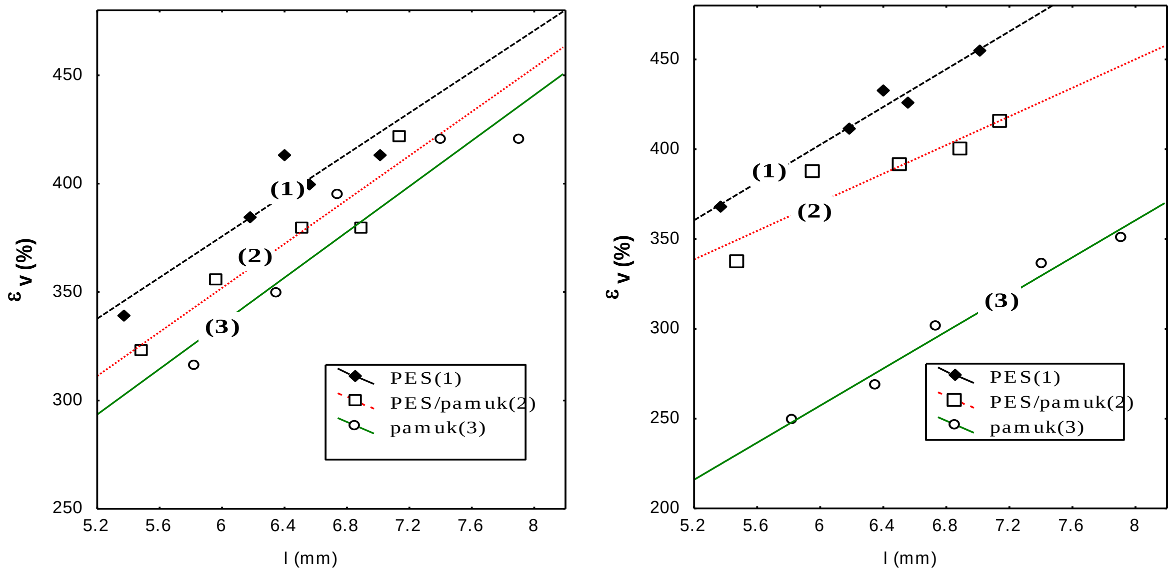

Figure 4: Relationship between total elongation, ε_v (%) and the length of the loop of the tested knitted fabrics in dry and finished state of relaxation

Table 3: *Linear regression equations and correlation coefficients for relationship between the share of the elasticity upon the total elongation $\Delta\varepsilon_e$ (%) and the length of the loop of the tested knitted fabrics in dry and finished state of relaxation*

The raw material	Dry relaxation state	Finished relaxation state
Cotton	$\Delta\varepsilon_e$ =73,47-3,99*l **(r = - 0,88)**	$\Delta\varepsilon_e$ = 42,13-2,76*l **(r =-0,80)**
cotton / PES	$\Delta\varepsilon_e$ = 69,59-6,03*l **(r = - 0,89)**	$\Delta\varepsilon_e$ = 48,82 - 2,58*l **(r =- 0,77)**
PES	$\Delta\varepsilon_e$ = 91,83- 7,46*l **(r = - 0,78)**	$\Delta\varepsilon_e$ = 101,05 - 8,76*l **(r =- 0,89)**

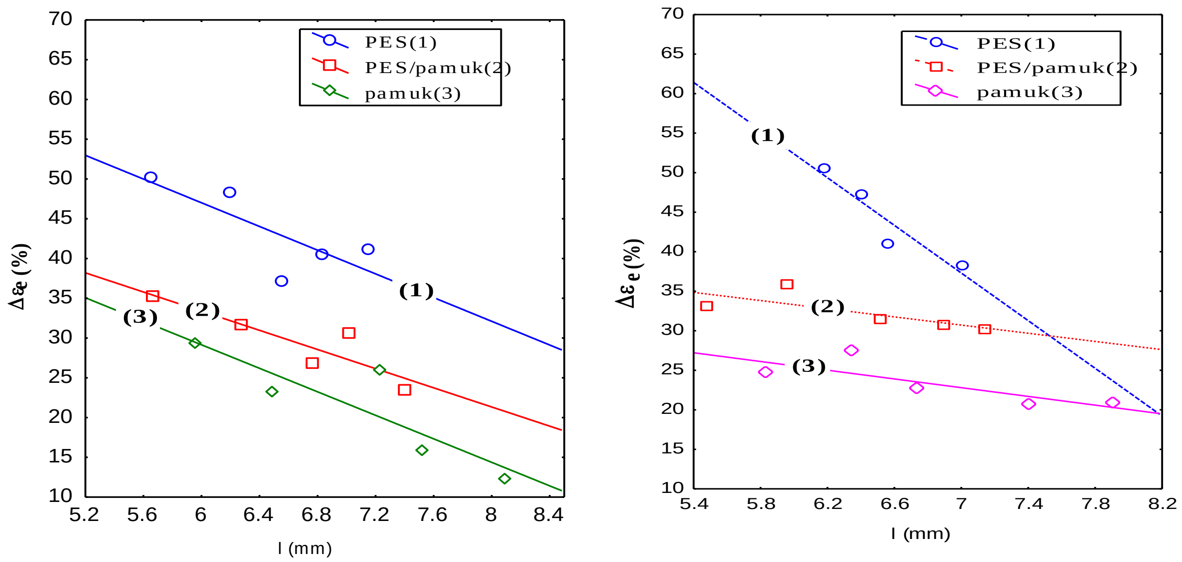

Figure 5: Relationship between the share of the elasticity upon the total elongation $\Delta\varepsilon_e$ (%) and the length of the loop of the tested knitted fabrics in dry and finished state of relaxation

Table 4: *Linear regression equations and correlation coefficients for relationship between residual elongation, ε_o (%), as well as their share upon the total elongation and the length of the loop of the tested knitted fabrics in dry and finished state of relaxation*

The raw material	**Dry relaxation state**	**Finished relaxation state**
	Residual elongation	
cotton	ε_o = - 327,62 + 79,95*l (**r = 0,98**)	ε_o= - 103,78 + 42,04*l (**r = 0,97**)
cotton /PES	ε_o = - 240,33 + 68,17*l (**r = 0,95**)	ε_o = - 49,08 +34,0*l (**r= 0,99**)
PES	ε_o = - 240,64 + 65,29*l (**r = 0,95**)	ε_o = - 228,60 +64,67*l (**r = 0,96**)
	The share of the residual elongation	
cotton	$\Delta\varepsilon_o$ = - 30,19 + 12,96*l (**r = 0,96**)	$\Delta\varepsilon_o$ = 36,05 + 3,61*l (**r = 0,84**)
cotton /PES	$\Delta\varepsilon_o$ = - 12,78 + 10,42*l (**r = 0,93**)	$\Delta\varepsilon_o$ = 15,58 + 4,36*l (**r = 0,97**)
PES	$\Delta\varepsilon_o$ = - 15,23 +9,50*l (**r = 0,78**)	$\Delta\varepsilon_o$ = - 22,74 + 10,34*l (**r = 0,92**)

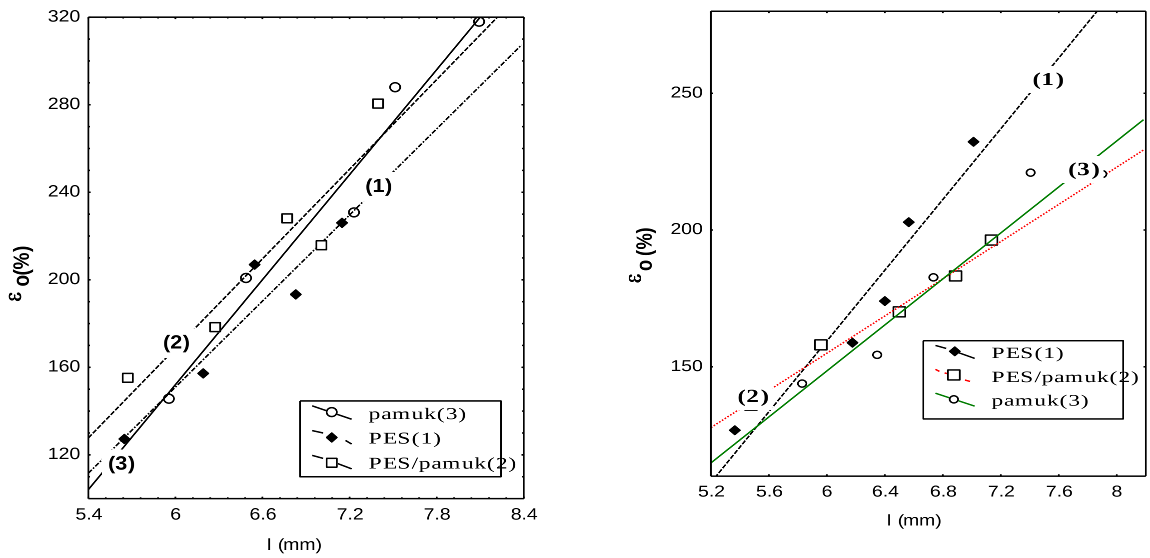

Figure 6: Relation between residual elongation, ε_o (%) and the length of the loop of the tested knitted fabrics in dry and finished state of relaxatio

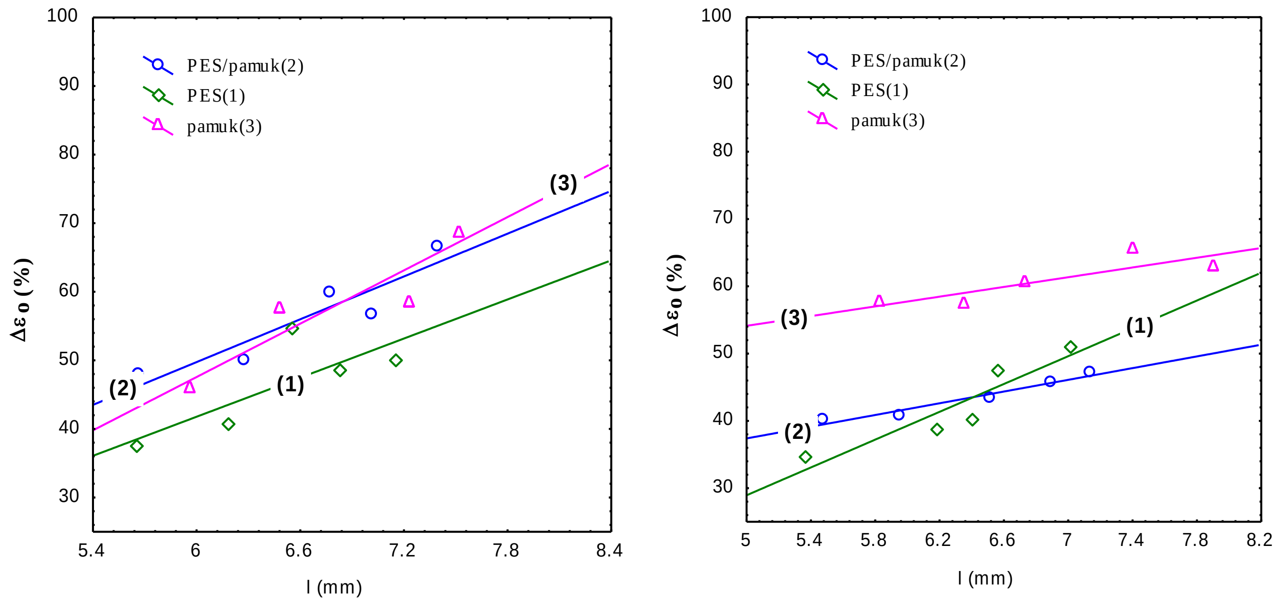

Figure 7: Relation between the share of the residual elongation upon the total elongation, $\Delta\varepsilon_o$ (%) and the length of the loop of the tested knitted fabrics in dry and finished state of relaxation

The importance of the length of the loop and raw materials with regard of fore mentioned tensile properties of the finished knitted fabrics were confirmed by analysis of variance (table 5). The table 5 shows F-values obtained using two-way analysis of variance.

Table 5: *Analysis of variance (F- statistics)*

Source of variation	ε_v (%)	ε_e (%)	ε_{ze} (%)	ε_o(%)	$\Delta\varepsilon_e$ (%)	$\Delta\varepsilon_{ze}$ (%)	$\Delta\varepsilon_o$ (%)
Length of the loop	40,93**	2,70	3,21*	32,82**	10,52**	7,09**	64,61**
Raw materials	29,17**	215,60**	97,10**	1,01	113,83**	49,63**	20,54**

* significance level of 0,05; ** significance level of 0,01.

Statistical analysis demonstrated that tensile properties of the rib knitted fabrics significantly influenced by the structural characteristic and the raw materials. The most significant influence on the total and residual elongation of the rib knitted fabrics has had the loop length. The influence of the raw materials comes to expression especially upon the elasticity and slowly recoverable elongation as well as their share.

CONCLUSION

The structural properties, as well as, mechanical properties of 1 X 1 rib knitted fabrics significantly influenced by the type of the raw materials, the change on cam setting and the state of the relaxation of the knitted fabrics.

Increasing of the length of the loop the total elongation, the residual elongation and the share of the slowly recoverable process in the knitted fabrics increased with statistical significant linear correlation in both of state of relaxation.

REFERENCES

[1] Mikucioniene D., Ciukas R., Mickeviciene A. (2010) The influence of knitting structure on Mechanical Properties of Weft Knitted Fabrics, Material Science Vol.16, No.3,221-225

[2] R.Oinuma (1990) Factors Affecting Dimensional Properties of Cotton 1 x 1 Rib Knitted Fabrics, Journal of the Textile Machinery Society of Japan, Vol.39.No.2, 57-63

[3] Azim,a.m, Morshed M., Sarker Y., et al (2014) Effect of fabric structure on rib fabric properties, European Scientific Journal, Vol.10, No.36, 211-220

[4] Ichetaonye Si., Ichetaonye Dn., Adeakin Oas, Tenebe Og., Yibowei Me, et all (2014) Effect of Stitch Length on the Physical Properties of Borh Plain and 1 x 1 Rib Knitted Fabrics, J.Textile Sci Eng 4:177.doi:10.4172/2165-8064.1000177

[5] Choi,M., Ashdown, S. (2000) Effect of Changes in Knit Structure and Density on the Mechanical and Hand Properties of Weft Knitted Fabrics for Outwear, Textile Res.J., 70 (12), p.1033-1045

[6]Weiss A.N., Introductory Statistics, Arizona State University Addison –Wesley, 2002

THE USE OF ECO-FRIENDLY RED BEET (*Beta Vulgaris* L.) EXRACT FOR SOYBEAN FIBRE NATURAL DYEING

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ABSTRACT

This study presents the natural textile dyeing of soybean fiber fabrics with red beet (*Beta vulgaris* L.) extract. Soybean fibre fabrics were dyed with exhaustion method and using red beet extract at various acidic and alkaline pH values (pH 3, 5, 7, 9 and 11). Gallnut natural mordant was applied with simultaneous mordanting method during natural dyeing. The color and color fastness properties, such as rub, perspiration and wash fastness values of dyed samples were examined. Beetroot dye led to beige and brownish colors on soybean fibres under different pH values. The highest color strength value was observed on soybean fabric dyed at pH 9 in company with gallnut natural mordant. Overall, the dyed soybean samples exhibited quite good wash, rub and perspiration fastness performance.

Keywords: Beetroot, Beta Vulgaris L., natural textile dyeing, soybean

INTRODUCTION

Natural dyes has been used as a food, leather, wood, natural fiber colorants from the beginning of human history (Kumbasar, 2011; Boo et al., 2012). Before 19th century, natural dyes were the major colorants in the textile applications (Betchold et al., 2006). However, in the later 19th century the synthetic dyes have been developed and synthesized immensely (Boo et al., 2012). Synthetic dyes exhibited moderate to excellent color fastness in comparison with natural dyes. Also, they are cheaper than natural dyes (Kumbasar, 2011; Boo et al., 2012). Nowadays, there are more than 10,000 synthetic dyes which are being used in textile industry. The usage of the synthetic dyes often possesses pollution problems and moreover some dyes are mutagenic, toxic and carcinogenic due to their metal content and other chemical presence in their structure (Aksu and Isoglu, 2006).

Consequently, production and usage of natural dyes are becoming even more important due to the increasing expectations for better life quality and eco-friendly way of living (Boo et al., 2012). In textile dyeing, natural dye extracts can be used for coloration. The red beet extract (or juice) is the one of the natural dyes that used in textile dyeing. Natural dyes extracted from red beet (*Beta Vulgaris L.*) are used in food, textile and leather as a colorant (Betchold et al., 2006; Vemurugan et al., 2010; Henry, 1996; Siyalkumar et al., 2009; Crinela et al., 2007; Atodiresei, 2011; Chen and Li, 2006; Frick, 2003; Yildirim et. al, 2013; Yildirim et. al, 2014; Jayalakshmi and Jijvana, 2011). The beetroot (*Beta Vulgaris L.),* also known as Red beet, is widely known as a garden beet, red beet, or just beet, and it is the most commonly encountered variety which can be found in North America, Central America, and Great Britain (Wiki, 2013) (See also Figure 1). Red beet (*Beta* V*ulgaris* L.) has betanin and isobetanin. Betalains are very sensitive to low pH, elevated temperatures, or high water activity (*3-7*). Therefore, the thermal instability of the betalain limits their usage (Wybraniec, 2005).

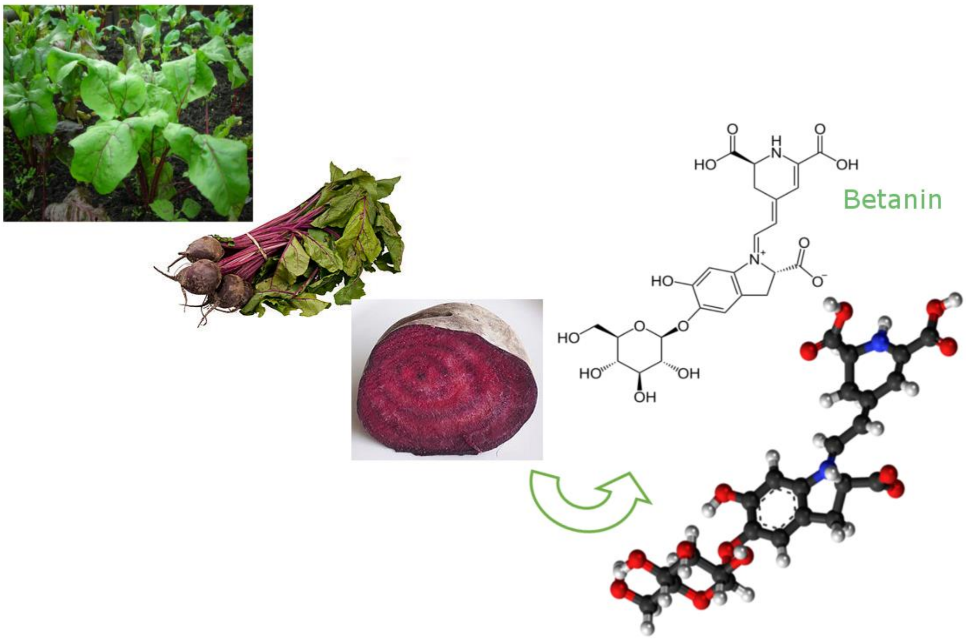


Figure 1: Red Beet (Beta Vulgaris L.) (Wiki 1, 2013; Wiki 2, 2016; Wiki 3, 2016; Wiki 4, 2016)

In this study, soybean fiber fabric samples were dyed with an eco-friendly and renewable red beet extract via simultaneous mordanting and also without the usage of mordant as a control. The colorimetric and fastness properties of dyed samples are analyzed and compared.

EXPERIMENTAL

Materials

In this study, 100% soybean fiber yarn knitted fabrics were dyed with red beet juice in company with and without natural gallnut mordant. The juice of red cabbage wastes were extracted using Arzum AR 164 Mela Plus Whole Fruit Juicer. Natural dyeing of soybean fabrics were carried out in Atac Lab-Dye HT machine at a liquor ratio of 40:1 at various pH values (pH 3, 5, 7, 9, 11). Simultaneous mordanting was carried out with 20% gallnut concentration during the dyeing process.

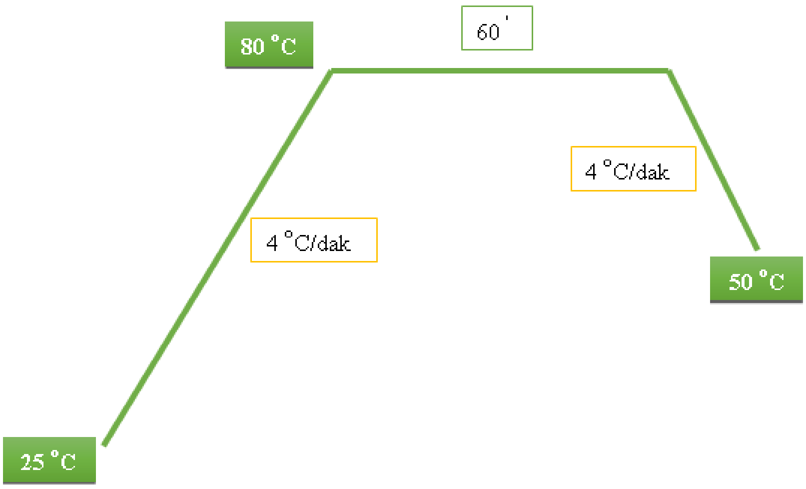


Figure 2: The natural dyeing proses with red beet extract

As seen on Figure 2, the dyeing process was started at room temperature and the dyeing temperature reached to 80 ^oC (*by increasing the temperature for 4 ^oC per minute*). The dyeing process at dyeing temperature was performed for 60 minutes and then the baths were cooled down to 50 ^oC. After dyeing, the samples were rinsed in tap water for 5 minutes and air-dried. These air-dried samples were used for color measurements and fastness tests.

Colorimetric and Fastness Measurements

The CIE Lab *L***, *a***, *b***, *C***, and h^o values were measured with using a DataColor SpectraFlash 600 (Datacolor International, Lawrenceville, NJ, USA), spectrophotometer under illuminant D65, using 10^o Standard observer for each dyed samples. The colour strength value K/S is calculated by using the Kubelka-Munk equation. The equation of *K/S, Eq. (1)* is given at below:

$$K/S = (1-R)^2/2R \qquad (1)$$

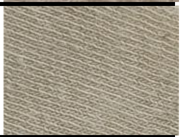
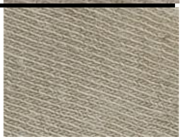
Both dry and wet rub fastness testing were performed with the ISO 105: X12 protocol. Wash-fastness test was carried out in a M228 Rotawash machine (SDL ATLAS, UK) at 40^{o}C according to ISO 105:C06 A2S test. Perspiration fastness test were carried out in accordance with ISO 105: E04 standard. Overall color fastness properties were determined using ISO grey scales.

RESULTS AND DISCUSSION

The effects of dyeing pH and mordant presence on Colorimetric Properties

Color strength values, CIELAB colorimetric values and the visual shades of naturally dyed soybean fibre fabrics are shown on Table 1.

Table 1: Color strength, CIELAB color values of dyed samples

Dyed fabric samples	*L**	*a**	*b**	*C**	*h^o*	*K/S*	Appearance
Dyed at pH 3, mordanted with gallnut	71,27	4,83	17,2	17,89	74,3	1,5	
Dyed at pH 3, unmordanted	71,36	2,28	15	15,14	81,4	1,4	
Dyed at pH 5, mordanted with gallnut	69,82	2,7	15,4	15,6	80	1,6	
Dyed at pH 5, unmordanted	69,85	2,07	14,8	14,9	82	1,5	
Dyed at pH 7, mordanted with gallnut	65,63	2,35	15,1	15,28	81,2	2,3	
Dyed at pH 7, unmordanted	71,99	1,64	13,7	13,78	83,2	1,2	

Dyed at pH 9, mordanted with gallnut	64,38	2,5	14,1	14,32	79,9	2,3	
Dyed at pH 9, unmordanted	71,31	1,37	13	13,05	84	1,3	
Dyed at pH 11, mordanted with gallnut	60,98	3,27	12,3	12,73	75,1	2,4	
Dyed at pH 11, unmordanted	71,31	1,15	13,1	13,18	85	1,3	

Dyed samples displayed slightly different shades of beige and brown colors (Table 1, Figure 3). The highest color strength value (K/S 2.4) was observed on soybean fabric dyed with red beet extract and simultaneously mordanted with gallnut at pH 11. All mordanted samples exhibited higher color strength values than those of unmordanted samples. When soybean fibre fabrics were dyed with red beet at pH 3 and pH 5, dyed samples with or without mordant exhibited close and low color strength values. At these pH values, mordanted samples showed slightly higher color strength values than those of unmordanted samples. However, when the dyeing pH surpasses pH 5, the color strength values of mordanted samples increased right away in comparison to unmordanted samples.

The color strength values of unmordanted samples dyed at each dyeing pH were very close to each other. It seems that more effective interaction is actualized between gallnut, red beet and soybean fiber above pH 5 leading to slightly higher color strength due to higher dye-mordant-fiber attachment. In the recent study, it was reported that gallnut extracts exhibited different absorbance values at different pH values. At lower pH values, gallnut extract exhibits low absorbance values. Or in other way of saying that the gallnut exhibited higher absorbance values at higher pH values. Consequently, it was reported that gallnut showed sensitivity towards pH and the color of gallnut solution intensifies with increasing pH (Shahid *et. Al*, 2012). So these observed slightly different color strength values, after dyeing at different dyeing pHs, could be due to this stated gallnut behavior in increased pH values. The color strength values of all dyed soybean samples are given on Figure 2.

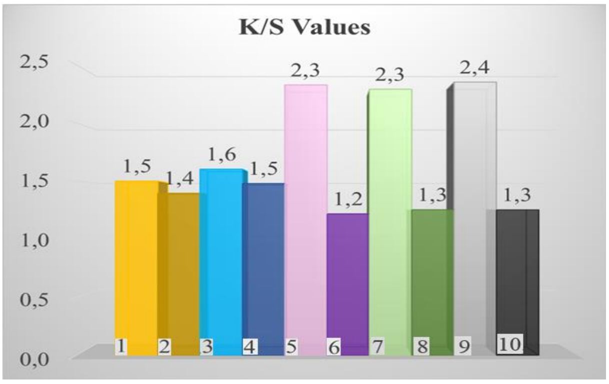
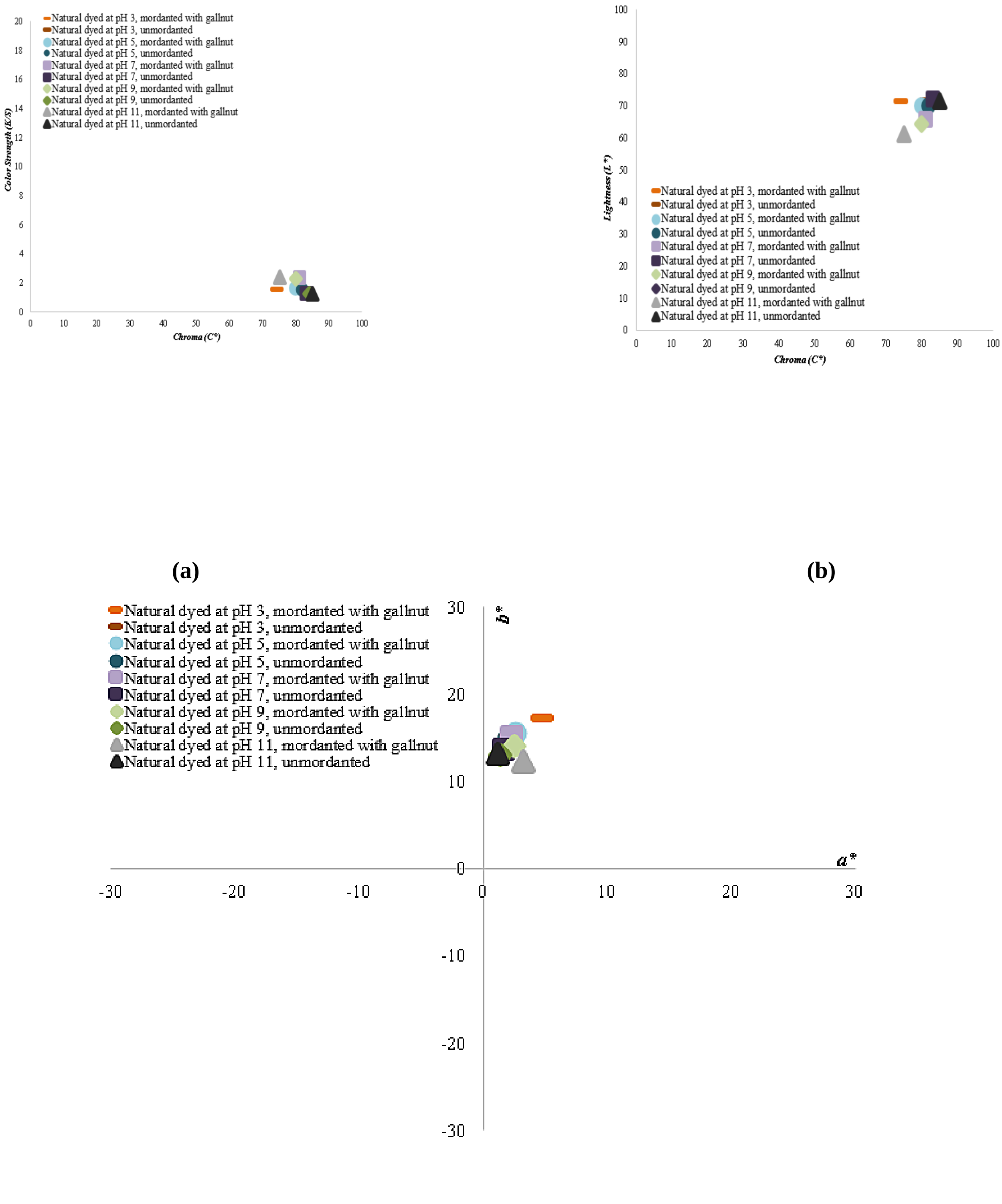


Figure 3:K/S values of red beet extract dyed soybean fabrics ((1), Dyed at pH 3, mordanted with gallnut; (2), Dyed at pH 3, unmordanted; (3), Dyed at pH 5, mordanted with gallnut; (4), Dyed at pH 5, unmordanted; (5), Dyed at pH 7, mordanted with gallnut; (6), Dyed at pH 7, unmordanted; (7), Dyed at pH 9, mordanted with gallnut; (8), Dyed at pH 9, unmordanted; (9), Dyed at pH 11, mordanted with gallnut; (10), Dyed at pH 11, unmordanted)

As can be seen on Figure 3, the color strength values of mordanted dyed samples were significantly higher, especially for higher dyeing pHs. Colorimetric properties of dyed fabrics are shown Figure 4.



(a) (b)

(c)

Figure 4: (a) color strength (K/S)-Chroma (C)plots, (b)lightness (L*)-Chroma (C*) plots, (c) redness (a*)-yellowness (b*) plots*

The usage of a gallnut mordant generally resulted in stronger appearance in color according to the lightness-chroma graphic. When all colorimetric properties were examined, it is possible to say that soybean fiber fabrics can be dyed with red beet extract via gallnut mordant existence at the range of pH 5 and pH 11.

The effects of dyeing pH and mordant presence on Color Fastness Properties

Color fastness properties of soyben fiber fabrics dyed with red beet are shown on Table 2.

Table 2: Wash and rub fastness values of dyed soybean samples

Samples	*Washing Fastness ISO 105:C06 A2S*							*Rub Fastness ISO 105: X12*	
	K/S	*AC*	*CO*	*N6.6*	*PES*	*PC*	*WO*	*Dry*	*Wet*
Natural dyed at pH 3, mordanted with gallnut	1,5	5	4/5	5	5	5	5	5	4/5
Natural dyed at pH 3, unmordanted	1,4	5	4/5	5	5	5	5	5	5
Natural dyed at pH 5, mordanted with gallnut	1,6	5	4/5	5	5	5	5	4/5	4/5
Natural dyed at pH 5, unmordanted	1,5	5	5	5	5	5	5	4/5	4/5
Natural dyed at pH 7, mordanted with gallnut	2,3	5	4/5	5	5	5	5	4/5	4/5
Natural dyed at pH 7, unmordanted	1,2	5	5	5	5	5	5	4/5	4/5
Natural dyed at pH 9, mordanted with gallnut	2,3	5	4/5	5	5	5	5	4/5	4/5
Natural dyed at pH 9, unmordanted	1,3	5	5	5	5	5	5	5	4/5
Natural dyed at pH 11, mordanted with gallnut	2,4	5	4/5	5	5	5	5	5	4/5
Natural dyed at pH 11, unmordanted	1,3	5	5	5	5	5	5	4/5	4/5

***4/5 indicates gray scale rating of 4,75**

As seen on Table 2, wash fastness values of dyed samples are either 4/5 (4.75) or 5 gray scale rating for all dyed samples. Cotton fiber parts of the adjacent multifiber fabric exhibited higher staining rates than those of other fiber parts of the adjacent multifiber fabric. All dry rub fastness values exhibited the range of 4/5 (4.75) to 5 gray scale ratings.

On the other hand, wet rub fastness values were slightly lower than dry rub fastness values and were measured to be between 4/5 and 5 gray scale ratings. Overall, wash and rub fastness values of dyed samples were evaluated as good to excellent and there is no clear trend about the effect dyeing pH on wash and rub fastness of dyed samples.

Table 3: Perspiration fastness properties of all dyed soybean samples

Samples	***K/S***	***WO***	***PC***	***PES***	***N6.6***	***CO***	***AC***
Perspiration fastness (*Perspiration Fastness ISO 105: E04)*							
Acidic Perspiration Fastness							
Natural dyed at pH 3, mordanted with gallnut	1,5	4/5	5	5	5	4/5	4/5
Natural dyed at pH 3, unmordanted	1,4	5	5	5	5	5	5
Natural dyed at pH 5, mordanted with gallnut	1,6	4/5	5	5	4/5	4/5	4/5
Natural dyed at pH 5, unmordanted	1,5	5	5	5	5	5	5
Natural dyed at pH 7, mordanted with gallnut	2,3	4/5	4/5	4/5	4/5	4/5	4/5
Natural dyed at pH 7, unmordanted	1,2	5	5	5	5	5	5
Natural dyed at pH 9, mordanted with gallnut	2,3	4/5	5	5	5	5	5
Natural dyed at pH 9, unmordanted	1,3	5	5	5	5	5	5
Natural dyed at pH 11, mordanted with gallnut	2,4	4/5	5	5	5	4/5	5
Natural dyed at pH 11, unmordanted	1,3	5	5	5	5	5	5
Alkaline Perspiration Fastness							
Natural dyed at pH 3, mordanted with gallnut	1,5	4/5	5	5	4/5	4/5	4/5
Natural dyed at pH 3, unmordanted	1,4	5	5	5	5	5	5
Natural dyed at pH 5, mordanted with gallnut	1,6	4/5	4/5	4/5	4/5	4/5	4/5
Natural dyed at pH 5, unmordanted	1,5	5	5	5	5	5	5
Natural dyed at pH 7, mordanted with gallnut	2,3	4/5	4/5	4/5	4/5	4/5	4/5
Natural dyed at pH 7, unmordanted	1,2	5	5	5	5	5	5
Natural dyed at pH 9, mordanted with gallnut	2,3	5	5	5	4/5	4/5	4/5
Natural dyed at pH 9, unmordanted	1,3	5	5	5	5	5	5
Natural dyed at pH 11, mordanted with gallnut	2,4	4/5	5	5	5	5	5
Natural dyed at pH 11, unmordanted	1,3	5	5	5	5	5	5
***4/5 indicates gray scale rating of 4,75**							

In general, good level of perspiration fastness values were observed on dyed samples. When dyeing pH exceed pH 7, the perspiration fastness values of dyed samples in the presence of mordant increased. When all colorimetric properties were examined, the soybean fiber fabrics can be dyed with red beet extract with mordant presence between pH 5 and pH 11. However, when the fastness perspiration values of dyed samples were evaluated, it can be concluded that it would be better to dye soybean fiber fabrics with red beet extract in the presence of gallnut mordant above pH 7. Mordanted samples exhibited lower values than those of unmordanted samples in terms of perspiration fastness due to higher dye content.

CONCLUSION

Soybean fibre fabrics were dyed using red beet extract with simultaneous mordanting at various dyeing pH conditions. The color and fastness properties, such as rub, perspiration and wash fastness values of dyed samples were examined. Beetroot dye led to beige and brownish colors on soybean fibres under different pH values. The highest color strength value was observed on soybean fabric dyed at pH 9 in company with gallnut natural mordant. However, when dyeing pH exceed pH 7, the perspiration fastness values of dyed samples in the presence of mordant increased slightly. When all colorimetric properties were examined, the soybean fiber fabrics can be dyed with red beet extract in company with gallnut mordant in the range of pH 5 - 11.

However, when the perspiration fastness values of dyed samples were evaluated, it can be concluded that soybean fiber fabrics can be dyed with red beet extract accompanied gallnut mordant above the pH 7. Overall, the dyed samples exhibited good wash, rub and perspiration fastness.

REFERENCES

Shahid, et. Al., Shahid, M., et al. (2012). "Dyeing, fastness and antimicrobial properties of woolen yarns dyed with gallnut (Quercus infectoria Oliv.) extract." Dyes and pigments **95**(1): 53-61.
Yildirim et. Al, F.Filiz Yıldırım, Arzu Yavaş ve O.Ozan Avinç, (2013), "Eco-Friendly Textile Printing with Red Beet", International Conference, Textile Science and Economy V, 5th International Scientific-Professional Conference, November 05-06th, Zrenjanin, Serbia, Sn 57-62, 2013
Kumbasar, Kumbasar P., (2011), *Natural dyes,* Intech, ISBN 978-953-307-783-3, Croatia
Boo et. al, Boo H-O., Heo B-G., and Gorinstein G., (2012), Analytical Methods for Enzyme and DPPH Radical Scavenging Activities of Natural Pigments from Some Plants, *Food Anal. Methods* Vol:5, pp:1354–1361
Betchold et. al, Bechtold T, Mussak R, Mahmud-Ali A,Ganglberger E., and Geissler S., (2006), Extraction of natural dyes for textile dyeing from coloured plant wastes released from the food and beverage industry, *J Sci Food Agric Vol:* 86, pp: 233–242
Aksu and Isoglu, Aksu Z and Isoglu A. I, (2006), Use of agricultural waste sugar beet pulp for the removal of Gemazol turquoise blue-G reactive dye from aqueous solution, *Journal of Hazardous Materials* Vol: B137, pp: 418–430
Sivakumar et. al, Sivakumar V., Anna J. L., Vijayeeswarri J., Swaminathan G., (2009), Ultrasound assisted enhancement in natural dye extraction from beetroot for industrial applications and natural dyeing of leather, *Ultrasonics Sonochemistry*, vol 19, pp: 782–789
Velmurugan et. al, Velmurugan P., Kamala-Kannan S., Balachandar V., Lakshmanaperumalsamy P., Chae J-C., and Oh B-T., (2010), Natural pigment extraction from five filamentous fungi for industrial applications and dyeing of leather, *Carbohydrate Polymers,* Vol 79, pp: 262–268
Chen and Li, Chen K. Fu C-y. and LI J-d., (2006), Dyeing Wool with Red Beet, *Dyestuff and coloration,* 001
Crinela et. al, Crinela D., Gorghiu L.M., Olteanu R. L., Bumbac M., (2007), NATURAL DYES USED IN TINCTORIAL PRACTICE, Bulletin USAMV-CN, 63/2007
Atodiresei, Atodiresei G-V., (2011), Botanical resources of spontaneous and cultivated flora with applications in the textile industry, *Lucrări Ştiinţifice* – vol. 54, Nr.1, seria Agronomie
Henry, Henry B.S:, (1996), Natural food colours, *Natural food colorants,* pp:40-79
Frick, Frick D., (2003), The coloration of food, *Rev., Prog, Color,* Vol 33, pp:15-32
Yildirim et. al, F.Filiz Yıldırım, Arzu Yavaş ve O.Ozan Avinç, (2014), "Eco-Friendly Pigment Printing With Red Beet (Beta Vulgaris L.) Juice And Red Onion Peel (Allium Cepa L.)", 6th International Scientific – Professional Conference Textıle Scıence And Economy Proceedings, Zrenjanin, Serbia, 28-30th, Sn; 47-53, 2014.
Jayalakshmi and Jijvana, Jayalakshmi I. And Jijavana R., (2011), Effect of treated natural dyed knit mesh material, *Man-made textiles in India*, 95-100
Wiki, http://en.wikipedia.org/wiki/Beetroot , Accessed: January 2013
Wiki 2, https://commons.wikimedia.org/wiki/File:Beta_vulgaris.JPG, Accessed: April 2016
Wiki 3, https://commons.wikimedia.org/wiki/File:Betaninzwitterion3Dballs.png, Accessed: April 2016
Wiki 4, https://commons.wikimedia.org/wiki/File:Betanin.svg, Accessed: April 2016
Wybraniec, Wybraniec S, (2005), Formation of Decarboxylated Betacyanins in Heated Purified Betacyanin Fractions from Red Beet Root (Beta vulgaris L.) Monitored by LC-MS/MS, *J. Agric. Food Chem*. Vol, 53, pp: 3483-3487

ANALYSIS OF THE CORRELATION BETWEEN RELATIVE DENSITY AND AIR PERMEABILITY OF WOVEN TEXTILE FABRICS

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ABSTRACT

Air permeability is an important textile feature and it depends on various parameters of the fabric. In this work, the influence of air permeability depending on the relative density in fabrics has been inquired. The aim is to establish the influence of relative density in fabrics on air permeability in different interlacement. In the research, cotton fabric (100% cotton) and mixtures (polyester/cotton) with different types of weaving have been used. The testing has been done on measuring instrument ITEM 5.107 for air permeabilitywhich is used for quick, simple and accurate determining of air permeability according to specific standards. The results of the research have shown that the relative density of fabric has an influence on air permeability of the fabric. In higher relative density of fabric, the air permeability is lower and vice versa (the lower the relative density, the higher the air permeability). This confirms that relative density of fabric has an influence on air permeability.

Key words: density infabrics, linear mass, air permeability, relative density in fabric.

INTRODUCTION

Nowadays, standards of living are rising. People's demands in all areas are on the increase, as well as the demands in terms of new textile fabrics with innovative or improved features which are of great significance for greater comfort or industrial needs [1].
Textile fabrics are relatively thin, flexible, porous materials. Most of them cannot beeasily folded and plaited. Textile fabricsare composed of yarns, and yarns are composed of fibres. Textile fabrics can be more solid or looserdepending on the amount of pores in their structure [2].
At selection of textile fabrics for clothing, fashion has the most important part, which causes the sense of beautiful, attractive and unusual. Especially the younger part of population chooses clothes that differ from others (in terms of style, colour and design), the one that make our body more beautiful and hide all imperfections. For all that, a person opts for clothes that are soft, elastic, do not irritate the skin or causeallergies, do not scratch, sting or prod, warm or cool, give the body freedom of motion, create pleasant and comfy feeling at wearing or simply, opts for the comfortable clothes [3].
Air permeability is one of the basic textile features thatinfluence the comfort of clothes. Mostly, it depends on the structure of fabrics, linear density, type of yarn, warp and weft density and weaving [4].
Air permeability of fabric is defined as the amount of air permeability through certain surfaceper unit of time. The flow of air through the fabric is mostly under influence of fabric pore characteristics. It is absolutely clear that the size and distribution of the pore are functions of fabric geometry. The radius of yarn and techniques of surface formation are factors which have influence on theporosity of fabric. Porosity of fabric is related to its defined important features, such as air permeability, water permeability, dying features etc. [5].

MATERIALS AND METHODS

For this experimental research, 100% cotton and mixture pes/cotton fabrics have been used, which are with different interlacement (linen and five-thread satin), and basic parameters for these tested fabrics are given in Table 1.

Methods of performing the testing are consisted of determining the basic parameters of tested fabrics in the first place (Table 1), determining the relative density of fabric and done testing of air permeability of fabric on measuring instrument ITEM 5.107for air permeability.

Table 1*. Basic characteristics of used fabrics*

Sample number	Material (%)	Linear density (tex)		Fabric density cm^{-1}		Structures of experimental fabrics
		Warp T_{to}	Weft T_{tp}	Warp g_o	Weft g_p	
1.	100 % Cotton	30	30	27	18	Plain 1/1
2.	100 % Cotton	50	48	22	22	Plain 1/1
3.	100 % Cotton	20	25	40	25	Plain 1/1
4.	100 % Cotton	30	34	30	22	Plain 1/1
5.	100 % Cotton	30	30	28	22	Plain 1/1
6.	100 % Cotton	30	30	24	24	Plain 1/1
7.	100 % Cotton	8,4	8,4	50	34	Plain 1/1
8.	100 % Cotton	15	16	47	29	Plain 1/1
9.	100 % Cotton	10.5	14	56	33	Plain 1/1
10.	100 % Cotton	14	14	44	37	Plain 1/1
11.	100 % Cotton	10	11.5	34	23	Plain 1/1
12.	100 % Cotton	14	13	44	35	Plain 1/1
13.	100 % Cotton	10	10	70	35	Plain 1/1
14.	100 % Cotton	14	14	53	40	Plain 1/1
15.	100 % Cotton	14	14	56	37	Plain 1/1
16.	100 % Cotton	20	20	45	23	Plain 1/1
17.	100 % Cotton	14	14	48	28	Plain 1/1
18.	100 % Cotton	14	14	63	26	Plain 1/1
19.	100 % Cotton	13	14	53	28	Plain 1/1
20.	100 % Cotton	10	10.5	33	31	Plain 1/1
21.	100 % Cotton	10	10	38	30	Plain 1/1
22.	100 % Cotton	8	8	35	25	Plain 1/1

23.	100 % Cotton	18.52	23.5	37	18.5	Plain 1/1
24.	100 % Cotton	18.52	23.5	36.5	20.5	Plain 1/1
25.	100 % Cotton	18.52	23.5	36.5	21	Plain 1/1
26.	100 % Cotton	18.52	23.5	36.5	23	Plain 1/1
27.	100 % Cotton	18.52	23.5	37	28	Plain 1/1
28.	100 % Cotton	18.52	23.5	37	29	Plain 1/1
29.	100 % pamuk	18.52	23.5	37.5	32	Plain 1/1
30.	O -100 % Cotton P - 100 % Cotton	13.54x2	19.55	43	36	Satin 1/5
31.	O -100 % Cotton P - 100 % Cotton	13.54x2	11.13x2	43	31	Satin 1/5
32.	O -100 % Cotton P - 100 % Cotton	13.54x2	24.37	44	35	Satin 1/5
33.	O -100 % Cotton P – 67/33 % pes/cot.	13.54x2	14.34x2	41	34	Satin 1/5
34.	O -100 % Cotton P – 33/67 % pes/cot.	13.54x2	14.62x2	41	33	Satin 1/5
35.	O -100 % Cotton P – 50/50 % pes/cot.	13.54x2	29.86	42	31	Satin 1/5
36.	O -100 % Cotton P - 100 % Cotton	13.54x2	17.28x2	46	33	Satin 1/5
37.	O -100 % Cotton P – 67/33 % pes/cot.	13.54x2	34.73	40	33	Satin 1/5
38.	O -100 % Cotton P – 33/67 % pes/cot.	13.54x2	35.85	43	34	Satin 1/5
39.	O -100 % Cotton	13.54x2	20.75x2	43	33	Satin 1/5

	P – 67/33 % pes/cot.					
40.	O -100 % Cotton P – 50/50 % pes/cot.	13.54x2	25.04x2	42	32	Satin 1/5

The density of fabric is the function of many parameters. These are: linear mass of yarn, volume mass of fibres, coefficient of the fibre packing in the yarn and coefficient of fabric construction. Coefficient of fabric construction is the function of the applied weave repeat, the number of changes of the effect of threads in repeat, position of intersection points in yarn repeat and the flexibility coefficient of the applied yarns.

Relative density of the warp and weft threads:

$$g_{rel,o} = \frac{g_o}{280{,}25}\left[\frac{a_p(2{,}6-0{,}6z_p)}{f_p R_o}\left(\sqrt{\upsilon_o^{\,2}+2\upsilon_o\upsilon_p}-\upsilon_o\right)+\upsilon_o\right] \quad (1)$$

$$g_{rel,p} = \frac{g_p}{280{,}25}\left[\frac{a_o(2{,}6-0{,}6z_o)}{f_o R_p}\left(\sqrt{\upsilon_p^{\,2}+2\upsilon_o\upsilon_p}-\upsilon_p\right)+\upsilon_p\right] \quad (2)$$

$$\upsilon_o = \sqrt{\frac{T_{t,o}}{\rho_o \cdot p_o}}\;; \qquad \upsilon_p = \sqrt{\frac{T_{t,p}}{\rho_p \cdot p_p}} \quad (3)$$

Relative density of the fabric:

$$g_{rel} = \sqrt{g_{rel,o} \cdot g_{rel,p}} \quad (4)$$

R_o, R_p – repeatof the observed system of threads
a_o, a_p– number of effect-changes
ρ_o,ρ_p, - volume mass of fibres - ($g\cdot cm^{-3}$)
p_o, p_p - coefficient (factor) of fibre packing in the yarn
z_o, z_p– the position of intersection points in weave repeat
f_o, f_p - flexibility coefficient of yarns [6].

Air permeability is determined on the basis of AFNOR G07-111 standard on the tested sample with surface of 20 cm^2 and pressure of 196 Pa, on the instrument for air permeability ITEM 5.107. The measuring instrument is used for quick, simple and accurate determining of air permeability of all kinds of flat materials and cube of foam. The tested sample is set in clamps above the head hole for testing by pressing on clamped hand, by which the vacuum pumpsare automatically launched.

The chosen tested pressure is maintained, and after a few seconds, air permeability of the tested sample is shown on the display, in previously chosen units of measurement.
The amount of leaking air (P) per unit of time through clearly defined surface is measured. The equation for calculation of air permeability [7]:

$$P = \frac{q}{p}[l/m^2/s] \quad (5)$$

RESULTS AND DISCUSSION

The influence of density changes along the weft has been examined where other parameters are constant in air permeability (see Figure 2) and the influence of linear mass of the weft has been examined where other parameters are constantin air permeability (see Figure 3). For comparison of these parameters, relative density of fabric in relation to air permeability of fabric for linen interlacement and five-thread satinhave been used (Figure 1, 2 and 3).

Table 2. Relative density of cotton fabric and air permeability of fabrics for linen interlacementand five-thread satin.

Sample number	Relative density fabric g rel	Air permeability $l/m^2/s$	Structures of experimental fabrics
1.	0.708529	636.5	Plain 1/1
2.	0.903575	208.5	Plain 1/1
3.	0.878052	345.5	Plain 1/1
4.	0.852108	415.8	Plain 1/1
5.	0.797682	997.5	Plain 1/1
6.	0.771348	315.5	Plain 1/1
7.	0.701202	1153.3	Plain 1/1
8.	0.852716	469	Plain 1/1
9.	0.8793386	116	Plain 1/1
10.	0.885869959	444	Plain 1/1
11.	0.537494419	2183	Plain 1/1
12.	0.845843401	484	Plain 1/1
13.	0.918463282	167.5	Plain 1/1
14.	1.010905839	136.5	Plain 1/1
15.	0.999396099	100.8	Plain 1/1
16.	0.84423612	136.8	Plain 1/1
17.	0.804900892	511.3	Plain 1/1
18.	0.888586525	167.5	Plain 1/1
19.	0.83032202	450.5	Plain 1/1
20.	0.600797619	2621.5	Plain 1/1
21.	0.62651458	2088	Plain 1/1
22.	0.490939275	4114.5	Plain 1/1
23.	0.701751554	636.66	Plain 1/1
24.	0.733702534	573.5	Plain 1/1
25.	0.742596223	523	Plain 1/1
26.	0.777153857	397.66	Plain 1/1
27.	0.863329407	194	Plain 1/1
28.	0.87861076	161	Plain 1/1
29.	0.929153099	112.7	Plain 1/1

30.	0.750604468	505.5	Satin 1/5
31.	0.719043538	402.83	Satin 1/5
32.	0.790350974	340.5	Satin 1/5
33.	0.795191905	305.83	Satin 1/5
34.	0.781918634	271.17	Satin 1/5
35.	0.773717836	335.13	Satin 1/5
36.	0.856753389	166.6	Satin 1/5
37.	0.81242852	367.83	Satin 1/5
38.	0.855920311	199.67	Satin 1/5
39.	0.881882788	124.33	Satin 1/5
40.	0.898129834	69.67	Satin 1/5

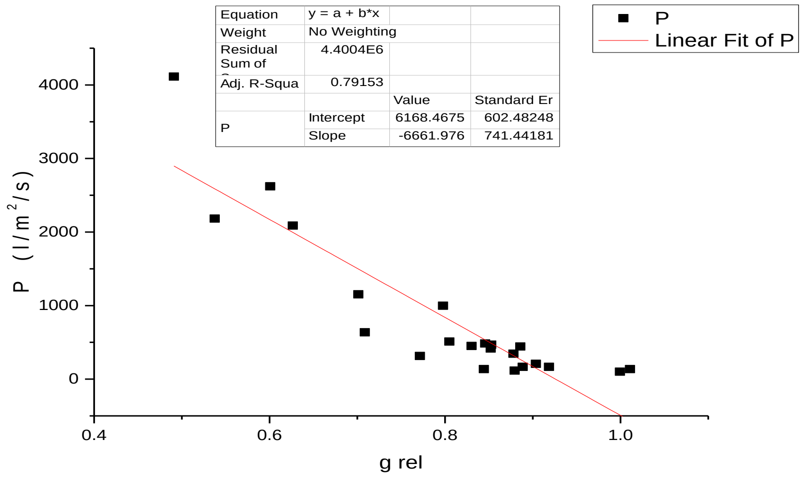

Figure 1. Air permeability of fabric (100% cotton) in comparison to relative density of fabric for samples from 1 to 22 in linen interlacement, r^2 = 0,79153

In Figure 1, relative density of fabric in comparison to air permeability in linen interlacementhas been shown, where other parameters are variable. From this figure, it can been seen that the increase of relative density of fabric leads to the decrease of air permeability and the higher the relative density, the lower the air permeability of fabric.

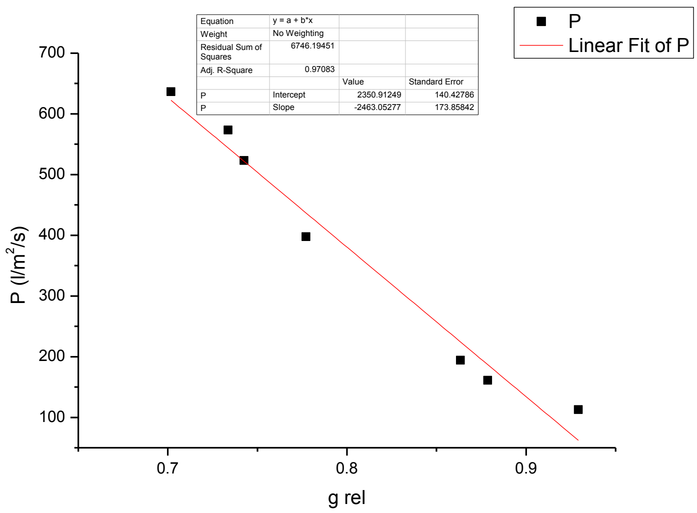

Figure 2. The dependence of relative density and air permeability for samples from 22 to 29 in linen interlacementwith the change of density along the weft, r^2 = 0.97083

In Figure 2, relative density of fabric depending on air permeability of fabric for linen interlacementhas been shown, with density changes along the weft where other parameters are constant. From the obtained results, it can be seen that the higher the relative density of fabric, the lower the air permeability and vice versa (the lower the relative density of fabric, the higher the air permeability of fabric).

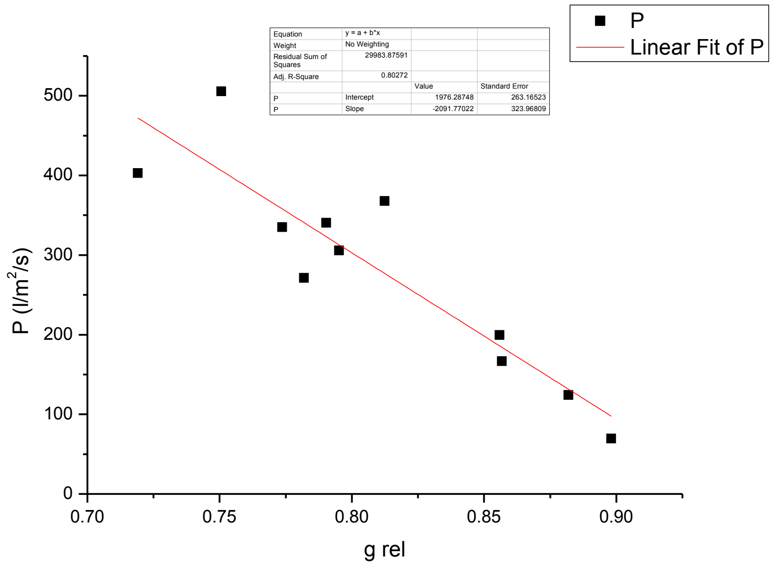

Figure 3. The dependence of relative density and air permeability for samples form 30 to 40 in five-thread satin with linear mass of weft changes, r^2 = 0.80272

In Figure 3, relative density of fabric depending on air permeability of fabric for five-thread satin has been shown, with linear mass of weft changes and other constantparameters. From the obtained results, it can be seen that the higher the relative density of fabric, the lower the air permeability, and the lower the relative density of fabric, the higher the air permeability of fabric.

On the basis of the obtained results, it has been established that the best results of the research for relative density of the fabric depend on the air permeability of fabric for linen interlacement, with density changes alongthe weft where other parameters are constant.

CONCLUSIONS

Does the clothing meet the aesthetic and ergonomic requirements which can easily be assessed even when being worn for the first time. In various climatic conditions and physical activities of users, clothing should allow heat - physiological balance. This means that a person does not feel if it is not cold, not heat more heat - physiological comfort. Wearing comfort is a decisive criterion for assessing the quality of a particular garment and consists of the interaction between the body, garment system (layers of textiles and air) and the environment. There is no doubt that kind of influence on the comfort of textile materials and their structural and structural parameters. Comfort, which is felt or not wearing clothes is a subjective reaction and effects the operation [8].
Air permeability is one of the important properties of the fabric. Air permeability of fabric is very closely linked to its structure. That is why many authors have described the relationship between air permeability and structure of the fabric [9].

In this study it was shown that air permeability has a significant impact, the density of warp and weft fibre composition and the type of weave.

Relative density has a significant impact on the air permeability of fabric, the lower the relative density of the higher air permeability fabrics, with increasing relative density decreases air permeability of the fabric.

Any textile product has its own specifics that change over time and improve application requirements. It has been found that permeability and porosity are strongly interconnected, representing a significant correlation. If the fabric has a very high porosity, it can be assumed that the throughput. Based on various studies it can be concluded that air permeability fabrics have different impact parameters on fabrics such as raw material composition, type of weave, the density of warp and weft and others [10].

REFERENCES

[1] P. Chidambaram and R. Govindan: Influence of Blend Ratio on Thermal Properties of Bamboo/Cotton Blended Woven Fabrics, Silpakorn U Science & Tech J Vol.6(2), 2012.

[2] Elena Saldaeva: Through thickness air permeability and thermal conductivity analysis for textile materials, Doctoral thesis, January 2009.

[3] M. Novaković, M. Bizjak, S. Stanković, Savremene tehnologije, 2(2) (2013).

[4] R. Tugrul Ogulata, Serin Mavruz: Investigation of Porosity and Air Permeabillity Values of Plain Knitted Fabrics, FIBRES & TEXTILES in Eastern Europe 2010, Vol. 18, No. 5 (82)

[5] R. Tugrul Ogulata, Jurnal of textile and apparel, Technology and management, JTATM Volume 5, Issue 2, 2006.

[6] J. Stepanović i B. Antić: Projektovanje tkanina, Univerzitet u Nišu, Leskovac 2005.god.

[7] J. Stepanović i B. Antić: Tehnologija tkanja, Univerzitet u Nišu, Leskovac 2001.god.

[8] Xueliang Xiao, Xuesen Zeng, Andrew Long, Hua Lin, Michael Clifford and Elena Saldaeva An analytical model for through-thicknesspermeability of woven fabric, Textile Research Journal 82(5), 2012

[9] X. Xiao, Jinlian Hu, Tao Hua, Xuesen Zeng i Andrew Long, Through-thickness air permeabilityof woven fabric under lowpressure compression, Textile Research Journal 0(00), 2015.

[10] Xueliang Xiao, Xuesen Zeng, Palitha Bandara andAndrew Long, Experimental study of dynamic airpermeability for woven fabric, Textile Research Journal 82(9), 2012.

EFFECTIVE CONCEPT OF FORMING SIEVES FOR PAPER INDUSTRY

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ABSTRACT

The energy consumption is a very important aspect in the paper industry. The constant growth of prices of energy and raw materials leads to an increase in production costs while the competition is reducing the price paper on the market. This clearly indicates lower profitability of the company. Therefore, the solutions should be sought in the use of new, cheaper and more efficient materials. For example, the use of forming sieves for papermaking has an impact on reducing production costs.

The forming sieves (from the technical point of view) are supplies in the production of paper. The function of forming sieves is to help to achieve higher quality products and to achieve the highest level of utilization of machines. Continuous innovations in the forming sieves design have helped to create bigger and faster machines with improved quality and utilization. A forming sieve is a technical product that has a big impact on the yield, energy saving, raw materials and the cost of additional resources. The most advanced triple-layer SSB sieves have allowed better machine utilization and the reduction of costs. Efficiency of the machine is increased as a result of the use of these sieves and the improved water flow. The formation is enhanced due to the application of less retention, and higher working speeds while ensuring controlled water flow.

Key words: SSB forming sieves, drainage - water flow through the sieve, machine utilization.

INTRODUCTION

The range of use of forming sieves in modern industry is quite broad; one can almost say that there are no industries where the sieves cannot find their application. In order to meet the requirements of the paper production, the designers have created different weaves for the production of sieves. The paper properties, the purity, the life of the sieve, sieve stability, pick strength, fibers resistance, permeability, etc., depend on the applied weave of the sieves. The warp direction on the loom represents the direction of the sieve on the paper making machine. In general, the sieves are classified according to the number of layers in their pattern design (weave). There are three basic types of sieves: single-layer, two-layer and three-layer sieves [1].

Depending on the type of paper to be produced, the forming sieve is selected that will allow obtaining the required characteristics of paper: fineness, thickness, surface area, strength and other characteristics. For example, printing papers and fine papers require the highest degree of smoothness and softness. Therefore, they are produced on the finest sieves. The packing paper should have an appropriate strength, so that they produced on the sieves with good mechanical characteristics. For these reasons, there are specific projects for forming sieves for the production of different qualities of paper [2].

The single layer sieves have a simple construction i.e., weave. They are constructed of a single warp system and a single weft system [8]. These sieves are used to produce all kinds of paper while one and a half layer sieves are used for production of packaging paper.

Double-layer and two-and-a-half-layer sieves belong to a newer generation of sieves and have much better performances.

They are used for the production of medium-fine and thin paper and packaging paper. On the sieve's face, in addition to the weft picks, there are incorporated the so-called filler picks.

These are smaller diameter picks with a mission to improve the technological properties of the sieve (retention - the capacity for holding the fibers on the surface of the sieve, formation - the quality of the fibers' layout in the paper sheet, and drainage - the flow of water through the sieve). On the reverse side of the sieve, the weave system allows a maximum arc of the lower weft picks the installation of large diameter picks and with a combination of polyester and polyamide the highest wear resistance is achieved.

The best technological performances were achieved by SSB triple-layer sieve used for tissues program for special and very high-speed machines (up to 2000 m/min) for the so-called "Crescent" formers. The main characteristic of the sieve is the interlace system, where the face is dominated by transverse structure (longer paths of weft picks than those of the warp) so that the paper of very small surface mass (15-18 g/m2) could easily be separated from the sieve. Also, the reverse side is dominated by transverse structure due to increased wear resistance [3].

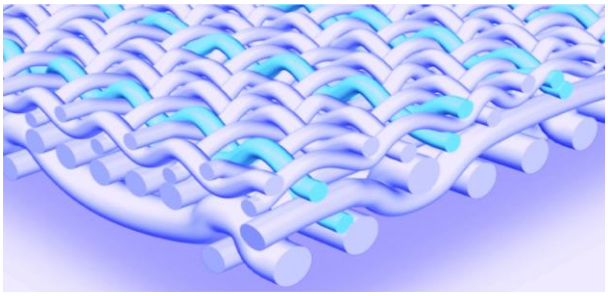

Figure 1. Triple-layer SSB forming sieve

The forming sieves (Figure 1) are used in the paper industry. They have a very important role in the process of forming a sheet of paper [4]. These functions can be classified into two basic groups: technological (the ability to retain the fibers, oriented transports, deposition of fibers on the surface of the sieve and water permeability) and mechanical (abrasion resistance, resistance to dirt and stability of the sieve).

A good way to estimate the price of the forming sieve is to show the specific costs of forming sieves in Euro/1,000 tons of produced paper. The specific cost can be easily determined by multiplying the specific consumption of the forming sieve (m^2/1,000 tons of produced paper) with the price of the forming sieves per m^2 (Euro/m^2).

Modern SSB sieves are characterized by a constructive solution that has significantly reduced the consumption of the forming sieves. The use of SSB sieves has increased from 10% to 50% in the period from 2001 to 2005. At the same time, the specific consumption of forming sieves was reduced from 14.3 m^2/1,000 tons to 13.0 m^2/1,000 tons, indicating a decrease of almost 10%. Currently, SSB sieves provide the best opportunities for achieving quality of the paper, utilization and production efficiency. SSB sieves with their special advantages optimally meet the requirements of customers, and therefore contribute to greater savings [5].

Formation of a sheet of paper on a forming sieve

A sheet of paper is formed when the fibers in the suspension are transferred to a fine mesh - the sieve. The sieve should perform three main roles: drainage (dewatering), support or substrate for the fibers, and transport. During the paper forming process a large amount of water is required to flow through the sieve structure in a short time, enabling the increase of its stability.

The impact of the sieve weave on the flow is usually critical only in the initial phase of solidification. As soon as the fibers are cross-linked, the situation is controlled by drainage. The sieve has to provide a solid substrate in order to retain the fibers and fillers, so the sheet of paper could be formed. A sheet of paper is formed by retaining fibers on the sieve holes.

Also, the sieve must be used as a transfer belt to transport the sheet of paper from the head box to the printing machine. In addition, it must retain its dimensional stability and maintain constant tension. The underside of the sieve surface is in contact with ribbed rollers. This side must be resistant to abrasion, caused by the friction between the bearing elements and the sieve.

Parker defined the drainage as the flow of water through the sieve. In the paper forming process, drainage has two functions: removing water from the suspension and from a sheet of paper. Removal of water may be accomplished by two mechanisms: by filtration or thickening [6].

In the filtration process the fibers are deposited on the sieve surface. The fibers in the slurry are mobile and free to move independently towards each other. A clear line of separation occurs between the untreated slurry and the formed fibers. As a result of the removal of water, the slurry disappears and fibers form an ordered and solid surface material. A sheet of paper formed by the process of filtration has a layered structure. In the process of thickening the fibers are randomly agglomerated in a complicated structure. The fibers are not free to move within the slurry and there is no clear boundary dividing the suspension and the forming sieve.

Turbulence maintains the cross linked fibers in motion, avoiding their premature flocculation and settling on the surface of the sieve. This fact allows the formation of paper sheet by randomized deposition of fibers, giving the paper sheet uniform composition and more uniform properties [6].

A combination of two mechanisms for the removal of water is applied when the sheet is formed in the current paper making machines. When the filtration mechanism is compared with the mechanism of the thickeners it can be seen that the drainage has improved, but the retention level remained much lower.

Turbulence is a random fluctuation, whose task is to keep the fibers and the fillers randomly oriented and distribute them (return them) to stock suspension. Turbulence is of great importance for a good paper sheet forming, because it prevents flocculation (deposition) of fibers. Figure 2 shows the evaluation of turbulence on the sieve table, from the most desirable to the lowest grade [3].

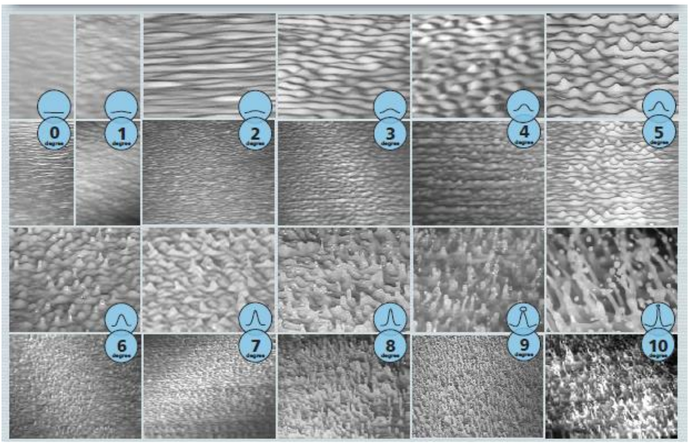

Figure 2. Activities on the sieve table, turbulence evaluation

The distribution of fibers on the sieve

One of the most important characteristics of the sieves is their ability to maintain an adequate amount of fibers on their surface. The sieve wires (picks) support the fibers. It is preferred that the fibers have a greater degree of distribution on the sieve, and in this case, and its resistance is enhanced.

But picks can act as a solid barrier reducing the flow of water. On the other hand, if the level of distribution is too low, the drainage will have a better water permeability, and the resistance will be reduced. Therefore, the compliance between the distribution of fibers and the density of sieve wires must be achieved. The level and type of fibers distribution have a fundamental impact on the resistance, dewatering and the release of a sheet of paper. The distribution of the fibers also depends on the strength, formation of wires and usage time (duration) of the sieve [2].

Air permeability of the sieve

Air permeability is a standard method for characterization of the finished sieves. It is a measure of air flow through the sieve under standard pressure. The unit of air permeability is $m^3/s/m^2$ (m/s) at the pressure of 100 Pa or in CFM (cubic feet per minute) at the pressure of 125 Pa [2]. CFM is the amount of air in m^3, which passes through an area of 1 m^2 for 1 minute ($m^3/min/m^2$). CFM measure is used to compare different sieves with different weaves.

Air permeability is a good indicator of the initial drainage before he the material is formed. When it is formed, then it becomes much more resistant to water permeability, i.e., vacuum is necessary because gravity alone will not enable water to pass through the material.

In the multilayer sieves with angular drainage, based on the characteristics of drainage and water retention of the given sieves it is not possible to predict air permeability with precision. However, it is used to check the drainage equality within sieves and as a parameter for comparison between the sieves of the same weave.

Drainage index

Drainage index was developed by Johnson [7] according to Beran's investigations of warp and weft coverage factor and air permeability:

$$DI = b \times P \times N_c \times 10^{-3} \qquad (1)$$

where: b is warp/weft coverage factor (number of weft picks/number of warps in repeat)

N_c is the weft count (cm^{-1})

P is the air permeability of the formed sieve (cfm).

Drainage index cannot be used for the purpose of precise drainage assumptions, because it has the same inconsistency in terms of reliability as the fibers distribution index. This index is useful for comparison of two different sieves which have identical air permeability, and they will have different drainage capacities.

Production of sieves is usually classified according to their surface areas, the number of sieves, yarn applied as warp, and the structure for obtaining a single-layer, double-layer, triple-layer SSB sieves. There are a number of methods for the production of sieves, where engineers need to consider many factors in order to decide on the best design for the sieves. In this production process it is sometimes necessary to make slight exceptions in order to form a sieve with the finest surface that would comply with the production rules and customers' wishes. New generations of SSB sieves are constantly being improved by changing the structure and ways of connecting picks, in order to increase the productivity of paper producing machines. In the sieve production process the upper and lower surfaces are precisely defined. During the production of sieves, special attention is given to the sieve upper surfaces. Modern forming sieves have been significantly improved compared to previous designs. In Figures 3 and 4 shown is the process of drainage - dewatering of SSB sieves [5, 8].

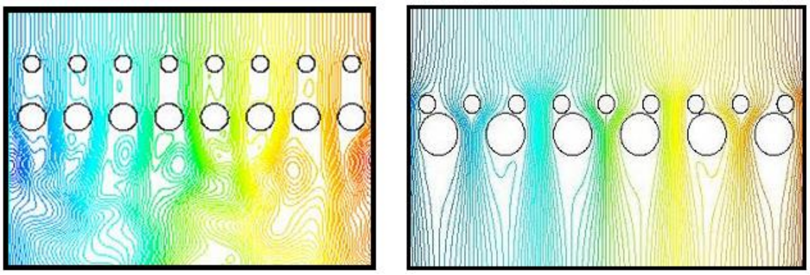

Figure 3. Display of SSB sieves drainage

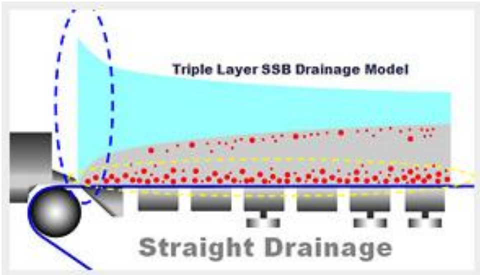

Figure 4. SSB sieves drainage at the paper making machine

The main characteristics of SSB sieves at the paper making machine, in comparison to the drainage of other sieves are: the fibers are uniformly and more thickly distributed over the band formed on the sieve, with minimum dissipation of fibers.

Measuring the dewatering from SSB sieves

Every manufacturer of sieves and paper factory has the reports for each sieve used. The report must include: date of setting the sieve on the machine, sieve's basic features, the name and type of paper, a schematic layout of the machine, duration of sieves use on the paper machine (days), the measurement data for each cylinder at the top and bottom sieves, histogram display of measurements and brief comments with positive and negative characteristics of the sieve [3].

In Figure 5 shown is the water measuring device on the sieve and in Figure 6 the measuring method used.

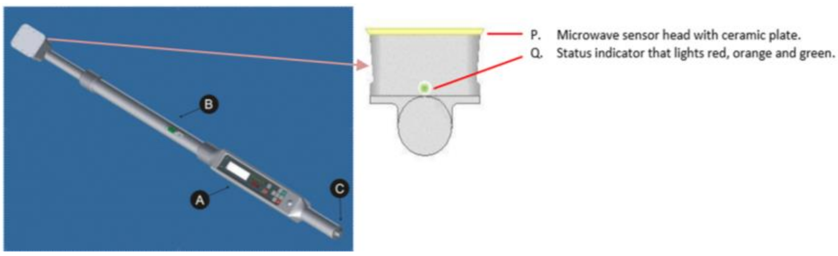

Figure 5. Water measuring device on the sieve during the paper production with the sensor head FiberScanONE™ (A - Control unit with the display and navigation keys, B - Adjustable pole with sensor head and water level, C - Auxiliary connector for data transmission and battery charging)

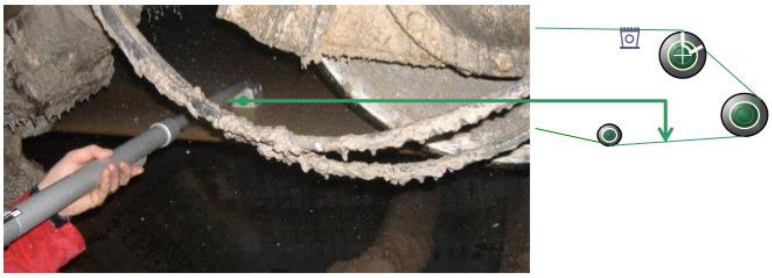

Figure 6. Determining the water content in the forming sieve

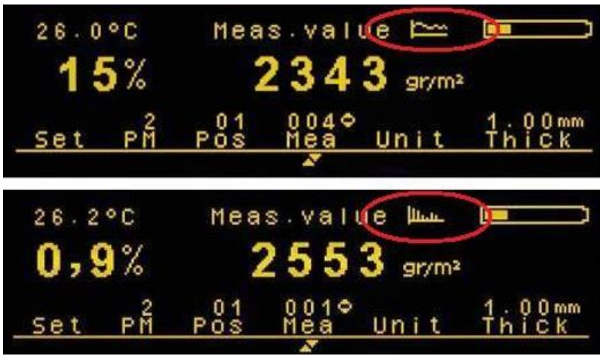

Figure 7. Display after a measurement on a FFT device

The parameters measured on the sieve and in suspension are: humidity of the room, layer, filler, the pouring solution, the temperature of the volume in the head box, pressure in the head box, the width and height of the hole of the inflow, concentration in the head box, the speed of the sieve, the amount of moisture on the sieve, concentrations of water on the sieve, total retention, filler retention, sieve water retention, the amount of water in the sieve, the total mass of paper, paper width at the winding, the width of the paper at Couch, collecting jet, total flow, paper winding speed.

All these parameters are determined for the upper and lower mesh and point of contact of the two sieves (Figure 8).

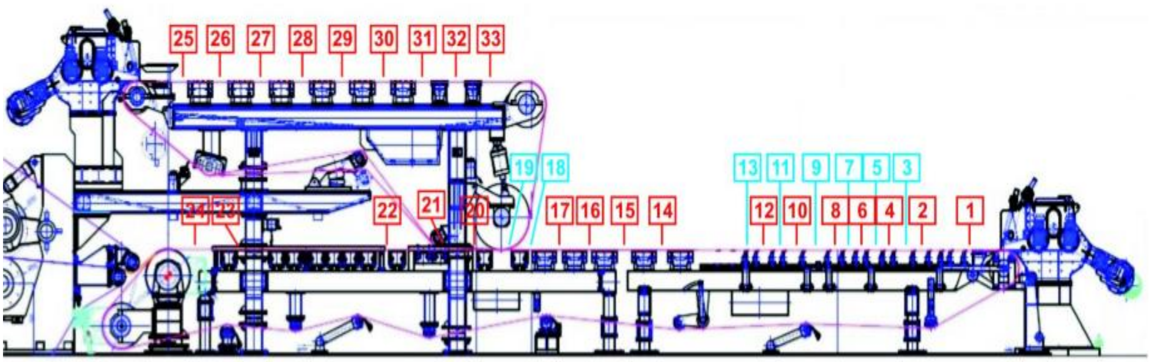

Figure 8. Paper machine layout

The paper producing machines differ depending on the type of paper that is produced, as well as on the construction sieves for that paper. Some of them have a larger or smaller number of rollers, chest planks, more or less vacuum sections, which indicates the difference in length of the sieve table.

For the evaluation of turbulence of the sieves, the behavior of the sieves and sieve stock is monitored and recorded for each cylinder at the top and bottom sieves (Figures 9 and 10).

Figure 9. Surface and layout of the lower sieve on the paper machine

Figure 10. Surface and layout of the upper sieve on the paper machine

Table 1 shows the values of the parameters for all measuring points in front of and behind the vacuum cabinet. On the first measuring point (behind the chest board) there is an abundant outflow of water, but also of dry matter, while from the package of hydro-rail 6 to the vacuum-cabinet 6 (measuring points 6-19) there is a very small outflow of water. It is proposed to install a wider chest board to additionally improve the outflow of water in the initial zone of the paper sheet formation, and thus reduce the loss of solids.

Lots of fibers pass through the sieve with the rapid outflow of water and it is necessary to slow down the first strike to initiate the deposition of fibers on the surface of the sieve. When the fibers are deposited, and do not fall into the structure of the sieve, the rest of the sieve table is more easily drained (no blockage of drainage). Angle pouring and turbulence on the sieve are at a satisfactory level [3].

Table 1. Values of the parameters on the sieve table shown in Figure 8

Name	Fs. Reading	WW	Water Ashes	Mass	Solids	Consist.	Solids lbs/min	l/min on wire	l/min drained	l/min/m drained	Drain. %	Total Drainage %	Drainage Eff %	Solids lost Km/min %	Ashes lost %
HB	0	0,98125	0	14509,3	142,37	0,98	125,44	12784	0	0	0	0	0	0	0
1	7280	0,25	0	7324,41	124,41	1,7	109,62	6454	6331	2371	51,42	51,42	49,52	15,83	0
2	6310	0,25	0	6351,99	121,99	1,92	107,48	5597	857	321	6,96	58,38	13,28	2,14	0
3	6163	0,25	0	6204,62	121,62	1,96	107,16	5467	130	49	1,05	59,44	2,32	0,32	0
4	5783	0,25	0	5823,67	120,67	2,07	106,32	5131	336	126	2,73	62,16	6,14	0,84	0
5	5720	0,25	0	5760,51	120,51	2,09	106,18	5076	56	21	0,45	62,61	1,08	0,14	0
6	5583	0,25	0	5623,17	120,17	2,14	105,88	4955	121	45	0,98	63,6	2,38	0,3	0
7	5513	0,25	0	5552,99	119,99	2,16	105,73	4893	62	23	0,5	64,1	1,25	0,15	0
8	5396	0,25	0	5435,7	119,7	2,2	105,47	4789	103	39	0,84	64,94	2,11	0,26	0
9	5340	0,25	0	5379,56	119,56	2,22	105,34	4740	49	19	0,4	65,34	1,03	0,12	0
10	5250	0,25	0	5289,34	119,34	2,26	105,15	4660	79	30	0,65	65,99	1,68	0,2	0
11	5140	0,25	0	5179,06	119,06	2,3	104,9	4563	97	36	0,79	66,78	2,08	0,24	0
12	4990	0,25	0	5028,69	118,69	2,36	104,57	4431	132	50	1,08	67,85	2,9	0,33	0
13	4900	0,25	0	4938,46	118,46	2,4	104,38	4351	79	30	0,65	68,5	1,79	0,2	0
14	3476	0,25	0	3510,9	114,9	3,27	101,24	3093	1258	471	10,22	78,72	28,91	3,14	0
15	2426	0,25	0	2458,28	112,28	4,57	98,93	2166	927	347	7,53	86,25	29,98	2,31	0
16	1530	0,25	0	1560,04	110,04	7,05	96,95	1375	791	296	6,43	92,68	36,54	1,97	0
17	1183	0,25	0	1212,17	109,17	9,01	96,19	1068	307	115	2,49	95,17	22,3	0,76	0
20	653	0,25	0	770,47	197,47	25,63	173,99	679	5491	5075	44,6	139,77	514,12	-1,55	0
21	633	0,25	0	750,42	197,42	26,31	173,95	661	18	7	0,14	139,91	2,6	0,04	0
22	623	0,25	0	740,39	197,39	26,66	173,92	652	9	3	0,07	139,98	1,34	0,02	0
23	463	0,25	0	579,99	196,99	33,96	173,57	511	141	53	1,15	141,13	21,66	0,35	0
24	420	0,25	0	536,89	196,89	36,67	173,48	473	38	14	0,31	141,44	7,43	0,09	0

The report on the control of the production process and the use of paper forming sieves, provide the corresponding graphs of all parameters so that in the event of irregular operation of the machines, immediate measures can be taken at any time. Thus, in Figure 11 given is an example of drainage control and loss of solids from the sieve table at 24 measuring points.

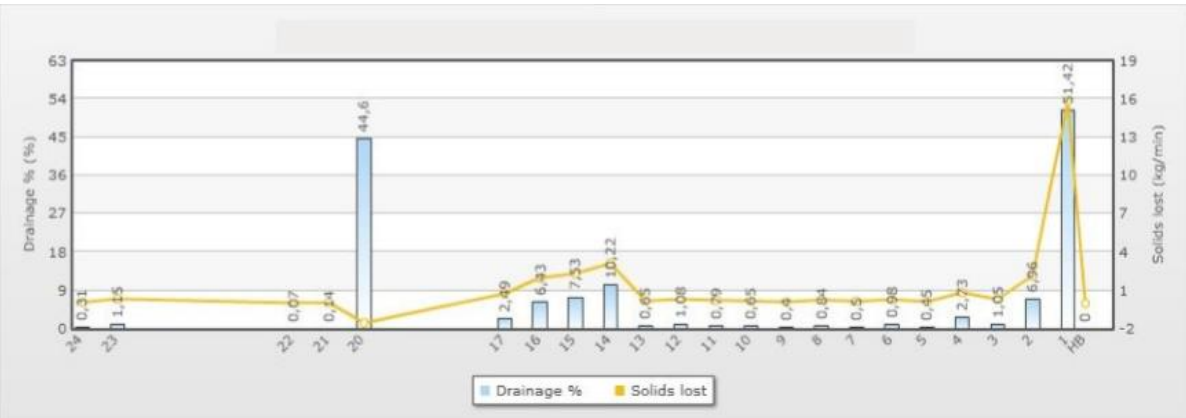

Figure 11. Graph of the „Fiberscan Analysis" of dewatering and loss of solids from the sieve

CONCLUSIONS

The paper industry has continued to emphasize the technological breakthroughs that would help increase the efficiency of machines, reducing fiber loss and energy consumption in order to improve paper quality and competition in the market. In the latest generation of SSB filters, it is successfully established that the upper surface is made as a simple woven cloth structure in plain weave (ideal substrate for retaining the fiber); while the lower surface is designed to have good wear resistance and sieve stability, usually in satin weave. The key progress has been made in the designing the forming sieves based on SSB platform that has proven to have a significant impact on the productivity of the paper machines (cost reduction) and quality. Present-day forming sieves, because of their good surface characteristics, enable a greater degree of drainage and retention of fiber, and result in obtaining high-quality paper.

Today, worldwide, over 50% of the total stocks of woven sieves are of SSB design. Types of modern SSB designs (design and structure) depend on the equipment which produces the sieve (folding, interweaving, adjusting the heat, edging). Modern looms can produce the latest SSB structure by applying warps of different diameters, with excellent uniformity and efficiency. SSB sieve design has made a great progress in the use of monofilaments, polyester for the preparation of fine warp wire and polyamide for weft wires, giving the sieves good abrasion resistance, longer service life and lower water absorption [5].

ACKNOWLEDGEMENT

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REFERENCES

[1] N. Radmanovac, J. Stepanovic, D. Trajkovic, T. Sarac, N. Cirkovic, (21 – 22.11.2014), Analysis of the mechanical properties of forming sieves for the paper industry, International scientific conference, Gabrovo, 213-217.

[2] E. Heriberto Jesus Espig Baros, (February 2002) A STUDY OF FORMING FABRICS.

[3] Documentation of the Factory for sieves and bearings „Fasil“, Arilje (www.fasil.co.rs).

[4] S. Dasgupta, N. Ray, (2009) „Designing of Forming Fabrics considering paper making aspects“, IPPTA Journal, No.4, 103-108.

[5] www.heimbach.com/paper machine clothing/ range of products/ forming section – accessed in August 2011.

[6] Parker J. D., *The sheet forming process*, TAPPI series 9, 1972., pp. 1 – 63.

[7] Jonhson D. B., *Retention and drainage of multilayer fabric*, Pulp and paper Canada, Vol. 87, No.5, pp. 56 – 59.

[8] http://weavexx.com/weavexx – accessed in Decembar 2011.

HOW MEN'S ELITE DRESSING DURING NINETEENTH CENTURY IN SERBIA

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ABSTRACT

Under Turkish rule, Serbia has lost the attributes of statehood, missing the nobility and rich bourgeoisie. The way of life has become a rural and oriental dressing, with some preserved elements of the old Slovenian and Balkan traditions.

In the struggle for the liberation of the early XIX century, in the First and Second Serbian Up rising, Serbia in 1830, became an autonomous vassal principality, and finally an independent principality in 1878. In 1882, Serbia became a kingdom.
In Serbia, during the nineteenth century, major changes took place in the political, socio-economic, ethnic and cultural spheres. Took place the processes of modernization, industrialization and urbanization, and the cultural level there was a permeation among the findings, Serbo-patriarchal, Levantine, and the newly acquired more and more dominant, European, cultural patterns.
Men's civil suits, XIX century, followed the fashion details that were not only supplemented but also decorated, but also pointed to the financial and social status.
In this paper, the trend of elite men's dressing during the nineteenth century, primarily rulers, or other important personalities of the time, as were Serbian rebels, former industrialists, military, and other persons clergy. The paper also presents the fashion details that are related to the appearance of the beard, mustache, hair styles, cylinders, sunglasses and other accessories.

Key words: elite, men, Dressing, XIX century, Serbia

INTRODUCTION

Serbian male civil suit were: shirt-sewn from homespun aba trousers “*poturlije*",wider tour ruffled socks and narrow or wide "*šalvare"*, pants that reach below the knees, knitted socks, and from shoes were worn "*Yemenis”,* shoes and boots. On his head is usually wearing a red aba *fez* with a large tuft of twisted silk, and winter hats. In the area of the belt to surround the silk "*trabolos*", and leather belt with compartments for smoking accessories, weapons and more. From waistcoats were used to vest (“anterija”) with long sleeves, bodice front fermented open and without sleeves, made of cloth, and richly decorated.
Europeanisation of dressing, until then, oriental, started in the Principality of Serbia in the first decades of the nineteenth century the introduction of the uniform, first in the army and then with the other members of the government, while the Serbian civil suit, as well as transition and European civil suit, with rare exceptions, appear a little later.
The process of acceptance of the European bourgeois mode of dress was gradual and protracted. Officially, the suit was the first in the early nineteenth century began the Europeanization of dress in Serbia.
Already during the First Serbian Uprising there was a need for uniformity of the army after the European model, which would be an expression of statehood. Such attempts have already been 1811., 1808.year, and establishing the right of standing, regular and uniformed military (so-called.

"Regulaši"), but with a very difficult process because of the unfavorable military and political situation.
At the time of obtaining the autonomy of 1830, starts uniformity and other members of the government. Prince Miloš and his actors wore the other semi-attila equestrian cloak of Hungarian origin decorated with braids (later to be silver over and coll "dušanka". After Sretenjskog Constitution, 1837. year, the entire state apparatus is uniform.
By the decree of 1850, in addition to civil servants in the strict sense uniforms are professors, doctors, district engineers, judges, postal workers and others.
Festive gown was "*dolman*" with halved pin "sleeves, wearing a winter "ćurak (Juba)" in the form of a long coat, ranked lamb skin or handcuffs. Less wealthy citizens were flying only had a shirt with a vest "*ječerma*" or "*ćurčetom*" and his shorts, on his feet "*tozluke*"-socks without foot sock pulled over pants. In winter they wore trousers of cloth and a shorter or longer doublent.
The men were first worn tobacco pouch, leather purse for money, calument, later watches the silver and gold chain and pendant, gloves, fashion rods, cylinders and others.

FASHION ARISTOCRACY IN SERBIA

In the seventh decade of the 19th century, women's costumes were "*colorful as parrot feathers*", a male, according to the spirit of the epoch in which the model was serious and sober voice to industrialists, composed of dress coat, "*redingote*", jacket, cylinder or bowler, and mandatory in black. (Fig. 1, 2, 3)

Male mundane world they did, duds from the houses of the rich, who look down at the world around us, then tastefully uniformed officers and junior diplomats trained in the latest Parisian fashion. Prince Božidar Karađorđević is slightly decadent look to their cultivated aristocrat was a real dandy Serbian. (Fig. 4, 5, 6)




Fig. 1. Architect Anastasijević *Fig.2.Moda middle class* *Fig.3.Captain Miša Konstantin Jovanović*

In the mid 19th century, the Victorian time, men wore the day black coat narrow at the waist and in the evening tuxedo, jacket or without accented waist, which had previously only worn by boys and workers. Life jackets were double row in the sports types, and festive, single with a shawl-collar. The trousers were straight-cut seamless, tight, band under the feet.
Nikola Pasić was a man who belonged to the relatively high people with considerable harmony, so he left an impression of comfort, beauty and dissuasive. (Fig.7)

Fig. 4. Prince Božidar Karađorđevic (1862-1908)

Fig.5 KostaTaušanović

Fig. 6. Politician Milenko Vesnić

Fig.7. Nikola Pašić

The men in the last decade before the First World War, an era known in Anglo-Saxon countries as the Edwardian era, along with the resulting white epoch or imaginative art new, carried further, *dressing* classic black tuxedo, top hat, a shirt with a high collar and narrow trousers with pleat.

FASHION RULING AND CULTURAL ELITE

It is known that King Milan lived luxurious lives. At his court spent two times more than at the court of Prince Mihajla. The suit he had worn once or twice, just to cast his or presented Jaeger. Gloves consumed two-three pairs a day. (Fig.8). The official dress of Prince Miloša Obrenovića and Prince Alexander Karađorđevic, shown in Fig. 9 and 10.

Fig. 8. The wear of King Milan Obrenović

Fig.9.PrinceMiloš Obrenović

Fig.10. King Aleksandar Karađorđević

Edwardian fashion, in the first decade of the 20th century, an epoch known as the Edwardian era, or white epochs, women prefer to wear corsets that their special construction pulled in the stomach and the chest thrust forward, forming a new characteristic silhouette of the modern woman. Men wore a short beard, long jackets to vests.

Reveal the rebel's leaders were striking and luxurious. Long-dolman suit, had a high strong below which wore black scarves. Below dolman, were worn trousers that were narrow from the knee down to the ankles, and over the dolman surrounded the strip of silk or wool, and then the leaves of the skin where they placed a gun and a knife. (Fig.11)

Fig. 11.Uniform insurgent leaders

Jakov Nenadović was wearing a green blanket and blue dolman, and Luka Lazarevic, while Petar Jokic wearing a red suit. Uzun-Mirko Apostolović, clothed in a red dolman with silver buttons over it, which consisted of twenty-plate... Milos Obrenovic was wearing a red suit and ducal turban around the fez, indicating the freedom of dress on which the Turks are reluctant to watch.

By the decree of 1837, prescribed the uniform for the military (Field) and civilian (Statski) officers, consisting of redcoats (whey) with a long „*peševima*“ to the knees, which is buttoned with nine buttons.(Fig.12,13,14)

Fig. 12.The clerk uniform, LazarTeodorović

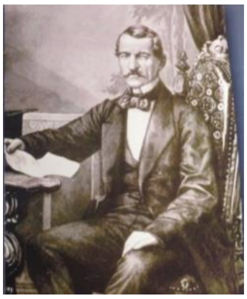

Fig.13. Ilija Garašanin

Fig.14. The clerk Mihailo Jovanović (1897)

The clerks wore coffee-brown redcoats and gray pants. With this suit as refined white epaulettes and buttons, the head of cap otters and sables, of sword belt. Members of the Soviets had a black uniform a prince’s entourage quench-blue. Senior officials had fringed epaulets-tama.
Empire (1800-1820) is a fashion style of the late classicism distinctive in its purified and reduced expression after coat with high collar *(strong*), which often reaches the ears. Some former fashion accessories used are known Serbian cultural regents, as can be seen in Fig. 15,16, 17.

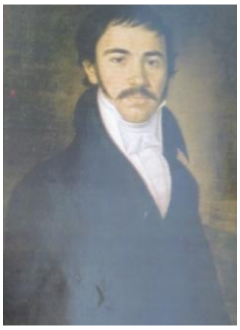
Fig. 15.Vuk Karađžić

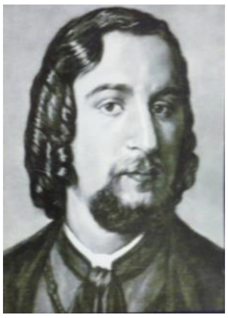
Fig. 16.Branko Radičević


Fig. 17. ĐuraJaksic

After vests from pike color, the narrow trousers of leather or some elastic fabrics and slammed boots with rolled pattern up set yellow skin, and since 1804., by the tails that are worn over the shallow open shoes, which are the much elation wore the first dandies.
With redingote and cylinder, which enter into vogue in the late 18th century, were worn favorite „brutus" haircuts, with beautifully shaped curls on his forehead.

Insurgent army wore a uniform dark-brown-brown color with red „*aufšlazima*", dark blue trousers with red „*lampazima*", „*čakoy*" with red roses and yellow embroidered uppers, shoes with buckles and leashes even according to our custom". This description fits Serbian "*regulasi*", empire silhouette of military and civil figures and is in line with the aesthetics of neoclassical figures. (Fig. 18,19, 20). Officers were well off thanks to high wages.
Prince Mihajlo was a courtly man, aristocrat, gentleman, a good player, the shooter and rider. He was a great fan of racing horses and horse riding, and was the first Serb who has built playgrounds for cricket and tennis.


Fig.18.Uniform soldiers guard


Fig. 19. Replica uniforms King Petra I Karađorđevića


Fig. 20.Officer uniform

On ceremonial occasions Mihajlo wore a special uniform, *"gilded kalpak, dolman called atila"* sword studded with precious stones, spurs with diamonds. He had a special military uniform, a red coat, white pants, three-cornered hat with huge plume of ostrich feathers, gold-embroidered sash and silver-plated sword. (Fig.21).

Fig. 21. Prince Mihajlo Obrenović

Until the eighties of the 19th century were in fashion wide lapels on jackets and coats, and from the ninth decade of entering into fashion jackets with very narrow lapels that were buttoned high on the first upper button. In view of the very scarce jewelry the men wore, besides "*ćusteka*" and pocket watch should mention the decorative button shirts. Made are also filigree with granulation or casting.

FASHION BEARD, MUSTACHE AND GLASSES

At the time of Constitution (1839-1858), officials at one time were forbidden to wear beards, because they wore beards Turks. After 1850., coming fashion "*sideburns*" who wear the authorities: officers, officials and citizens, and since the sixties became the chin, and the latest fad among youth. At the end of the eighties in vogue were small shapely beard and mustache curled wide of the mountains.

Towards the end of the century men's beards have become less and everything stylized. Below the lower lip were worn very small stylized beard. From the eighth decade of the nose glasses with a thin metal frame. Monocle has evolved from glasses with a handle. (Fig. 22, 23)

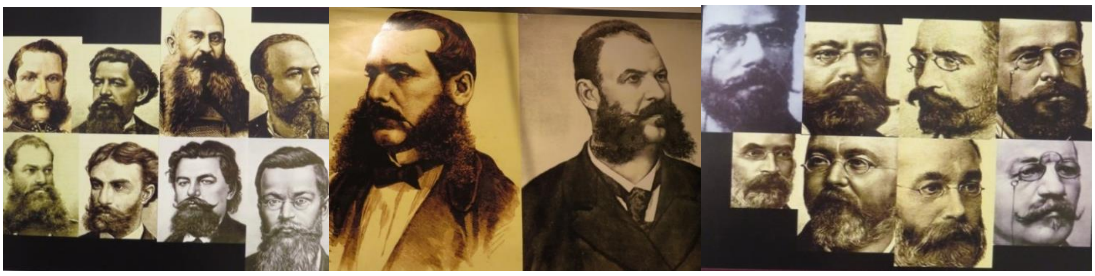

Fig. 22.Moda beard and glasse

Most progressives ministers and radicals, wore a beard, some even as long beard patriarch. Thus, the Pašićeva beard remembered as the last monument of the time.

Fig.23.Moda hairstyle and mustache

FASHION LAPEL, CYLINDERS AND MUSTACHE

In the late 19th century male costume consisted of a jacket, striped trousers, and a half-cylinder. Suits are narrow in the shoulders and buttoned high only on the first button. Collar shirts were raised and carried tie or bow tie. (Fig. 24, 25)

Fig. 24.Fashion lapels of his jacket and coat

Fig. 25.Fishion cylinders

In the second half of the 19th century, worn cylinders, half-cylinders, girard hats and wide-brimmed hats worn by advanced youth and socialists ... In the ninth decade wore bow ties are of all shapes and designs.

DRESSING CLERGY PERSONS

At the time of the first Serbian metropolitans have adopted the classic type of clerical vestments. Long black upper and lower robe with wide sleeves and a cone-shaped hat-„*kamilavka*“. (Fig. 26)

Fig. 26. Dressing clergy

Official monastic and priestly garments was determined according to church ranks: deacon's vestments consists of: surplice, orar and bracelets, priest: surplice, „epitra hilj”, felon, belt, bracelets and decorations from the thighs and pectoral cross. Pontifical vestments of: surplice, stole, “*omophorion”, “sakos”,* belt, bracelets, the thighs, and during the conduct of liturgical actions pectoral cross, panagia, miter, crosier, and orlec mandija.

CONCLUSION

Serbia at the time of Karađorđevic had 533,000 inhabitants and was administratively divided into 29 nahija and 72 principality. In the mid 19th century during the reign of constitution, Serbia had 957,000 inhabitants, of whom only 11,827 Belgrade. Already in 1900., Serbia is due to the massive colonization but also high birth rate had nearly three million inhabitants.

In the 19th century the urban population amounted to about 10%, and there were almost three times richer than the rural population while dressing their options were far higher than the rural elite inhabitants. Serbian consisted of only about 3% of the population, and it belonged to the middle and high bureaucracy all intellectuals of the free professions, lawyers, professors, clergy, officers, bankers, industrialists, owners of large companies and craft all the rich peasantry.

In the mid 19-th century there was a unique symbiosis of elements of Levantine-Balkan and European clothing fashion costumes and creating authentic Serbian civil suits. Men wore a shirt, „*ječerma*“, vest, „*kopran*“, „*čohan dolman*“, “*anterija*“ from cotton fabric and silk or cotton belt, with receptacles for smoking accessories and weapons.

Since the mid-thirties, in the higher strata of society adopts the traditional European suit in the coming decades will dominate the fashion styles of the epoch of the biedermaer through the tournament mode to the sophisticated Edwardian fashion.

REFERENCES

[1] Babović-Bakić M.: "Experiences and memories from the end of XIX century", 2015.
[2] Stanković L.: "The ceremonial costume of medieval Serbian ruler"
[3] Šibalić T.:"Ethnology"
[4] Stanković L.:"Fashion and sport Vojvodina lady-at the end of XIX and early XX century"
[5] Anđelković V.:"Fashion 1804-1918 Serbian elite“, Signs of modernity, Centre for research on digital culture, 2015.
[6] Maržik S.:"Karanovac-Kraljevo in the Serbian press of 1868-1903", 2015.
[7] Petrović P.:"Mataruska Banja-memory and oblivion", monograph, 1896-2016., publishers of „Kirilo Savić", and the Union of engineers and technicians of Serbia, 2016.

HOW REVEAL ELITE WOMEN DURING NINETEENTHCENTURY IN SERBIA

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ABSTRACT

Under Turkish rule, Serbia has lost the attributes of statehood, missing the nobility and rich bourgeoisie. The way of life has become a rural and oriental clothing, with some preserved elements of the old Slovenian and Balkan traditions.
At the beginning of the struggle for the liberation of the early nineteenth century, in the First and Second Serbian uprising, Serbia in 1830., became an autonomous vassal principality. Serbia finally became independent principality in 1878., and in 1882. became a kingdom.
In Serbia, the European fashion and oriental dress code exists in harmony with the historical circumstances. The wear was done in phases depending on the development and transformation. The middle of the nineteenth century is characterized by the formation of Serbian women civil costumes that accepts and prosperous rural population, but it adapts to their needs and socio-economic status.
Female civil suits nineteenth century followed the fashion details that were not only supplemented but also decorated, but also pointed to the financial and social status. Women's fashion in addition to fine jewelry (string of pearls and gold coins, branch, earrings, rings, bracelets) adorned handbags, gloves, hats, fans and umbrellas and the like.
This paper provides an overview of dressing especially women elite royal throne of Serbia, as well as the citizens during the nineteenth century. In addition to the royal and civil suits, are shown in some fashion accessories other clothing and accessories, such as „crinoline“, shirts, bouquets, hats, fans, purses, umbrellas and other female accessories.

Key words: elite, women, clothing, nineteenth century, jewelry, Serbia

INTRODUCTION

Serbian female civil suits consisted of silk shirts from Serbian canvas, on which he dressed „*fistan*“-long dress, narrow at the top of the heart-shaped cut-out around the breast with a wide skirt. On his chest is crossed as the European scarf („*fichu*“), a waist long silky explained-„*bajader*“. Over the garment libade-open a short jacket with wide sleeves funnel.
On his feet were worn knit socks and slippers, and later European stifle shoes. In winter they used gabardine, modeled on the west. On his head was worn headgear fez-framed by pigtailsor „*tepeluk*“ with „*barešom*“-shallowcap of red cloth wrapped ribbon decorated with gold or silver embroidery and ropes of pearls and gold coins. We used a rich jewelry (low coins, bracelets, branches, rings ...) and a European fashion accessories (parasols, fans ...).
Material for evening fabric yield is from Vienna and Paris, as well as from our stores .... Ladies wore long white gloves ... range of valuable feathers. Shoes were worn patent, buttoning low shoes and high on the button or buttoning.The jewelry worn by the beautiful diamond earrings, brooches modern antique, bracelets and collies with diamonds or necklace of several rows of pearls ...
In Serbia prevailing Western European way of dressing, and in the cities of Belgrade and in the interior, arriving as magazines "Die Modenwelt", "La Parisienne Mode", "Chic Parisien" and "La Tailleur".

If fashion crinoline in Serbia, in a way, was responsible princes Julija Obrenović, then fashion the tournament was even more Natalia Obrenović, wife of the prince of Milan, which is said to be for each exit from the palace had a new dress that a model for fashion fashionable ladies of high society.
There have been famous balls that prince, and then Queen Natalija held at the court which, according to the riches, luxury and beauty dresses for the ball, they lag behind those in Europe. Start mode crinolines, very broad, bell dress with a wire structure, the Principality of Serbia, after returning from exile, ruled by prince Mihajlo Obrenović, married the Hungarian Countess Julia Hunyadi, who was a big supporter and propagator of this European fashion. Fashion biedermeier starts thirties XIX century.

FASHION WOMEN INSURGENT LEADERS

Joakim Vujić in his journey through Serbia described the Serbian women's fashion from the mid-twenties of the 19th century this way: *"Women wear a fez on his head*" in gold or colorful scarf, neck wear pearls or a series of medium-sized ducats in two rows... shirts with long sleeves embroidered cotton and gold. Lower debt to dress is mandatory articles and has sleeves. Through it goes above a long sleeveless dress of fine cloth, or red or green "*kumaša*" embroidered with golden thread. The belt is made of silk with a big buckle studded with gold thread and precious stones. On his feet are wearing white socks and yellow or red slippers on the ears earrings and rings on his fingers made of gold and encrusted with diamonds.... Women insurgent leaders in the early thirties dressed the European when they went to a meeting in Zemun "*parlatorium*" (Fig. 1)

Fig.1. Women insurgent leaders

FASHION CRINOLINES, CORSETS AND PUFFY SLEEVES

Blouses, with many folds, the steering wheel and the scoring of lace, have become a common piece of clothing. On the transition from third to fourth decade of the 19th century, women began to wear corsets. Skirt expands the ranks of the steering wheel and numerous starched petticoats and reinforced stitching. Dresses were to the ankles, and beneath the edge of the skirt is often protrudes lace petticoats. Cleavages are large, as can be seen in the details. (Fig.2)

Fig. 2. Fashion crinolines and corset

In the fourth decade of the women wore a short, puffy sleeves, which are in the early fifties extend and receive forms "*of child legs*" (if broad and accumulated above the elbow, and narrow down). (Fig. 3)

Fig.3.Moda lapel women's shirts

In the last decade of the 19th century women's shirts and blouses have become an important part of the clothing, the typically by folds, frills and lace from scoring. Large straps were in vogue in the first decade of the twentieth century. And in the early 20th century, women like to wear dresses clinging to the body and long skirts in pastel colors, bell cut.

FASHION HATS

In the ninth decade of worn hats with a small brim, "*richly decorated with flowers and ribbons*". (Fig. 4)

Fig 4. Fashion hats

FASHION WOMEN'S ELITE

End of the 19th century women swear changing radically. Sharp lines of women's rotation is calm and begin to fall "*soft on the hips spreading bell to the ground*". Dresses had a "*collar to the neck decorated with a big bow tulle"*. The sleeves were "*harvested at the shoulder and narrow at under armpit taking on the form of sheep's leg"*. (Fig.5 and 6).

Until 1860, they wore straw hats wide-brimmed, small umbrellas decorated with tassels, sleeves and bags, and in the seventh decade of slightly inclined round hats. In the evening wore silk and lace shawls, like the photo of Julia Obrenović. (Fig. 7)

Fig. 5.Natalija Karađorđević (about 1865)

Fig. 6.Natalija Karađorđevic (about 1882)

Fig.7.Julia Obrenović

Natalija for each release has a new dress made with the "*Fran-son*" in Vienna or in the „Monasterlije "in Budapest. Dresses are usually sewn from silk rep, atlas, moaera silk or velvet with lace details. For all day and evening dresses incomes were different. Ballroom gowns are sure to have down. Lila and „*heliantrop*“ colors to stand for the most nobly, which is clearly seen on this Bukovac portrait of Queen Natalija in 1882.
Bitter cold in the winter wore the felt or velvet hats decorated with silk ribbons and a variety of feathers. Hats were fastened with large needles decorated with beads.

The late 19th century, Serbian civil suit was so transformed and simplified to the details of their wealth remains only a long skirt, a simple shirt, and ultimately reduced libade tepeluk. From jewelry retain the brooches, rings and little branches. Jewelry is made using mostly of metals-gold, silver, brass, copper, bronze, in all the techniques that are applied to the metal. Zone of women decorating the head, neck, chest, arms and belt. (Fig. 8, 9)

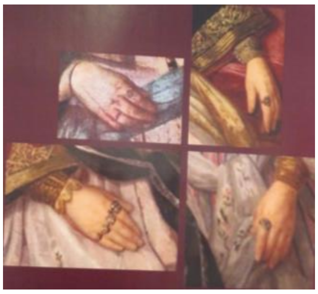

Fig. 8.Femail decorative jewelry

Fig. 9.Decorative female accessories

Socialites wore small round or oblong hats, while older women wore hats tied with silk ribbon. Winter of extreme cold, wore the felt or velvet hats decorated with silk ribbons and a variety plumage hats were fastened with large needles decorated with beads. The jewelry they wore gold chains, rings and diamond ornaments and large gold and silver branches.

Women's hairstyles were, as was once hailed as "*nakolmovane*" with mandatory small bun and, a few discreet natural or artificial flower in her hair.
Gloves were long up to the elbows made of fine and thin skin. Young women and girls wore silk stockings in various colors, and older women only black matte stockings.

Women wore black patent shoes or boots of fine black or brown *„ševre*“. In fashion were the shoes of „*mordorea*“ (a combination of brown leather with gold), shoes of fine and thin white leather with buttons, or from an atlas with a small bow or buckle colored dress. (Fig. 10, 11,12)

Fig. 10. Fistan, tepeluk, Tomanija Karađorđević bayader and libade

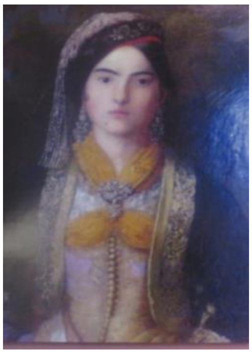

Fig.11.Julija Obrenovic (about 1850)

Fig. 12. Persida Karađorđević (abaut 186o)

Fig. 13.Persida (wife of Alexander Karađorđević)

Fig. 14. Obrenović (wife Jevrem Obrenovic)

In the first half of the 19th century women wore the shirt, waistcoat, vest, skirt, or *„anteriju“ or fistan, belt, „ćurči“, „đžube“, „škuteljku“* of cloth and fur coat, velvet, satin, the *"almost exclusively black, posted-lamb or rabbit fur, and processed sable, marten, fox and other precious species feather "*. On their heads they wore teleluk "*small fes*", adorned with pearls, and decorated with silver and gold, and gold embroidery.
Around „*teleluka*“ older women linked mufflers, a girl wrapped only *"krajake*". Waist were tied "*bajader*" long strip of silk, which ends are falling forward. The girls wore white or pink, a married woman dark. (Fig. 13,14)
For Persida Karađorđević publicly rumored to have her, and not her husband, Serbian Prince Aleksandar, managed by Serbia. Princes came from a respectable home Nenadović. She wore dresses made of silk or velvet, whose lower part (skirt), or bio with a round neckline, who went to the door, or by using sharp cleavage. The sleeves were narrow and long. Over the top of clothes had „*ekri*“ or white silk scarf that crossed the front at the bottom of the waist and the ends of her retractable bead, which is wrapped around the entire waist.

Like all women who wore rich Serbian costumes, had „*škuteljku*“ of heavy velvet, with precious fur. The front parts „*škuteljke*“ were not assembled to the upper part of the video is somewhat dresses and silk scarf that was made of the most beautiful white or „*ekri*“ thread. She wore sometimes instead *„škuteljke*“ satin libade, edged with gold thread in your favorite color maroon, soldier blue, the colors of cocoa, cream color, color dunkl green, cherry-brick color.

Sephardic Jews after the expulsion from Spain in 1492. via Turkey and Serbia, Bosnia settled sometime in the early 16th century. In Vojvodina, the Ashkenazi Jews settled Maria Theresa in the great national project of settlement of border places. Integration Jews begin their integration into the Serbian army under the provisions of the constitution of 1869. (Fig. 15 and 16)

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Fig. 15.Moda Jews in Serbia *Fig. 16.Dressing mother and child* *Fig. 17. Serbian civil suits*

Jews participate in the war with Turkey in 1876., and already in 1877., was elected first deputy Jew Abraham Ozer (ović). At the end of the 19th century comes to Christianize the first, and thus enslaving the Jews. Many Jews add to their surnames *"ić"* and accept Serbian nationality, while retaining the religious distinctiveness. That is how the "Serbs of Moses faith"

The Jews of the traditional ceremonial and ritual clothing in the first half of the 19th century wore somewhat modified Levantine and Serbian folk costume, in the second half of Serbian civil suit, in the 20th century European clothes as they usually carried in Serbia. Serbian Jews were mainly engaged in "*trade in textiles, clothing and footwear*", gallantry, haberdashery and fashion through a tailor shop and salons. In Serbia in 1874., lived 2049 Jews accounted for 0.15% of the population. In Belgrade was in 1754 or 6.35% of the population, and in 1910 in Serbia was 5,995, or 0.21%. In Belgrade, which then had a population of 89,876, it was 2192 or 4.66% of the Jews. (Fig. 17)

Women wore a short jacket-spenser, longer coat-pepis, often made or lined with fur, and under the influence of the Empress Josephine, underwear brewed from batiste, in the form of two separate socks, which have surrounded the waist". On his feet were wearing "*a Greek-type sandals and open shoes without heels*".

The hair is tied in a bun, an antic. Hats were varied, with rim tape over the face and under the chin. The jewelry worn by the "*garlands and bracelets diadem, broad necklaces, hair bands, diadems, and as an accompanying fashion accessories, scarves, gloves, purses, and winter muffs*“.

FASHION TOURNAMENTS AND BALLS

In mid 1890., the tournament mode is changed by a narrow bra extends to the stomach, and continues with the skirt-sheath decorated with a series of drapery and folds falling to the ground and extend in tow. (Fig. 18,19)

Fig. 18.Moda tournament

Fig. 19.Moda balls

In the eighties and nineties of the 19th century, women start to wear straight skirts front and rear wrinkled due to the raised "*tournament"* made of "*horsehair or a small bag*". Skirts have extended their rear tow, and together with "fine waist and tight bra composed a very feminine figure".

At the end of the sixties of the nineteenth century, when the fashion of wide skirt reached its extremes and when the crinoline, due to lower prices become available to all women, regardless of social status and so lose exclusivity, *"steel cage*" left the fashion scene. Fashion tournament lasted almost two decades. The then fashionable forms are too emphasized the sexuality of the female body. Ideal beauty was: slender waist, prominent breasts, and accentuated hips. Evening and ball gowns were pastel shades, while the daily variations was characteristic that were made from materials of bright colors and contrasting patterns.

Since the eighties of the nineteenth century, women began to be intensely involved in sports, so he made clothes which brought a temporary relaxation of torture fashion toilets-short skirts, flat-heeled shoes, comfortable blouses, casual jacket. The biggest revolution sparked clothing for the bike.
With the return of trained "*otečestvenih sons"* from abroad to study at prestigious universities in the early fifties, at a time of constitution, and with the new brand "*western*" fashion that they brought with them, "*Belgrade-based company*" is received, in a narrow layer of enlightened intelligence "*superficial* compliance to *was considered a mark of European civilization"*, and in the following decades on the streets of Serbian cities ruled by the incredibly colorful styles. Most of the men from the upper and middle strata of society, adopted a European suit, overcoat and hat and clerical uniform, a woman civil suit, which was an important sign of emancipation, while some of the people still wore "*red fez, a short blanket and wide trousers'.*
Intellectuals and youth in cities wore wide-brimmed hats that are like the last cry of fashion launched socialists in the seventh decade of the 19th century (Fig.20).
Crinolines were made of lightweight wire skeleton tied to the waist and by whom is wearing a big coat.

Fig.20.Moda crinolines and dresses for the ball

Crinolines liberated the women's movement because they allow women freedom movement than that which they had when they "*wore starched petticoats and a dozen*". Skirts were simply cut with mandatory *"frills of flowers or stuffed horizontal strips*". (Fig. 21, 22, 23)


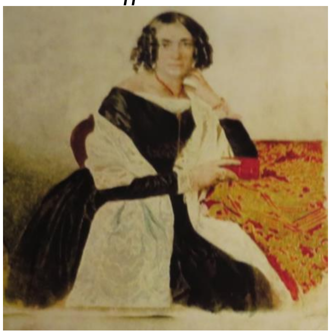

Fig. 21.Skirts shaped of the tone (Mina Karađžić)) *Fig.22.Moda puffy sleeves family Jovanović* *Fig.23.Biedermeier* *Fig. 24. Ladies the Serbs*

In the mid-forties of the 19th century there is a change in women's fashion. Colors become something darker, something big cleavages, women are beginning to button up to the neck. The width of the sleeve on the shoulder decreases, skirts the ankles, and start to wear caps tied under the chin.

Fashion epoch of romanticism identified by dark overcoats wide shoulder straps, a waist accentuated by an extremely wide „*peševima*" long to his knees with a single row of buttons, according to well-tailored jackets and pants in bright colors. With a black tuxedo went white vest and white tie. During the day wore the plaid striped design, a black evening cylinders, gloves, stick and glasses with one glass. Women wore wide skirts with lots of steering wheel tight corset waist that detects open shoulders. (Fig. 24)
In the evening occasions wore large range of ostrich feathers soft and long gloves, which were "*buttoned with twenty buttons*".

Fan more were part of the equipment evening, but were worn during the day, a variety of shapes, colors and materials, such as lace, chiffon, feathers, beads, ivory, etc. (Fig. 25 and 26)
Women's hairstyles in the ninth decade have been, as was once hailed as "*nakolmovane*", with compulsory bun small and occasional discreet natural or artificial flower in her hair. Male buns were in vogue around the passage of the nineteenth century.

In the second decade of the 20th century, the marked cruel experiences of the First World War, there is a major change in women's costume. Colors become strong, sometimes even gaudy, and mode inputs and "8" expression. The skirt was the first shortening and spreads to the next season suddenly became narrow and clung to the body.

And in the first decade of the 20th century women wore gloves during the day, fan, umbrellas, handbags of all shapes, hanging earrings, brooches and bracelets, and winter fur muffs or decorative clocks with chain, which is before the First World War, was a real fashion hit.

Umbrellas were also required daily companion toilets. They were made of luxurious lace, chiffon and silk, are a favorite winter details were muffs, fur boas and long fur and feathers. Coats, tweed jackets and overcoats were of various lengths, shapes and cuts, but mostly tailored at the waist. They were made of cloth and tweed, often with collars, of management the borders of astrakhan, beaver, sable and chinchilla. decorated with frills, burrs, etc. (Fig. 27, 28, 29)


Fig. 25. Fashion female figures


Fig.26. Silhouette modern women Serbia


Fig. 27.Moda fur muffs


Fig.28.Moda "Belle Epoque"


Fig.29.Dress of heavy silk

Women wear gloves, fans, umbrellas and muffs, handbags of all shapes, dangle earrings, and bracelets *brooches*, and *"decorative clocks with the chain on the waist"*, which fits perfectly pronounced pallor of their faces. In the first decade of women wore a short, puffy sleeves, which are extended take shape "*mutton leg"* (a very broad and accumulated above the elbow, and narrow down).

FABRIC PATTERNS

Patterns fabrics were the most geometrically arranged, with prevalence network of rhomboids, sometimes filled with simple patterns within the rhombus or patterns on decorated line, as shown in Fig. 30.


Fig. 30. Patterns of fabrics with different geometric patterns

CONCLUSION

The basis of women's clothing then make a shirt, long dress-fistan, silk belt „*bayader*“, libade female upper-shirt, jacket-fetched from the west, a cutting characteristics under the influence of the East, fes. „*Tepeluk*" is a special type of decoration you are on a fez worn by wealthy women. Pearl „tepeluk" considered to be authentic work of Serbian civil jewelry. Bares the strips of velvet or silk scarf twisted and wrapped around the *fezu* with jewelry. Silk scarf folded on his chest worn under libada. At the end of XIX century fistan-dress, skirt and blouse replaced. In some places still bear the *„bayader*", bares and a silk scarf on her breasts, which later replaced lace, silk scarf printed with the fringe or a scarf.

Until the thirties of the twentieth century and survive libade „*tepeluk*" known as elements of national costumes. Libade modest workmanship and appearance is an integral part of the festive peasant clothing of married and older women. Skirt and blouse were replaced by fistan. Sewn from brocade silk or similar fabric. The features of these garments are released woman wearing numerous petticoats. Blouses with high collars and decorated with embroidery and lace and pleated sleeves are rich. With them it was carried libade, cashmere scarves, silk or lace, mostly machine-made. At that time, the entering numerous leisure fashion gowns, cloaks, muffs, hats, garters, fans, purses, etc. The socks are first hand, and then machine-knit. Shoes make slippers, shoes and boots. Only since the early decades of the twentieth century can be traced museological lingerie and various ancillary details-handkerchiefs, gloves, umbrellas, etc. Fashion influences coming from Vienna, Budapest, Paris. Clothing children were modeled after the adult, but much simpler.

REFERENCES

[1] Babović-Bakić M.: "The experiences and memories of the late nineteenth century,"
[2] Stanković L.: "The ceremonial costume of medieval Serbian ruler"
[3] Šibalić T."Ethnology"
[4] Stankovic L.: "Fashion and Vojvodina sport lady-at the end of XIX and early XX century "
[5] Anđelković V.: "Fashion 1804-1918 Serbian elite", Signs of modernity, Centre for research on digital culture, 2015.
[6] Maržik S.: "Karanovac-Kraljevo in Serbian the press of 1868-1903", 2015.
[7] Petrović P.:"Mataruska Banja-memory and oblivion", Monograph, 1896-2016., publishers of"Kirilo Savić "and the Union of engineers and technicians of Serbia, 2016.
[8] Stanković L.: „The Europeanisation of the civil dress in the principality of the Kingdom of Serbia in the XIX century",2013.

THE REGISTRATION OF INDUSTRIAL DESIGN IN THE REPUBLIC OF CROATIA AND THE REPUBLIC OF SERBIA

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ABSTRACT

Industrial design protection represents a significant market instrument which producers can use in protecting their own investments in developing and manufacturing products. The reason for the legal protection of the results of industrial designing is in economic value of the esthetic shaping of goods.The subject-matter of the industrial design rights is appearance of industrial or handicraft product.There are two general affirmative conditions which have to be fulfilled in order that the right on industrial design is granted: novelty and individual character. The conditions and legal procedure for industrial design registration in the Republic of Serbia and Republic of Croatia is the subject-matter of this research paper.

Key words: industrial design, novelty, individual character, registration**,** Croatian Law, Serbian Law.

INTRODUCTION

The reason of legal regulation of industrial design is in economic value of esthetic shaping of goods. Economic value of esthetic shaping of goods cosisted of values of labour, time, knowledge, skilfulness and means invested in creation of industrial design as well as profits rising effects as a consequence of commercial use of industrial design. Nowadays, consumers search for the products that will satisfy their needs in the best possible way. For capacity of industry to make various products, especially in relation to quality level and usability, as well as to offer them to the market there is a competition among producers who produce products for the same purpose. This competition is present both on domestic and international markets. Consumers have more serious criteria at selecting and buying products. As for profit-related issues it is emphisized that the first impression on the products has being gotten upon their design that is in the marketing of immeasurable significance. Except that, industrial formating understands creation not any but nice-looking and likeable appearance of goods. Conferred to the area of doing business it means that products without any beauty are monotonous and they do not, that is from the marketing aspect the most important, attract attention of consumers. Therefore, since majority of people, more or less, feel natural need for esthetic, good-looking appearance of product serves to attract attention of consumers and influence their choice decision. Thereof the statement that "design can represent value for consumer and facilitate choosening". (Kotler, P.,1989)

By esthetic configuring of goods is possible to influence consumers decision on choice because, the same as with trade mark, industrial design in customers' conscience generates psychologic effect. While watching nicely shaped and fit out products people react emotionally, i.e. make a judgment which administer to the final decision making on buying. In respect to contribution of esthetic formation of goods to total marketing effects, work on creating and improving esthetic quality of products is the subject of increased commercial interest. (Ljubojev,N.,Varga,S.,2010)

Industrial design in scientific and professional meaning is multidisciplinnary. Creation of new appearance of goods means application of knowledge from many areas such as: (applied) art, economics, marketing, psychology, sociology, esthetics, even ecology and customers security.

Because of that esthetic formation of goods is economically very worthy and, at the same time, very complex activity.
It is very true that for successful industrial design is necessary to employ various experts. In relation to all of that it is necessary to provide legal protection of holders of results attained with such endeavor against parasite practices of those who do not want to invest enough time, money and efforts in esthetic modeling of goods. (Ljubojev,N,Varga, S,2010)

Nowadays, design represents a creative discipline considering almost all modern producers. A product must function in optimum way, it must be good-looking and economically acceptable as well as ergonomic. If this is achieved a product attains success on the market. The role of design is to create quality and attractive product.Therefore, economists think that industrial design protection contributes to market product development and enables its investment return. Industrial design protection promotes creativity in industrial and workcraft sector, contributes to business activity expansion and increases export potential of domestic products.

Industrial design protection represents a significant market instrument which producers can use in protecting their own investments in developing and manufacturing products.

Industrial design can be classified in different ways. But the most important divisions of industrial design are divisions made by criteria such as numbers of dimensions or nature of designed objects. (Varga, S., 2000) There is also a distinction between registered and non-registered design. Registered design is design protected with exclusive industrial property right granted in an administrative procedure by authorized state body. Non-registered design is particularly protected in European Union (EU). Non-registered design is protected for three years. One can design industrial or handicraft products, packing material, graphical symbols and typographic signs.

Industrial design protection is performed according to territory principle, which means that the protection is valid only on the territory of the country where the law is acknowledged.

Protection on the territory of other countries can be realized in the following ways:

- Submitting a special form to a competent body of every country on whose territory is protection requested.

- Submitting a form for the whole territory of EU, or E-form for a **Registered Community Design (RCD)** directly to the competent EU Office: European Union Intellectual Property Office (EUIPO) or under the Hague System for the International Registration of Industrial Design.

- Submitting an international form using the Hague System for the International Registration of Industrial Designs directly with the World Intellectual Property Organization (WIPO).

International registration of design is recorded under the provisions of the Hague Agreement Concerning the International Deposit of Industrial Designs of November 28, 1960 and the Genava Act of July 2, 1999.

The Hague Agreement governs the international registration of industrial designs. First adopted in 1925, the Agreement effectively establishes an international system – the Hague System – that allows industrial designs to be protected in multiple countries or regions with minimal formalities.

The Hague Agreement contracting parties are:

African Intellectual Property Organization (OAPI)	Finland	Oman
Albania	France	Poland
Armenia	Gabon	Republic of Korea
Azerbaijan	Georgia	Republic of Moldova
Belize	Germany	Romania
Benelux	Ghana	Rwanda
Benin	Greece	Sao Tome and Prencipe
Bosnia and Herzegovina	Hungary	Senegal
Botswana	Iceland	Serbia
Brunei	Italy	Singapore
Bulgaria	Kyrgyzstan	Slovenia
Cote d Ivoire	Latvia	Spain
Croatia	Liechtenstein	Suriname
Democratic People`s Republic of Korea	Lithuania	Switzerland
Denmark	Mali	Syrian Arab Republic
Egypt	Monaco	Tajikistan
Estonia	Mongolia	The former Yugoslav Republic of Macedonia
European Union	Montenegro	Tunisia
	Morocco	Turkey
	Namibia	Ukraine
	Niger	
	Norway	

Table1. The Hague Agreement Contracting Parties.

International protection of industrial design can be realized in the countries that are The Hague Agreement members. (See: Table 1.)
International protection of industrial design lasts 5 (five) years, counting from the date of international registration and can be renewed every fifth year depending on national regulations of the countries named in the form (maximum 25 years). Registration procedure is consisted of formal conditions examination and classification and the notice of International registration of industrial design and is carried out by International Bureau of the WIPO/OMPI.The form is submitted directly by applicants.

THE REGISTRATION OF INDUSTRIAL DESIGN IN THE REPUBLIC OF SERBIA

Nowadays, design represents a creative discipline considering almost all modern producers. According to some theoretic opinions design should give quality to products in technical, functional, esthetic, economic and ergonomic sense (Desnica, E., Nikolic, M., 2000). A product must function in optimum way, it must be good-looking and economically acceptable as well as ergonomic. If this is achieved a product attains success on the market. The role of design is to create quality and attractive product. According to theory, »design is a scientific, professional and creative discipline, the symbol of product`s quality as well as system, function, union of activities, organizational whole and the field of management in a company – oriented towards full satisfaction of needs, requirements and wishes of consumers, economic developing objectives of individual companies and the economy, enviromental improvement as well as progress of society as a whole.« (Vasiljevic, M., 2000)

Subject-matter of the industrial design rights

The subject-matter of industrial design rights is appearance of industrial or handicraft product. It is only a part of the industrial design conception as it is considered in design profession where industrial design is coherent unity of structural and functional elements of a product, including its appearance (Fruht, M., 1990). In industrial property law, however, industrial design is only overall visual impression left by industrial formating to informed customer or user of esthetic formed product. Subsequently, in the industrial property law, industrial design is deemed as a creation of exclusivelly esthetic character.

Industrial design is intellectual good because it is a result of intellectual creative labour which is possible to materialize on industrial or handicraft products countless times. It is exclusivelly of esthetic character because functional features and technical solutions at al are legally irrelevant in the sense of granting legal protection. In contrary legal protection of industrial design would extend to all products used for the same function. By regulating of industrial design as a legal notion confined to product appearance such danger is removed and subject of law has an exclusive right to produce goods of those appearance which the legally is protected, avoiding to obstruct anyone to produces goods which serve for the same function but of different appearance.

Albeit of intellectual character, industrial design is not an abstract or indefinable form. As a legal subject-matter, industrial design must be determiante. Industrial design is determined by visual characteristics such as: lines, contours, colours, shapes, textures, materials the product is produced of or decorated by, as well as their combinations (Fruht, M. et al.2003; Kuzmanovic, S., 2008; Vasiljevic, M,1999).

Requriments for registration

There are two general affirmative conditions which have to be fulfilled in order the right on industrial design would be granted. These are: ***novelty*** and ***individual character***.

Novelty of industrial design

Industrial design is deemed as a new one if no identical design has been made available to the public before the date on which the design for which protection is claimed has first been made available to the public as well as before the date of filing of the application for registration of the design for which protection is claimed, or, if priority is claimed, the date of priority. The first question in connection with the novelty of industrial design is the question of identity of industrial design. Identity exists not only when comparable designs are the same - identic but also when they differ but not in intrinsic details. Intrinsic details of industrial design are those elements of industrial design which are dominant over appearance of a product. Inversely, immaterial details of industrial design are its less perceivable elements. Difference in immaterial details is a complex legal standard and has to be ascertain in every new case. It exists if informed user is not able to distinguish two designs on the first sight. For this legal standard is said that is complex because its contents are determined by two legal standards: *informed user* and *on the first sight*. Informed user is a phisical person to whom the design is directed. It means that informed user is neither manufacturer nor average consumer. They are regular users of the designed product who "have basic knowledge of product trend and availability and technical considerations, if any" (Bainbridge, D., 2007). On the first sight is a legal standard bz which is determined degree of informed user attention. Using described legal standard to determine identity of two designs has being done by spotting and compare differences but not similarities between them. (Ljubojev, N., Varga,S., 2010)

Industrial design is new unless have been made available to the public. One may make industrial design available to the public on many vary ways such as: publication, exibition, use in trade etc. Availability to the public does not have to encompass complete appearance but part of it enough to reproduce design in full. Industrial design is deemed available to the public as for its picture, drawing or shape of body. Availability of its oral or written description is not legally relevant saving that artistic reproduction of the design identical to the described one is possible. A disclosure of an industrial design has not being taken into account if an industrial design has been made availabe to the public by the designer, his successor in title or a third person as a result of information provided or action taken by the designer or his successor in title. This legal fiction is a temporary one - lasts for 12 months (so called *grace* period) and during the period persons authorised to claim protection are able to check marketing value of appearance and by virtue of that to decide is it worthy to invest effort, money and time in obtaining of exclussive legal protection. The same term is valid in the case of an industrial design disclosure beside designer or his successor in title volition (Article 7(3) of 2002 Council Regulation (EC) on Community designs). Consequently, industrial design irremissible terminates to be new if available to the public has been made by the act of third person which is not in any legal or factual relationship with designer or his successor in title. But even then industrial design remains new if there is not possiblity that design become known to the business circles specialised in the sector concerned. Business circles specialised in the sector concerned are businesses registered for production and trade of designed goods as well as phisical persons - designers of those goods and firms where they are employed. But even in the case of availability of an industrial design to the business circless specialised in the sector concerned, industrial design remains legally new if it has been disclosed to a third person under explicit or implicit conditions of confidentiality.

So called *grace* period and esspecially prescription of relative publicity/confidentiality of industrial design tranquilize absolute effect of novelty but not convert it to relative one. This can be concluded particularly considering that "art of design" (Manigodic, M.,1988), along with a note on priority, contain all creations of industrial shaping comprised in industrial design applications filed anywhere, i.e. to any IP office in the world, regardless on their final legal epilogue. (Ljubojev, N., Varga,S., 2011)

Individual character of industrial design

The second general requirement for legal protection of industrial design is individual character. Industrial design has individual character if the overall impression it produces on the informed user differs from the overall impression produced on such a user by any design which has been made available to the public before the date on which the design for which protection is claimed has first been made available to the public or before the date of filing the application for registration or - if a priority is claimed - the date of priority. This requirment refers to creative work criterion, i.e. inventive contribution as an element for estimation if filed industrial design is eligible for registration. It means that industrial design consisted by simple summary of known appearances (e.g. calendar and thermometar) has not individual character.It does not mean that design must not be consisted from known esthetic elements. It does, of course. But it is very important that known esthetic components of design are combined on such a way that overall impression produced on informed user by that combination is different from overal impression produced by any other industrial design. (Ljubojev, N., Varga,S., 2010)

During esthetic formating of goods, designers are confined by technological and functional characteristics of products. Such stints are tolerate if appearance of the product is not solely dictated by its technical function.

There are two common rules for novelty and individual character. The first related to novelty and individual character of components and the second is related to moment when requirements for protection have to be fulfilled. In such a way, the legal protection of industrial design is not extended to those component parts which are not visible drugin normal use of a product, nor to those features of such part which are not visible when the part is mounted or which would not, in themselves, fulfil the requirements as to novelty and individual character. Normal use of a product is use of a product by final user excluding maintenance, servicing and repairing of a product. As for the second common rule, the moment when requirements for legal protection must be fulfilled is the moment of application filing i.e. moment of application priority, if claimed.

Apart from mentioned, there are examples where in comparative law as a requirement for granting of right to industrial design is laid down possibility of industrial or handicraft application. Application of industrial design in industrial or handicraft production is element of differentiation between industrial property law and copyright law. (Ljubojev, N.,Varga,S., 2010) "In contrast to works of applied art where as a requirement for protection is not laid down industrial or handicraft application, as for industrial design this condition is *conditio sine qua non*" (Janjic, M.,1982). Therefore, in order to enjoy protection on the basis of industrial design law, picture, drawing or model have to be eligible for production in industry or by craftsmen. Otherwise, picture, drawing or model remain author's works and as such subject-matter of copyright only (Besarovic, V., 1993).

The legal procedure for industrial design registration of the Republic of Serbia

In Serbia, protection of industrial designs is regulation by the Law on Legal Protection of Industrial Design (“Official Gazette of the Republic of Serbia”, No. 104/2009, 16/12/2009) and Regulations on the content of the register of applications and register of industrial designs, content of requests filed in the procedure for the grant and protection of rights on industrial designs and data published in the official gazette of the competent body (“Official Gazette of the Republic of Serbia”, No. 43/2010)**.**

The registration of industrial design is the subject matter of a special administrative procedure that after application is filled, launched and conducted by the authority - in the Republic of Serbia it is Intellectual Property Office (IPO) in Belgrade.

The contents of industrial design application

The application of industrial design contains:

- request for industrial design registration,
- description of the industrial design,
- two-dimensional representation of industrial design.

The request for industrial design registration is filed in two copies on D-1 form.

The description of industrial design must be precise, concise and literally focused onto design. It means that an industrial design description should not contain data on construction and function of the product and its functional advantages with respect to congeaerous products as well as other similar data. Instead of that, an industrial design description firstly should contain assignement to esthetic characteristics of overall appearance of the product - appearance of the product in full and secondly descriptions of industrial design elements, especially those esthetic components which are distinctive and by virtue of which the described industrial design is dinstinct to any other known industrial design.

An industrial design description must be terminologically clear and readable. Clearness is attained by using of art and geometry terminology. An industrial design description is readable if description is printed or typed on typing machine on the A4 paper format. Only one side of the sheet of paper is allowed to be used.

An industrial design description must contain: information identifying applicant (on the left corner of the top of the page), short and real but no commercial name of the designed product (centered), information by virtue of which one may conclude that industrial design is new, information on intented purpose of industrial design, if it is not deducable from the name of the designed product, applicant's signature.

For every industrial design applicant must file two copies of the industrial design description. Videlicet, industrial design application may be filed as multiple. Towards Serbian law, one may file industrial design application for up to 100 designs, under condition that all of them are eligible to be applied on the same class products as it envisaged by Agreement Establishing an International Classification for Industrial Designes (Locarno Classification, 1968). In the case of multiple application, it is necessary to write separate descriptions on a new sheet of paper (two copies) for every industrial design.

An industrial design description must be based on the industrial design representation. In that sense, parts of descriptions contain numerical signs (arabic numbers written in brackets) identical to those contained in industrial design representation marking the component that is described.

The representation of industrial design must be filled in two copies. The first copy should be fixed or written in by computer in so called block-house - a bordered space located on the D-1 form reverse side on a such a way that around the representation must be left empty space the least 5 mm. The second copy, maximal dimensions 16x16cm is filed separately. The same as description, representation must be literally focused on industrial design. It means that industrial design representation must not contain images of any other thing, face or animal. Industrial design must be represented so that all details are clearly visible. If it is not possible to be done by one representation, then is filled more representation of the same industrial design either from different angles or of different parts of designed product. In that case the rules on numbering are applied. Numbering of industrial design representation is done by writing in two arabic numbers separated by full point towards general numerical queue (1.1, 1.2, 1.3,...).

On the representation copy which is adhered to or written in by computer in the D-1 form reverse side numbering is done on the front side and on the industrial design representation copy filling separately, numbering is done on the reverse side. Additional rules on numbering are applied in the case of multiple application.
In that case, the first number is the ordinal number of industrial design and the second number is ordinal number of the industrial design of the same ordinal number detail representation (1.1, 2.1, 2.2, 2.3, 3.1,...). In any case, representations must be fixed on the D-1 form reverse side on that queue as they are numbered. For these purpose there are 20 "block-houses" available on the one form specimen.

Representation of the industrial design can be filled as a photography or graphic reproduction of industrial design. Photography must be of professional quality, with flat angles and neutral background. It must be got by virtue on photo negative or slide. It means that industrial design must not be represented by instant photography, photography retouched with ink or correcting fluid, photography that is not suitable for offset reproduction or photocopy.

If an applicant file of industrial design representation is in the form of graphic reproduction it must be original, of professional quality, made by equipment for technical drawing or by computer both on opaque white paper. Industrial design must be presented in perspective, but it is allowed to contain shadows due to reliefs presentation. Graphic reproduction must not be technical drawing where industrial design is presented in elevation views (projections) or cross-mode and especially it must not be a technical drawing that contains centerlines and dimensions. Graphic reproduction of industrial design must not contain explanations or legends (as those on maps) and must be siutable for offset reproduction.

Howsoever filled, industrial design representation must not be folded or stapled.

In Serbian law is prescribed that applicant is allowed to file a specimen instead of two-dimensional representation of industrial design. Maximal dimensions of such specimen are 26cm x 17cm x 3mm and it must not be heavier than 50 grams. Specimen is filed fixed on the paper (A4 paper size) and regularly numbered. Must not be folded. In such cases application will be deemed formally regular under condition that in next 6 months applicant file two-dimensional representation of industrial design prepared in accordance to law to IPO. Products that are suitable for spoilage or dangerous for storage will not be accepted as specimens.
After the application had been filed, the representation of industrial design cannot be amended so that the scope and contents of it are essentially different from that as it described.

Application may be supplemented by: appointment of representative, if representative appointed, certified transcription of the application, if priority claimed, certification, if exhibition priority claimed, statement of designer(s) that (do)es not want that application contain his/her(their) name(s), statement on the legal ground for filing of application, if applicant is not designer, statement on appointment of common representative, if there are more applicants, and proof that taxes are paid.

Statistical data of the IPO show the structure of industrial design register from 2007-2014:

Year	Hague Agreement	National registrations		Total
		Foreign submitters	Domestic submitters	
2007	431	16	148	595
2008	322	37	116	475
2009	197	17	118	332
2010	258	23	81	362
2011	280	24	78	382
2012	343	22	66	431
2013	284	30	94	408
2014	219	9	97	325

Table 2. Statistical data on the structure of industrial design register in the Republic of Serbia (2007-2014).

By adoption of The Law on the Legal Protection of Industrial Designs Republic of Serbia a harmonization with the Directive 2004/48/ of EC of European Parliament and Council from April 2004 on inforcement of intellectual property rights and Directive on Legal Protection of Design 98/71/EC of EU Parliament and Council. The significance of the Law of Intellectual Property of EU for Republic of Serbia lies in the fact that even the countries which are not currently members of EU take over solution from EU regulations when forming their national legislation.

International protection of industrial design in Serbia

Significant regulations: Law on the Ratification of the Hague Agreement Concerning the International Deposit of Industrial Designs (Hague document) and the Complementary Act of Stockholm ("Official Gazette - International Treaties", No. 3/1993), Law on Ratification Locarno Arrangements on Establishing an International Classification for Industrial Designs ("Official Gazette - International Treaties. No. 51/1974"), Law on Ratification of the Geneva Act of the Hague Agreement Concerning the International Registration of Industrial Designs adopted at a conference of 02.07.1999 ("Official Gazette of RS - International Treaties", No. 42/2009).

Natural persons who are nationals of Republic of Serbia or who have their domicile in its territory, and legal entities which have a registered address or a real and effective industrial or commercial establishment in the territory of Republic of Serbia, desirous of protecting their design abroad, are obliged to first file an application in the country.

The Hague Agreement is an international registration system which offers the possibility of obtaing protection for industrial designs in a number of States and/or intergovernmental organizations (both referred to as Contracting Parties (See: Table 1.) by means of a single international application filed with the International Bureau of the World Intellectual Property Organization (WIPO)

THE LEGAL PROCEDURE FOR INDUSTRIAL DESIGN REGISTRATION OF THE REPUBLIC OF CROATIA

In Croatia, protection of industrial designs is regulation by the Industrial Design Act and Acts on Amendments to the Industrial Design Act (OG Nos. 173/2003, 76/2007, 30/2009 & 49/2011) (2011) and Regulations on Industrial Designs and Regulations Supplementing the Industrial Design Regulations (OG Nos. 173/2003 & 76/2007) (2011) 72/2004, 117/2007, 66/2011, 125/2013).

Registered industrial design as the right of intellectual property is achieved in Croatia on the grounds of the registration carried out by the State Intellectual Property Office of the Republic of Croatia (SIPO) based on the results of the performed procedure of examining the registration of industrial design.

The basic conditions that a design must satisfy in order to be protected as an intellectual property are novelty and individual character of design. In addition, its features musn't be exclusively conditioned by its technical function.

Registered industrial design provides its owner an exclusive right of usage, offer, putting on sale, import, export of the product which either contains industrial design or on which industrial design is applied. Protected design represents intellectual property whose usage can be permitted by the owner during the protection period. In other words, the owner can give a licence or completely transfer the right to other person.

Upon joining EU Croatia introduced a new right of intellectual property – non-registered design of EU which is achieved without a formal registration procedure by an appropriate exposure of design to public on the territory of EU. The rights resulted from non-registered design are related to prohibition of misuse through multiplication of the protected design.

Industrial design can also be copyright if it satisfies the conditions for copyright protection. In this case industrial design will be protected from its creation no matter whether the procedure for registration of industrial design is carried out or not. In Croatia, unlike some other countries, these two forms of protection are not mutually excluded, so they can exist simultaneously for the same industrial design.

The registration process in Croatia

Protection of a product appearance by industrial design as a form of intellectual property is carried out during registration procedure in SIPO. Protection conditions and the whole procedure upon industrial design registration in Croatia are regulated by the Industrial Design Act and the Regulations on Industrial Designs and application forms are to be submitted on the forms D-1 and D-2.

Taking into account that one of the main conditions for industrial design protection is novelty, SIPO emhasizes on their site that registration procedure should be started before putting a product on sale, in other words, before exposing a design to public.

Registration procedure is started by issuing an application/registration form which can be for one or more different designs. The condition for applying for more different designs is that all designs in the application form must be related to products which belong to the same class of International Classification for Industrial Design (Lokarno Classification, 1968).

The application form should contain information about the applicant, designer, other necessary data, a photo or graphic of design which is to be protected. Upon submission of a regular form or after the procedure of its formal arrangement, the Office will carry out a regular procedure of examining the conditions for industrial design protection. If all the conditions are satisfied, a decision is made on indusrial design registration and the information are published in Office official gazette. The application form can be also submitted online via SIPO.

International Classification of Industrial Design (Lokarno Classification)

The registration form of industrial design must contain a product mark which should include design or on which design should be applied.

The form must include a mark of the product class according to the Locarno Agreement Establishing an International Classification for Industrial Designs (of 8 October, 1968) (Lokarno Classification), which contains 32 classes of a product. Classification serves for publishing design in official gazette and for browsing the register. However, if an applicant does not mark a class according to Lokarno Classification, it will be marked by the Office during the procedure.

Registration form examination

The submitted registration form of industrial design is examined by the Office on the basis of formal condition issued by the by the Law and the Regulations. Payment of procedure costs is also checked. If the form does not satisfy the conditions, the Office asks the applicant to fulfill the conditions in the prescribed terms, otherwise the application will be rejected.

The correct application is further examined *ex officio* in respect to certain **requirements** for the registration of an industrial design, so the registration can be refused entirely or partially if:

- Design does not satisfy a very definition of design;
- Design is opposed to public interest or moral norms;
- Design contains the elements of country’s symbols, marksor coat of arms.

If registration form is not against legal conditions, industrial design will be registered and information about it published in Office official gazette (the Croatian Intellectual Property Gazette).

The Office **does not examine *ex officio*** the novelty of a design applying for registration, nor its individual character, which can be established as a possible legal invalidity subsequently, in the procedure for declaring the industrial design invalid.

International protection of design

International treaties of the Republic of Croatian: Hague Agreement Concerning the International Registration of Industrial Designs of 1925, as revised at The Hague in 1960 and amended in Stockholm in 1967 with the amendments of 1979 and the Geneva Act of the Hague Agreement Concerning the International Registration of Industrial Designs, adopted in Geneva in 1999. (“Official Gazette - International Treaties ", No. 14/03), Common regulations under the Hague Agreement Act of 1999, Act of the agreement from 1960 and the Act of the Agreement from 1934 (which is in force since 2009) (“Official Gazette - International Treaties", No. 02/10), Amendments to the Common Regulations under the Act of the Hague Agreement of 1934, which entered into force in 2010. ("Official Gazette - International Treaties", No. 02/10), Administrative Instructions for the application of the Hague Agreement ("Official Gazette - International Treaties", No. 02/10) and Locarno Agreement Establishing an International Classification for Industrial Designs (1968) ("The Official Gazette - International Treaties", No. 12/93 and 3/99).

Croatia is a Member of the 1999 (Geneva) and 1960 (Hague) Acts of the Hague Agreement, so every physical and legal entity from Croatia can submit international registration form via the Hague Agreement.

International registration of industrial design is submitted directly to International Bureau of the WIPO/OMPI, for all submitters from Croatia, in English or French. International body examines the formal registration and after that announces the information on international registration in the form of E-bulletin on the Internet page WIPO.

Member countries in which the protection was requested would carry out the examination of every registration in relation to the conditions of protection prescribed by their national law. On the grounds of such examination the national body of the country in which protection was requested can reject the activities of international registration on the territory of the country in the period of 6 or 12 months. In this case the procedure will be continued directly before the national body of the country until the final decision is made.

Industrial design protection in the European Union

Besides industrial designs protection in the national offices of the EU Member States, there is a possibility to protect **Registered Community Design (RCD)**. On the territory of the EU there is a certain protection provided for **non-registered** Community designs, which protection is time and content limited.

RCD is valid in all EU Member States, and the registration procedure of such a design is carried out by the Office for Harmonisation in the Internal Market (OHIM) with headquarters in Alicante, Spain. An RCD is valid in the EU as a whole and it is not possible to limit the geographical scope of protection only to certain Member States.

Until the moment of accession of the Republic of Croatia to the full membership of the EU, citizens of the Republic of Croatia and legal entities having an effective commercial establishment in the Republic of Croatia may protect a Community Design directly with the OHIM, or under the Hague System for the International Registration of Industrial Designs (it must be indicated that protection is requested in the EU (EM)). Following the accession of Croatia to the full membership of the EU, it will be possible to file a RCD application through the State Intellectual Property Office of the Republic of Croatia.

From the moment of accession of the Republic of Croatia to the full membership of the European Union, the legal effects of all RCD applications and acquired Community designs will be automatically extended to the territory of the Republic of Croatia.

CONCLUSIONS

The reason for the legal protection of the results of industrial design is in economic value of the esthetic shaping of goods.The subject-matter of the industrial design rights is appearance of industrial or handicraft product.There are two general affirmative conditions which have to be fulfilled in order that the right on industrial design is granted: novelty and individual character.

Fulfillment of the mentioned requirements is the subject matter of a special administrative procedure that, after the application is filled, is launched and conducted by authority that in the Republic of Serbia is Intellectual Property Office (IPO) in Belgrade. The right on industrial design is granted for 25 years. During the period, commercial exploitation of the registered industrial design is reserved for the right holder(s) (and their successors in title) exclusivelly.

By adoption of The Law on the Legal Protection of Industrial Designs Republic of Serbia a harmonization with the Directive 2004/48/ of EC of European Parliament and Council from April 2004 on inforcement of intellectual property rights and Directive on Legal Protection of Design 98/71/EC of EU Parliament and Council. The significance of the Law of intellectual property of EU for Republic of Serbia lies in the fact that even the countries which are not currently members of European Union take over solution from European Union regulations when forming their national legislation.

Registered industrial design as the right of intellectual property is achieved in Croatia on the grounds of the registration carried out by the State Intellectual Property Office of the Republic of Croatia based on the results of the performed procedure of examining the registration of industrial design. Upon joining EU Croatia introduced a new right of intellectual property – non-registered design of EU which is achieved without a formal registration procedure by an appropriate exposure of design to public on the territory of EU. From the moment of accession of the Republic of Croatia to the full membership of the European Union, the legal effects of all Registered Community Design applications and acquired Community designs will be automatically extended to the territory of the Republic of Croatia.

REFERENCES

Bainbridge, D. (2007). *Intellectual Property*, Sixth edition, Pearson Education Limited, Harlow.

Beazley, A., Bond, T. (2003) *Computer – aided pattern design & product development*, Blackwell, London.

Besarovic, V. (1993). *Intellectual Property Rights, Industrial PropertyandCopyright*,Second edition, Belgrade.

Bowman E., Kogut, B. (1995) *Redesigning the Firm*, Oxford University Press, New York, Oxford.

Carr, D. K., Johansson, H. J. (1995) *Best Praktices in Reengineering*, McGraw-Hill, Inc., New York.

Cooper, R.G., Kleinschmidt, E.J., Success Factors in Product Innovation, *Industrial Marketing Management*, Vol.16, Issue 3, 1987,215-223.

Council Regulation (EC) No 6/2002 of 12 Dec. 2001 on Community designs (*OJ* No L 3 fo 5th. Jan. 2002) amended by Council Regulation No 1891/2006, amending Regulations (EC) No 6/2002 and (EC) No 40/94 to give effect to the accession of the European Community to the Geneva Act of the Hague Agreement concerning the international registration of industrial designs (*OJ EC* No L 386 of 29.12.2006) .

Crawford, M., Di Benedetto, A.,(2003) *New Products Management* 7th Edition, McGraw-Hill / Irwin, Boston.

Directive 98/71/EC of the European Parliament and of the Council of 13 October 1998 on the legal protection of designs (*Official Journal L 289, 28/10/1998).*

Fruht, M. (1990). *Designin Manufacturing*, Second edition,Scientific Books,Belgrade.

Fruht, M., Rakic, M., Rakic, I. (2003). *Graphic Design: the Creation of Markets*, Second edition, Institute for Textbooksand Teaching Aids, Belgrade.

Industrial Design Act and Acts on Amendments to the Industrial Design Act (*OG Nos*. 173/2003, 76/2007, 30/2009 & 49/2011)

Janjic, M. (1982). *Industrial Propertyand CopyrightLaw*,SecondEdition, *Official Gazette of the SFRY*, Belgrade.

Kotler, P. (1989).*Marketing Management2*,Informator,Zagreb.

Kuzmanovic, S. (2008). *Industrial Design*, Faculty of Technical Sciences, Novi Sad.
Law on Legal Protection of Industrial Design (*Official Gazette of the Republic of Serbia*, No. 104/2009; 16/12/2009)
Law on Ratification Locarn Arrangements on Establishing an International Classification for Industrial Designs (*Official Gazette - International Treaties*. No. 51/1974).
Law on Ratification of the Geneva Act of the Hague Agreement Concerning the International Registration of Industrial Designs adopted at a conference of 02.07.1999. (*Official Gazette of RS - International Treaties*, No. 42/2009).
Law on the Ratification of the Hague Agreement Concerning the International Deposit of Industrial Designs (Hague document) and the Complementary Act of Stockholm (*Official Gazette - International Treaties*, No. 3/1993).
Lindinger, H. (1991), Ulm Design: The Morality of Objects, Cambridge: The MIT Press.
Ljubojev N. Ivin, D (2013) *Basic Characteristics of European Union Legislation In The Field of Industrial Design Protection,* 5rd Scientific-profesional conference "Textile Science & Economy III" , University of Novi Sad, Technical faculty „Mihajlo Pupin", Zrenjanin , Republic of Serbia, 3 (1).
Ljubojev N. Varga S.(2011) *Registracion of Industrial Desing in the Republic of Serbia*. Proceedings,3rd Scientific-profesional conference "Textile Science & Economy III" , University of Novi Sad, Republic of Serbia, Zrenjanin, 3 (1), 103-110.
Magrab, E., *Integrated Product and Process Design and Development*, CRC Press, New York, 1997.
McDermott, C. (1992). Essential Design. London, UK: Bloomsbury Publishing Plc.
Regulations on the content of the register of applications and register of industrial designs, content of requests filed in the procedure for the grant and protection of rights on industrial designs and data published in the official gazette of the competent body (*Official Gazette of the Republic of Serbia,* No 43/2010).
Regulations on Industrial Designs and Regulations Supplementing the Industrial Design Regulations (*OG* Nos. 173/2003 & 76/2007) (2011) 72/2004, 117/2007, 66/2011, 125/2013).
Sapinski A. N. (1965) Design '65.*Work of the Society of Industrial Designers,* Australia. 10.
Van Doren H.L. (1954) *Industrial design; A practical guide to product design and development* ,Unknown Binding.
Vasiljevic,M. R. (1999). *Design:ContemporaryViews*,NewDays, Belgrade.
Woodham J.M. (2004) *A Dictionary of Modern Design*, Oxford University Pres

PERSONNEL – KEY PROBLEM OF TEXTILE INDUSTRY

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ABSTRACT

This paper discusses real business conditions that impose on manufacturers of clothing the choice of selecting their own strategy, by which they will look for their success on the market only in places where there was some space left for them by their competition. The paper points out that these are primarily innovative products and for the development of these products, the existence of strong links between retail, research institutions and industry is necessary. It is emphasized that this relationship can only be established by the personnel with industrial experience. The studies of attitudes of the owners of textile companies in the region of South Banat are displayed which show a lack of trained workers, mainly tailors and personnel for the management of the production.

Key words: Serbian textile industry, personnel with industrial experience, a lack of trained workers in manufacturing.

INTRODUCTION

Textile industry is particularly sensitive to the recession. Overstocking the market with cheap textiles and expansion of production in Asian countries have led to a crisis in the textile industry, especially in countries in transition. Serbia welcomed the transition without resources, development strategy and entered the privatization process while expecting new investments and increasing business efficiency of existing social companies. However, when choosing the model of privatization the state opted for a model that provides state budget revenues, the financing of the expensive state apparatus and the lack of new greenfield investments to the fullest extent. In such conditions, textile industry was the first to suffer the consequences.

It is true that the problem of personnel now in the textile sector is the basic problem but it is difficult to bring up strong facts about this problem arousing only in the state school system from the central to higher education. Mainly, by closing large social textile companies all current private companies from the textile sector have emerged. The fact is that these private companies at their foundation mainly employed professional workers with industrial traditions that have lost their jobs in social enterprises. Therefore, the problem of personnel in the textile sector is in the fact that professional workers with industrial experience, in whose training social enterprises have invested substantial resources, are going to a retirement these days in a growing number. The reluctance of private companies to invest in the training of highly qualified personnel for specific jobs required only by the same companies and expectations of these companies of the state to do it instead of them, is the main problem and may result in the diminishing of the competitiveness of this sector today. Therefore, this paper proposes solving personnel problems in real conditions in which the sector operates in Serbia. The basic idea is to include as many young people as possible through promotional activities in this sector and to enable them, by the implementation of envisaged activities, not only to look for work but to create their own work themselves in the current textile enterprises. [1-2].

THE PERFORMANCE OF COMPANIES IN THE FIELD OF FASHION SECTOR

Today, the success of business entities is reflected in the manner how they direct their own development towards innovation, new knowledge, education and the creation of a unique added value.
When assessing the performance of textile enterprises, it is necessary to take into account the crisis that has been present in the country as well as the additional impact of the global crisis in the world.
In order to clarify the difficult situation that the textile industry has been experiencing, it is necessary to look back to the former development of this industry.

However, this situation has been changed in early 80s mainly under the influence of political changes in many countries in Africa, Asia and South America. Many companies from developed countries have taken an advantage of these policy changes, and started making cheap products with small investments designed primarily for markets of these countries. This way, the market life of products was prolonged because it did not require an expensive development that has been necessary for new products on the market.
This has led to the emergence of a completely new concept in the global economy that can be expressed with the question: Why give workers in Europe and America 10 times higher pay than in Asia and Africa? as well as with a request: Let them make this "stupid" thing for us as cheap as possible. According to this concept, the profit of the company is the only important thing. It is interesting that in this conception there is no room for investment in science - because no one will look for a product that does not exist. This concept first hit the textile industry which has resulted in a large displacement of jobs to countries with cheap labor force. The development of technology seemed unnecessary because it seemed unnecessary to improve the manual operation of someone working for a dollar a day. This conception has also put the quality of a product in the second place. What is emphasized is a very new scientific discipline - marketing which is used to convince people that this very product is made just for them. An aggressive marketing has imposed the product on customers as something that expresses a personal opinion, property, etc. The aggressive marketing has not emphasized the quality and comfortability of clothing but it replaced them with the story that if we for example buy the same brand of T-shirts that Novak Djokovic is wearing, we will be playing tennis like him, that we will be fashion conscious if we wear clothes of Versace, etc. The aggressive marketing went even further into the story that if a person didn’t wear branded clothes then he or she had no identity and no attitude and in that case the person would not be socially accepted. All of these stories have experienced a very easy access to citizens by the occurrence of private televisions which used this type of advertising as their main source of income.
Today, information about fashion trends is available on global databases. Thus, for example WGSN trends, has over 6000 users who believe in advice and predictions of WGSN's, providing them with the security of making the best decisions related to design and retail.

*Figure 1: Global database – **WGSN***

This concept of the global economy, which has replaced the technology as a science with marketing, has proved to be unsustainable because in countries without production there were left only: well-paid jobs related to the service, a small number of civil servants, jobs in highly subsidized economic sectors as well as a large number of users of social assistance.

A new story of aggressive marketing had to be placed in the new concept of the sale of products. This results in the commercial centers in the suburbs, where the customer usually goes to by his own vehicle and where all day long contents are provided for him or her. At these places the customer has access to a very large assortment of products. These centers are designed in a way that we can lose a sense of reality in them, creating thus a sense of personal satisfaction by buying products that are not of a good quality but should create a sense of identification. The whole conception strives to convince the customer that only one product does not provide a full identification but it requires many different products as well.

Figure 2: Some examples of the application of a fashion design

This concept of selling is quite different from selling in small retail stores. These stores are in the real environment, they are located in city centers, shop assistants directly and realistically communicate with customers in them and customers are aware that they are spending hard-earned money.

So these stores do not communicate with customers through the media but through their shop windows, next to which thousands of people go by every day. In such an environment only innovative clothing that has a real purpose and clear reasons for buying can be sold. To turn the attention of customers, who are primarily passing by, to products in shop windows, these products must be attractive and suggestively displayed. This need resulted in the significant development of a design that has, in a very short time, established itself as the most important scientific discipline of technology. The design was actually created as a synthesis of an entire textile science with psychology and sociology with the aim of shaping and producing new products that have to be functional, beautiful and socially acceptable.

Design opens a new story that presents designer clothes, which are now of a high-quality and innovative, as an expression of individuality. With design customer receives a possibility for a huge selection used for expressing individuality in appearance. This is a completely different story from the one offered by the aggressive marketing about an identification with someone or something.

It is obvious that the concept of design uses the media to communicate with customers as well. At the same time it is obvious that the media are no longer being used in an aggressive and suggestive way but they are informing people moderately about what they are offered with and how they can use it to express their individuality.

The conception of design has largely brought the customers back to the stores that are located in city centers and thus significantly positioned the sale of innovative products which are the result of the interaction between technology as a science and production.

It cannot be expected that the concept of the design, that is innovative products will completely suppress the concept of "make me a stupid thing as cheaper as possible" but its merit is certainly in the positioning of two concepts on the global market. It is realistic to expect that the global economy will grow and thus the standard of the citizens, which will increase the market share for innovative products as well.

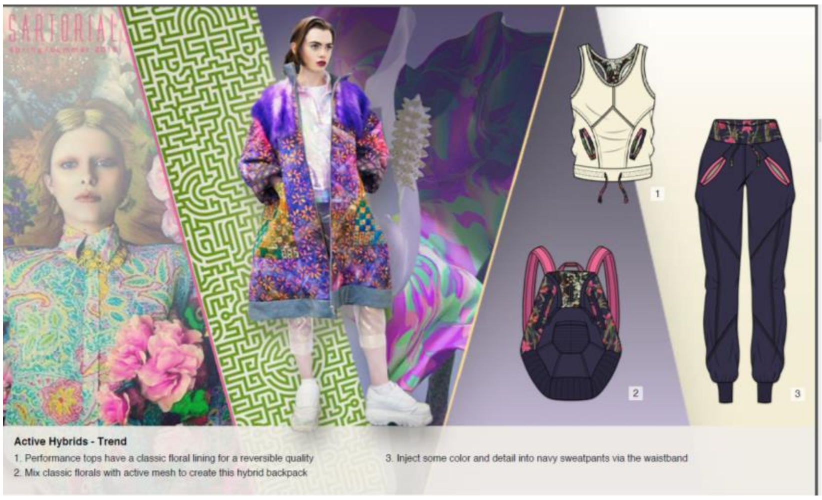

Figure 3: Some examples of the application of a fashion design

THE PRESENT CONCEPTION OF THE PRODUCTION

The fact is that nowadays manufacturers are offered with three concepts, namely: to create cheap products of suspicious origin and quality and sell them cheaply; to make cheap products and to sell them at higher price thus assuring the customers that the brand is the most important issue and that, by owning the product, the customer identifies himself or herself with something or someone; to make expensive, high quality and inventive products which will, with their properties rather than with aggressive marketing, convince customers in their acceptability, and to sell them at higher price.

Figure 4: A production plant for sewing clothes

Nowadays real operating conditions impose on manufacturers the choice of their own strategy with which they will seek their success on the market only in places where the competition left them some space. It can be freely said for textile manufacturing that they are inventive and expensive products which remained free on behalf of the competition. Naturally, the development of these products requires a highly professional workforce and a series of related activities such as: researching the market in order to determine what kind of product the market demands; the development of research centers in which the product would be made as a result of research and development of new materials; the development of technological development centers in which production process would be developed and adapted to the existing technology of manufacturers.

These are very large requirements that must be met to make the system sustainable. Specifically, there must be a strong link between retail, research institutions and industry. This means that what retail, which is constantly in contact with customers, demands such a product scientific institutions should develop and industry itself should produce [3-10].

PERSONNEL - KEY PROBLEM IN SERBIAN TEXTILE INDUSTRY

As it has already been said, there must be a strong link between retail, research institutions and industry to make the production system sustainable. This connection can be achieved only by a highly creative personnel that will provide solutions and the development of new technologies and products capable to cope with the strong competition in the world market.

In order to review the problem of personnel, an analysis of the attitudes of managers in textile companies from the region of South Banat was conducted. The research was conducted on the basis of a specially designed instrument – an expert interview. This research involved the design of the questionnaire and the sample.

Methods of assessment of surveys fall under the so-called qualitative or event-based methods, for example they generally give answers to the questions of what will happen, when it will happen and what is the probability that it will happen. Basically, these are unconditional methods because the phenomenon of a predicted event is usually not caused by the occurrence of another event. These methods are based on the basic hypothesis that the future status largely conditions information about the current and previous state.

Given that the predictions are means to decrease uncertainty of the future, it is logical that forecasting should precede the planning because it is the method by which it can be determined how far weather plans can go. What should and what in the given circumstances cannot or will not pay off to plan.
The sample of the survey was designed to a size of 18 units. Of this number, 5 enterprises had up to 10 employees (micro enterprises), 10 enterprises had up to 50 employees (small enterprises), 2 enterprises had up to 250 employees (medium enterprises) and one enterprise had over 250 employees (a big enterprise).

All enterprises were in private ownership. Regarding the structure of the respondents, 16 of them are business owners, while one respondent is HR manager and one respondent is an associate in organizing and monitoring production. When it comes to the level of education, 6 respondents have the 4th level of professional qualification, two respondents have the 5th level of professional qualification, 7 respondents have the 6th level of professional qualification and only one respondent has the 7th level of professional qualification.

ATTITUDES OF RESPONDENTS

To the question of whether they need help to solve the problem of lack of personnel, in the training of workers (support for the establishment of the Center for industrial training), the respondents answered affirmatively to:

- ❖ tailors - 55,56%
- ❖ designers - 22.22%
- ❖ constructors and modelers - 33.33%
- ❖ technicians - 33.33%
- ❖ specifiers - 33.33%
- ❖ managers of the production - 50%

The largest number of respondents, 53% believe that their enterprises have an average innovation, while 47% believe that their enterprises have a satisfactory level of innovation. When it comes to the issue of business flexibility, the largest number of respondents, 62.5% of them believe that it is satisfactory, 25% of them think that the level is of an average flexibility, while 12.5% of them believe that the level of business flexibility is high.
When it comes to the issue of improving the productivity of knowledge, 50% of respondents refer to their organization as traditional, 31.25% of refer to their organization as the organization based on knowledge, 12.5% of them believe that their organization is based on the resource, while 6.25% of them consider that their organization creates knowledge.

When it comes to the need for the permanent training of employees, 86.6% of respondents have said that their employees have not been engaged in professional training in the management field in the past year, while 13.4% of respondents have answered affirmatively. Those who were engaged in the training in the management field, improved their skills in the following areas:

- ❖ Quality - 33,3%
- ❖ Marketing - 33.3%
- ❖ Human Resources Management - 16.7%
- ❖ Development - 16.7%.

❖ CONCLUSIONS

Not much is needed to prove the fact that, for the success of each sector and individual enterprises, managerial, technological and technical knowledge as well as the experience of experts in the enterprise play the crucial role. This relates to an intensive integration of young people into the textile sector. However, due to an incorrect transition, the textile sector in Serbia has experienced the closure of many enterprises and the layoff of a large number of employees, which results in a negative attitude of young people towards this sector. The paper presents the research of the attitudes of the owners of textile enterprises in the region of South Banat which show a lack of trained personnel, mainly tailors and personnel for the management of production. The basic idea for improving the current situation is to include as many young people as possible in this sector through promotional activities and to enable young people not to look for work only but to create it themselves in the current textile enterprises by the implementation of envisaged activities.

REFERENCES

1. V. Petrović: Model of revival of the textile and clothing industry in Srbia, 6th International Scientific-Professional Conference Textile Science and Economy, Tehnički fakultet »Mihajlo Pupin«, Zrenjanin, 28-30.,oktobar 2014., Book of proceedings, ISBN: 978-86-7672-235-8, 137-145.
2. M.Stamenković: Ekspanzija produkcije i primene tehničkih tekstilija novi trend u tekstilnoj tehnologiji, Sekcijsko predavanje, VIII Simpozijum: Savremene tehnologije i privredni razvoj – sa međunarodnim učešćem, Tehnološki fakultet, Leskovac, 23-24-10.2009.godine.
3. V. Petrović: European Textile Platform for the Future of clothing and Textile, Regional Textile conference "Sustainable development of the Textile Industry in Republic of Macedonia", Ministry of Economy of Republic of Macedonia in cooperation with Faculty of Technology and Metallurgy, University "Ss. Cyril and Methodius", 04 - 05 October, 2012., Skopje, Macedonija, (*rad objavljen u Zborniku radova u elektronskoj formi*).
4. V. Petrović, J.Stepanović, M.Stanković, M. Reljić, S.Stefanović:Savremena kretanja u tekstilnoj i odevnoj industriji u Evropi, Menadžment, Inovacije, Razvoj, Volume 8, No.1, str. 83 - 89, (2013). UDK005, ISSN 1452-8800.
5. V. Petrović, J. Stepanović, M. Stanković, M. Reljić, S. Stefanović: Savremena kretanja u tekstilnoj i odevnoj industriji u Evropi, naučni E-forum: „Razvoj i upravljanje 2012.“, Vrnjačka Banja, 22. i 23. 11., 2012., ISBN 978-86-86677-10-5, COBISS.SR-ID 2760086791, (*rad objavljen u Zborniku radova u elektronskoj formi*).
6. V. Petrović: (2004), Pravci razvoja odevnih firmi u funkciji osposobljavanja za brze odzive na zahteve tržišta zemalja velikih potrošača odeće , I Naučno-stručni skup Tekstilne industrije Zapadne Srbije, Regionalna privredna komora Užice, decembar 2004.godine, Arilje, str.12-20.
7. Vasilije M. Petrović: (2006), Savremene tehnologije u odevnoj industriji, II Naučno-stručni skup Tekstilne industrije Zapadne Srbije, Regionalna privredna komora Užice, 21-23. septembar 2006.godine, Ivanjica
8. V.Petrovic, M. Stanković, I. Skoko, A.Zdravković, S.Stefanović: Optimization of cutting patterns using CAD system, Общотекстилна конференция’2012, „Inovacii v tekstila i oblekloto, oktobar 2012, Sofiя, Bulgaria.
9. V.Petrović, J.Stepanović, D.B-Popov, M.Reljić: Optimizacija izrade krojnih slika upotrebom CAD sistema, Naučno-stručni skup Efikasnost u privredi 2008, 04-05.04.2008.,Vrnjačka Banja, (štampan u elektronskoj formi).
10. V.Petrović, M.Martinović, D.Stojiljković, J.Stepanović, D.B-Popov: Designing well fitting clothes, VII Simpozijum “Savremene tehnologije i privredni razvoj”, 19-20. oktobar, 2007., Leskovac, str.258-265.

THE INLUENCE OF THE KNITTED PRODUCTS DENSITY CHANGE ON FRAYING RESISTANCE AND AIR PERMEABILITY

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ABSTRACT

The interest in knitted products has been on the rise lately because of their simple production technology, low expenses, a high level of comfort and their wide range of products. Consumers expect from knitted clothes to be durable, i.e. to keep its basic dimensions during the exploitation and to be resistant to fraying. In this study, knitted products (clothes), with different densities and made (knitted) of 100% polyester, were tested. The aim of the testing was to determine the influence of density change on the resistance to fraying and air permeability, as well as the relation between the fraying resistance against felt and fraying resistance against fabric (cloth). All tests were done according to the JUS and ISO standards. Besides that, the results show that the increasing of density of the knitted clothes increases the fraying resistance; in other words, the materials which have a higher surface weight also have a higher fraying resistance. The results also show that lower density knitted products have a higher air permeability and they lose more mass when fraying against felt; this means that they have a higher fraying resistance against fabric (cloth).

Key words: knitted clothes (fabric), fraying resistance, air permeability, knitted fabric density.

INTRODUCTION

Because of their specific structure in the shape of loops, knitted fabrics have a good extensibility, a pleasant feel to them; they fit the shape of the body and provide a high level of comfort. Besides that, consumers expect from knitted fabrics to be durable, to keep its basic dimensions during the exploitation and to be fraying resistant. The main factors influencing the quality of knitted fabrics are: the fiber composition, the characteristics of raw materials, i.e. the variations in the properties of yarn, the method of treatment of yarn and knitted fabrics, the construction - the structure and the geometric properties.

With little changes of different parameters in the quality of raw materials, technical characteristics of the machines and constructive characteristics of the knitted fabrics, big variations in the knitted fabrics quality are achieved [1]. In this study, 100% polyester materials are used. This artificial material has a bit of bad reputation. However, nowadays polyester materials, which are very comfortable to wear, are being made. Its best characteristic is the fact that polyester is resistant to crumpling and it keeps its shape (form). Polyester is a very resistant material, very hard for damaging, durable and easy-washing. It can be washed in the washing machine and dried in a drier at lower temperatures, or it can be air-dried because of its quick-drying characteristic. It usually does not need ironing.

The aim of the testing in this study is to determine the influence of density change on the resistance to fraying and air permeability, as well as the relation between the fraying resistance against felt and fraying resistance against fabric (cloth). The fraying test was done according to the BS EN ISO 12947-3 standard, which determines weight loss. The air permeability was done according to the ISO standard 9237.

THE ORETICAL PART

One of the most important parameters, technologically speaking, in the production of knitted fabrics is the density which is represented by the number of loops per a surface unit. This parameter has a huge influence on all other characteristics of the knitted item. As we have said earlier, the knitted fabric was made of elementary structural units-loops, which are arranged in vertical rows and horizontally inside the knitted fabric. This means that one row is consisted of a huge number of loops which stand one above the other vertically, while another one consists of a huge number of loops arranged side by side horizontally. According to this one can differ:

- Vertical density which represents the number of loops in one row in a certain length unit and it is marked as D_v (cm^{-1});
- Horizontal density which represents the number of loops in one course (line) in a certain length unit and it is marked as D_h (cm^{-1}).

The total density of the knitted fabric is the total number of loops per a surface unit of the knitted fabric. This density is calculated as the multiplication of the vertical and the horizontal densities of the knitted fabric and is calculated according to the relation [2].

$$D = D_h \cdot D_v \,(cm^2) \tag{1}$$

The coefficient of the knitted fabric density is given in the equation and it is the relation between the horizontal and vertical densities that represents the same relation between the height and the width of the loop, observed per the same length unit [2]. The knitted fabric density coefficient is calculated according to the relation.

$$C= \frac{D_h}{D_v} \tag{2}$$

The knitted fabrics density is one of the main parameters which physically-mechanical properties of the knitted fabrics depend on. So, vertical and horizontal densities are key parameters in the knitted fabrics calculations and their usability evaluation [2]. The surface weight (mass) of the knitted fabric is its weight per a certain surface unit and it's the function of the horizontal and vertical densities, the fineness of the yarns and the yarn's length necessary for the making of the loop. Since the length of the yarn needed for one loop is the function of both densities, one can say that the surface weight of knitted fabric depends on its horizontal and vertical densities and on the fineness of the used yarn. A square meter is most often used as a surface unit [2]. Fraying resistance is determined by the method of weight loss, am in regard to the initial mass of the knitted fabricm_1, i.e.:

$$\Delta m= \frac{m_1 - m_2}{m_1} \cdot 100(\%) \tag{3}$$

where m_1- the initial mass of the knitted fabric; m_2- the knitted fabric mass after the fraying (g) [3].

EXPERIMENTAL PART

Six knitted 100% polyester fabric with different densities and finenesses: $T_{t1} = 9{,}2$ tex, $T_{t2} = 8{,}8$ tex, $T_{t3} = 5{,}6$ tex, $T_{t4} = 12$ tex, $T_{t5} = 10$ tex, $T_{t6} = 12$ tex were tested in this study.
The aim of the testing was to determine the density change influence level on fraying resistance and air permeability, as well as the relation between fraying resistance against felt and fraying resistance against cloth. Structural characteristics of the knitted fabric: horizontal density- D_h, vertical density -

D_v, total density- D , thickness - h and surface mass - m, were tested according to the ISO standards and they are shown in Table 1.
The determining (establishing) of the fraying resistance was done in accordance with the Martindale's method - the determining of mass loss according to the standard BS EN ISO 1247-3 [4]. The testing was done with the use of the Abrasive tester - James Heal 900 series that can be seen in the Picture 1. In this study, the fraying resistance against felt (felt fraying resistance) and cloth fraying resistance (the resistance of the knitted fabric interacting with a cloth) were tested. A suitable weight with the load of 9 kPa was used. The sample was 30 mm in diameter and the measuring of the mass loss was done after 100, 250, 500, 750, and 1000 frayings.

Picture 1: Abrasive tester – James Heal 900

Picture 2: SDL Atlas M021 Air Permeability Tester

The establishing of air permeability was done according to the standard ISO 9237. The range of measuring (calculations) (where it's applicable) is (0,2 – 2160) mm/s [5]. The air permeability of the knitted fabric according to the standard procedure ISO 9237 was done by SDL Atlas M021 air permeability tester, shown in the Picture 2. The procedure included the measuring of the air flow through a material at a constant gradient pressure. The knitted sample was set face up on a round vent (whose surface is 20 cm^2) of the suction head of the apparatus, at the constant difference of pressures of 2000 Pa, the volumetric air flow (Q) ($cm^3 cm^{-2} s^{-1}$) through the vent covered by the knitted fabric was determined. The medium volumetric air flow values were calculated on the basis of five measurements for each knitted sample, and they were used for the calculation of the air permeability defined as the amount of air (in cm^3) which runs through 1 cm^2 of the material at the constant gradient pressure in 1 second. The air permeability of the material was tested on its both sides [6]. The basic characteristics of the knitted fabrics for the experiment were shown in the Table 1. The cloth which the knitted fabric was frayed against was made of filament, and its characteristics were given in the Table 2.

Table 1: Structural characteristics of knitted

The characteristics of the material	Material designation					
	U_1	U_2	U_3	U_4	U_5	U_6
Maretial type	Knitted fabric	Knitted fabric	Knitted fabric	Knitted fabric	Knitted fabric	Knitted fabric
The fiber compositton (%) -polyester	100 %	100 %	100 %	100 %	100 %	100 %
Longitudinal weft mass (tex)	9,2	8,8	5,6	12	10	12
Surface mass (g/m^2)	162,9	122,3	120,1	141,2	134,1	129,9
Thickness (mm)	0,53	0,43	0,53	0,43	0,37	0,41
Density (cm^{-1}) -in rows	13,71	12,77	22,72	13,77	12,8	16,2

-in lines	13,77	10,1	4,51	13,33	14,1	8,9
Surface density (cm^{-2})	188,78	128,27	102,46	183,55	180,48	144,18
Density coefficient of the knitted fabric	0.995	1,215	5,037	1,033	0.907	1,856
Interlacement	Accurate	Accurate	Accurate	Accurate	Accurate	Accurate
Width (cm)	160	140	160	160	160	160

Table 2: Structural characteristics of the cloth

Material type	Faber composition (%)	Longitudinal weft mass (tex)	Surface mass (g/m^2)	Thickness (mm)	Density (cm^{-1})	Surface density (cm^2)	Density coefficient
Cloth	100% polyester	38	173,55	0,42	Warp-22 Weft-20,5	451	1.073

RESULTS AND DISCUSSION

The table 3 shows the results of mass loss (%) of the six samples of tested knitted fabric after 100, 250, 500, 750 and 1000 fraying against/at felt. Tested knitted fabrics have different surface density (cm^{-2}).

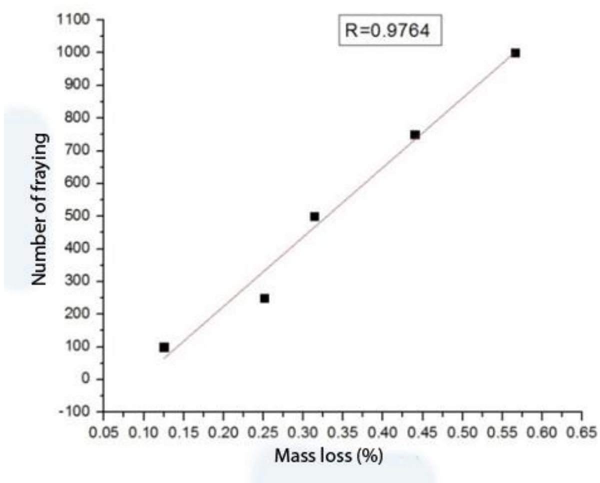
Table 3: The ratio of the mass loss depending on the number of knitted fabrics fraying against felt

Type of testing	Sample					
	U_1	U_2	U_3	U_4	U_5	U_6
The resistance of fraying at/against felt - after 100 frayings - after 250 frayings - after 500 frayings - after 750 frayings - after 1000 frayings	0,125 % 0,251 % 0,314 % 0,440 % 0,566 %	0,251% 0,402% 0,598% 0,714% 0,831%	0,320 % 0,460 % 0,614 % 0,767 % 0,882 %	0,143 % 0,273 % 0,362 % 0,411 % 0,570 %	0,200 % 0,301 % 0,434 % 0,501 % 0,602 %	0,243 % 0,373 % 0,583 % 0,689 % 0,768 %

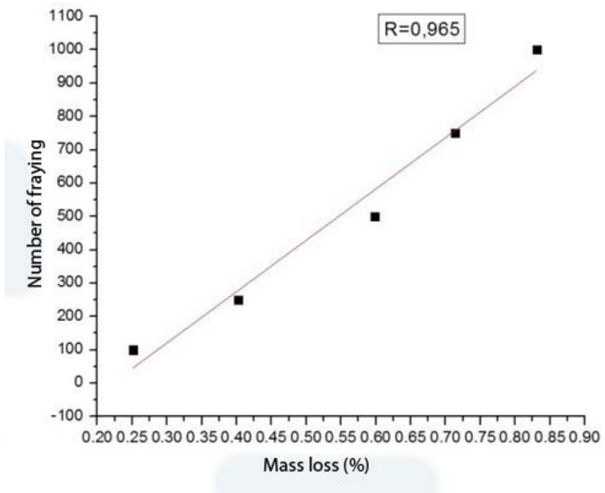
The pictures (3.1-3.6) show linear dependence of the mass loss (%) on the number of fraying of the tested knitted fabrics, for each sample separately, when fraying against/at felt.
U_1= a+b·x; a= -200.956; b = 2125,462; x= 162,9; Y=346036,8; R=0,9764;
U_2= a+b·x; a= -340,795; b = 1539,333; x= 122,3; Y=187919,63; R=0,965;
U_3= a+b·x; a= -455,264; b = 1602,471; x= 120,1; Y=192001,5; R=0,985;

U_4= a+b·x; a= -270,887; b = 2248,116; x= 141,2; Y=317163,09; R=0,943;
U_5= a+b·x; a= -403,014; b = 2264,51; x= 134,1; Y=303267,77; R=0,97;

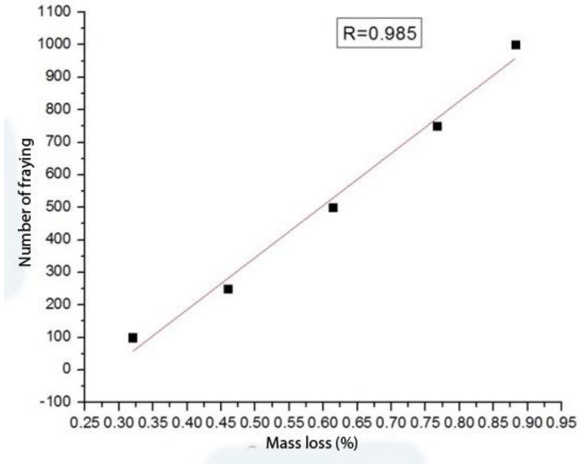
U_6= a+b·x; a= -346,232; b = 1630,7; x= 129,9; Y=211481,698; R=0,942;



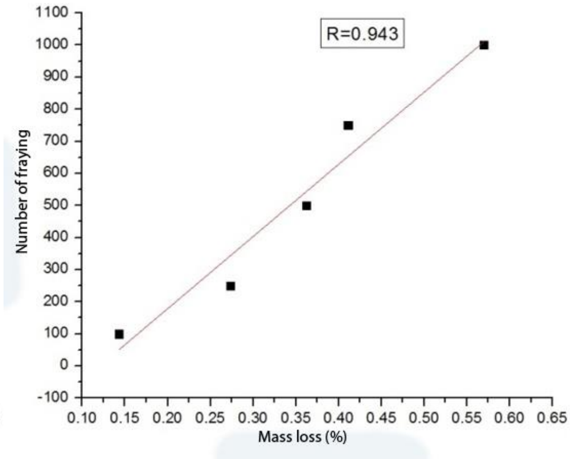
Picture 3.1: The first sample



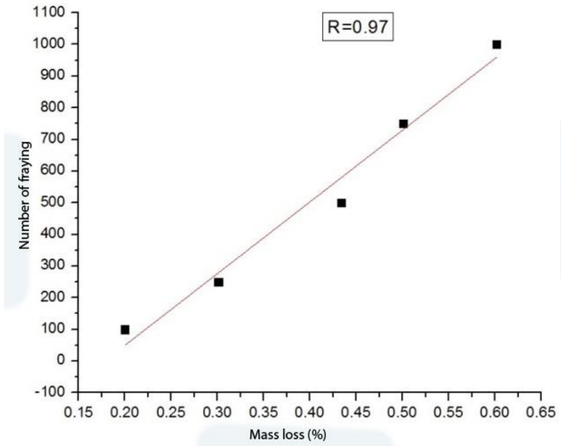
Picture 3.2: The second sample



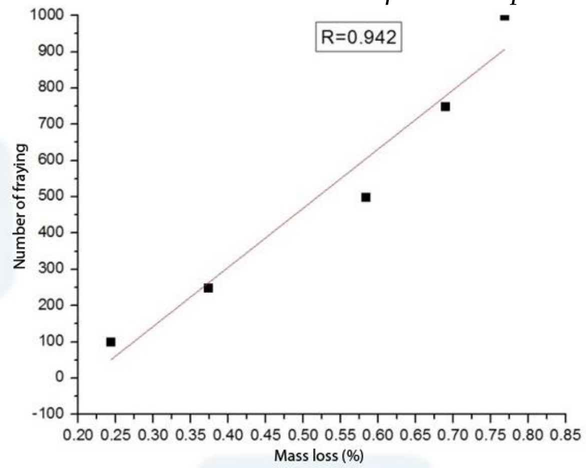
Picture 3.3: The third sample



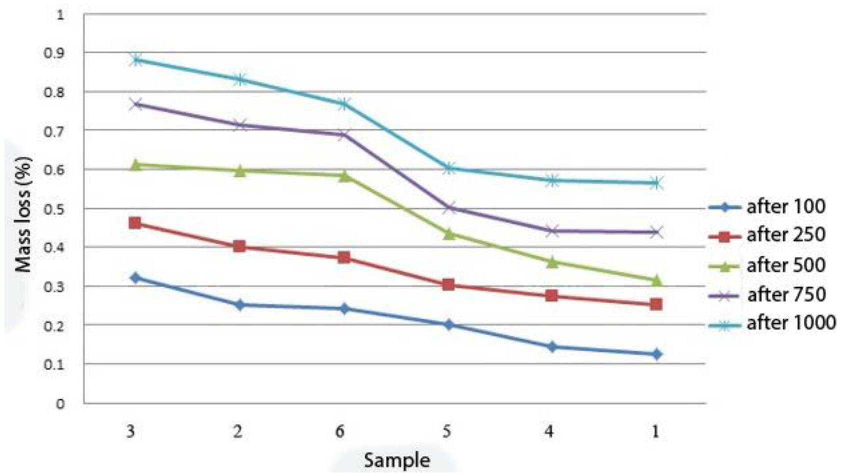
Picture 3.4: The fourth sample



Picture 3.5: The fifth sample



Picture 3.6: The sixth sample



Picture 4: Knitted fabrics mass loss in accordance with the number of knitted fabric fraying at/against felt of the tested sample

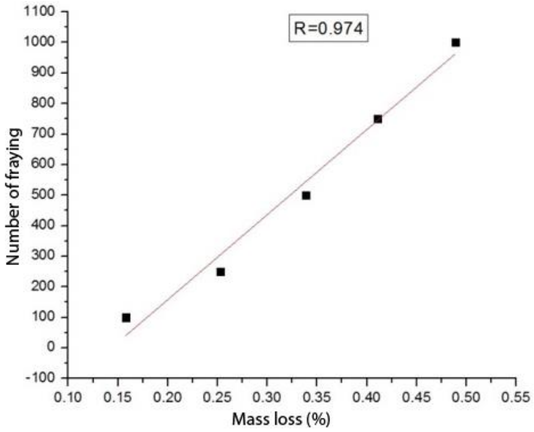
The results showed that knitted fabrics of lower density lose more of their mass when fraying, i.e. lower density knitted fabrics have less resistance when fraying. In the picture 4, one can see that knitted fabrics lose their mass in accordance with the number of fraying, after 100, 250, 500, 750 and 1000 knitted fabric fraying at/against felt. Table 4 gives the results of the mass loss (%) of all six tested knitted samples depending on the number of fraying, when knitted fabrics fray at/against a cloth. The cloth characteristics which tested knitted fabrics were fraying at, are shown in the Table 2.

Table 4: The ratio of the mass loss depending on the number of knitted fabrics fraying at cloth

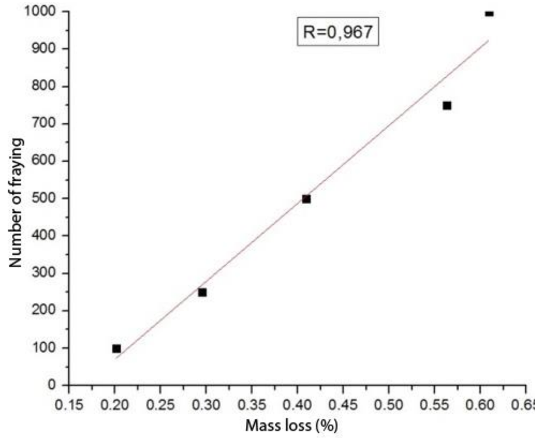
Type of testing	Sample					
	U_1	U_2	U_3	U_4	U_5	U_6
The fraying resistance against cloth						
- after 100 frayings	0,158 %	0,201 %	0,229 %	0,161 %	0,166 %	0,171 %
- after 250 frayings	0,253 %	0,295 %	0,305 %	0,258 %	0,275 %	0,283 %
- after 500 frayings	0,339 %	0,409 %	0,420 %	0,343 %	0,379 %	0,384 %
- after 750 frayings	0,411 %	0,563 %	0,576 %	0,436 %	0,448 %	0,549 %
- after 1000 frayings	0,489 %	0,609 %	0,621 %	0,499 %	0,517 %	0,601 %

The Picture (5.1 – 5.6) show the linear dependence of the mass loss on the number of tested knitted fabrics frayings, for each sample separately, when knitted fabrics fray against a cloth.

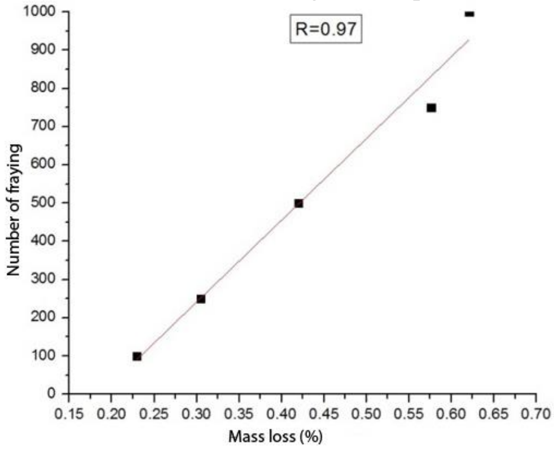
U_1= a+b·x; a= -399,004; b = 2784,862; x= 162,9; Y=453255,01; R=0,974;
U_2= a+b·x; a= -345,543; b = 2083,639; x= 122,3; Y=254483,5; R=0,967;
U_3= a+b·x; a= -400,005; b = 2138,553; x= 120,1; Y=256440,21; R=0,97;
U_4= a+b·x; a= -386,342; b = 2670,426; x= 141,2; Y=376677,8; R=0,9737;
U_5= a+b·x; a= -398,848; b = 2573,804; x= 134,1; Y=344748,26; R=0,952;
U_6= a+b·x; a= -278,041; b = 2007,146; x= 129,9; Y=260450,224; R=0,9663;



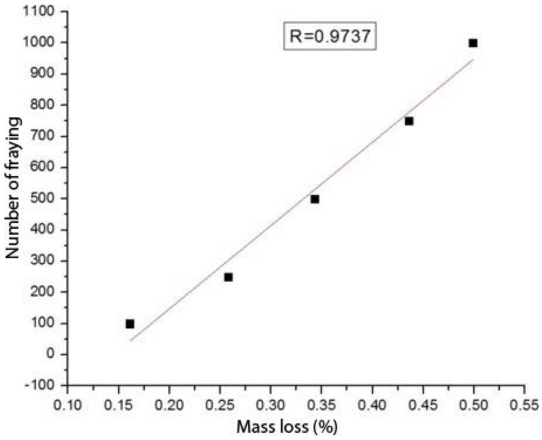
Picture 5.1: The first sample



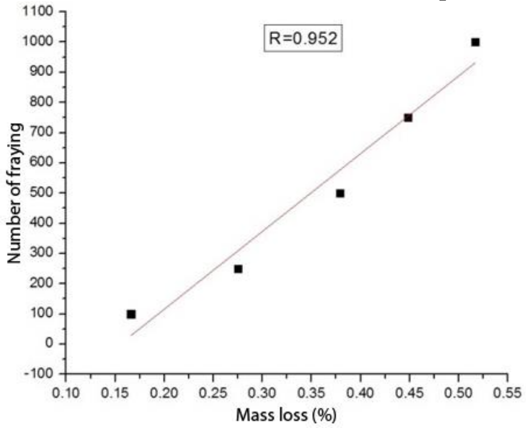
Picture 5.2: The second sample



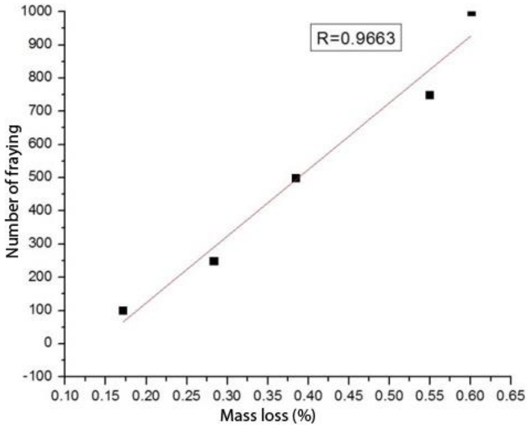
Picture 5.3: The third sample



Picture 5.4: The fourth sample

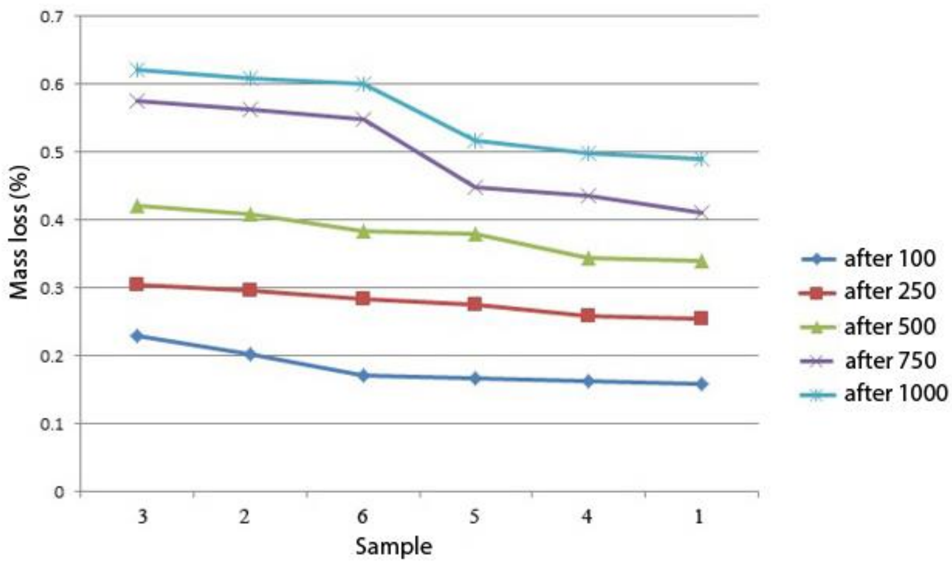


Picture 5.5: The fifth sample

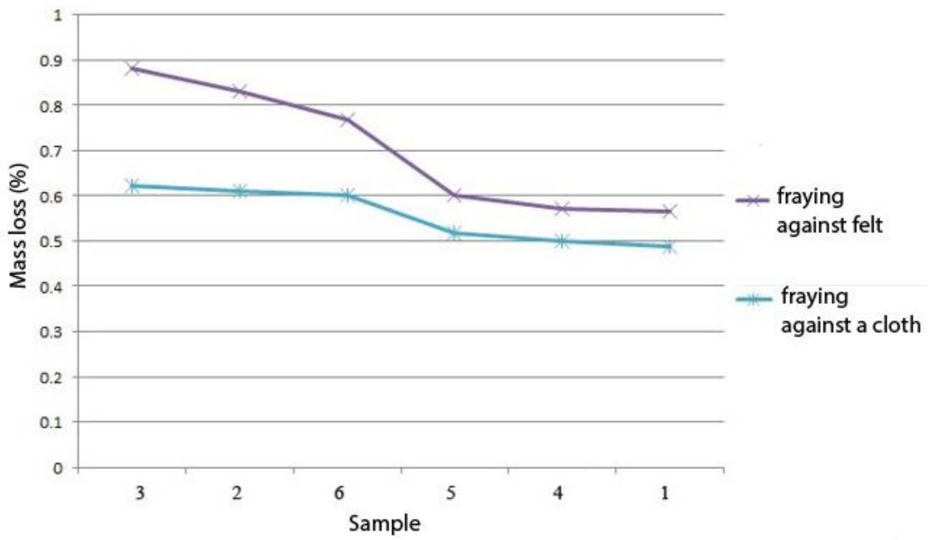


Picture 5.6: The sixth sample

The conclusion is the same - lower density knitted fabrics have less fraying resistance. In the picture 6, one can see that the knitted fabrics lose their mass in accordance with the number of frayings 100, 250, 500, 750 and 1000 knitted fabrics frayings against a cloth.

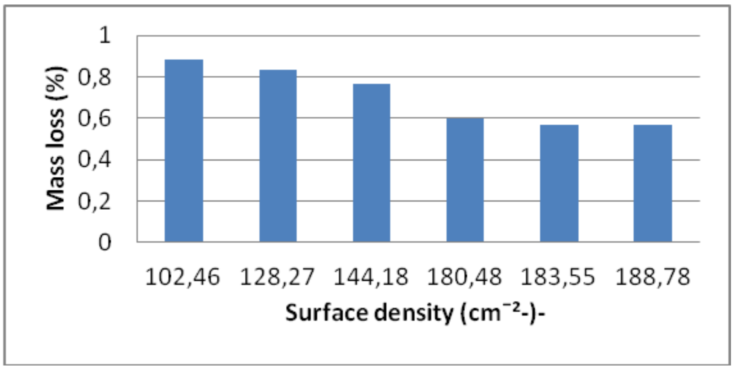


Picture 6: The knitted fabrics mass loss in accordance with the number of knitted fabrics fraying against a cloth



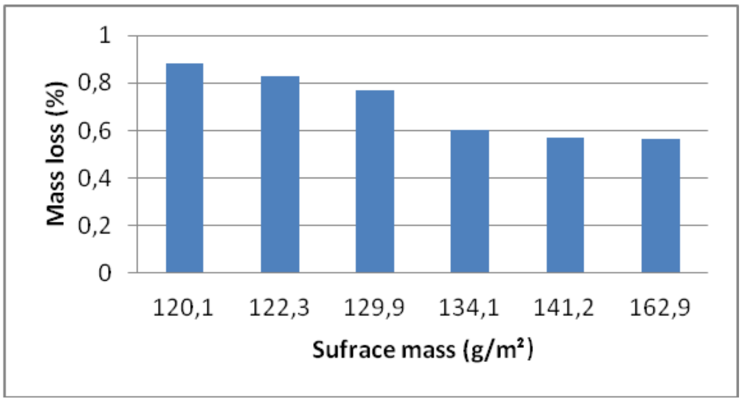
Picture 7: The ratio of the knitted fabrics mass loss when fraying against felt and the knitted fabrics mass loss when fraying against a cloth, after 1000 frayings

The results showed that 100% polyester knitted fabrics have a higher fraying resistance when the knitted fabrics surface density grows. In the Picture 7, one can see that the knitted fabrics frayed against felt lost more of their mass after 1000 frayings, with the correlation coefficient R=0.942, than the ones frayed against a cloth, with the correlation coefficient R=0.9663, so we can make a conclusion that 100% polyester knitted fabrics have a higher fraying resistance when frayed against a cloth. It can be seen in the Picture 8 that fraying resistance increases with the increasing of the knitted fabric's surface density.



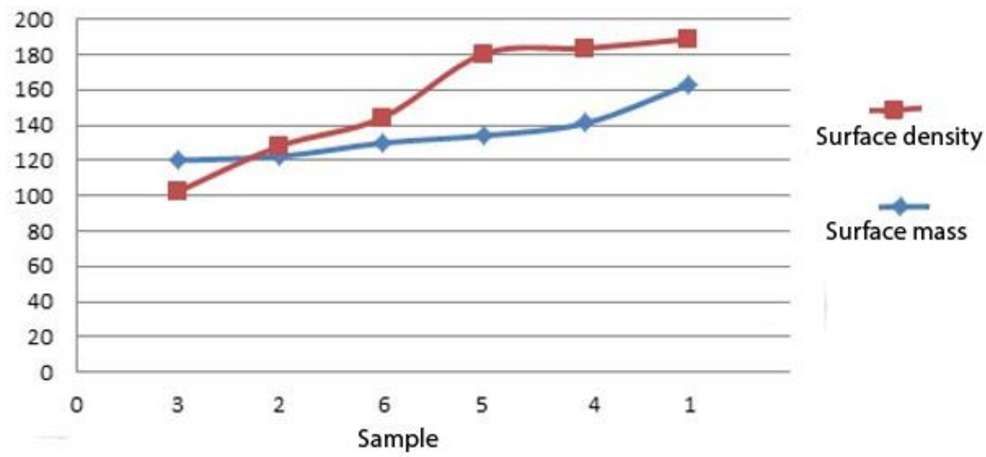
Picture 8: The dependence of the surface density on the tested samples fraying resistance

Picture 9 shows that fraying resistance increases with the increasing of the knitted fabric's surface mass.



Picture 9: The dependence of the sufrace mass on the tested samples fraying resistance

If the knitted fabrics surface density increases, their surface mass also increases, as shown in the Picture 10, which shows the linear dependence of the knitted fabric's density and tested samples surface mass.



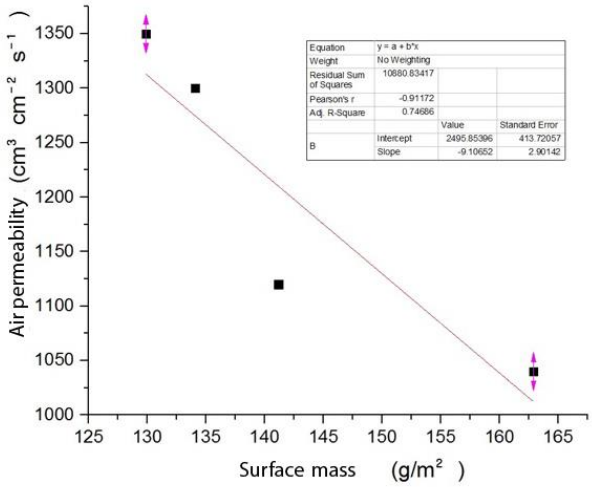
Picture 10: The linear dependence of the knitted fabric's density and tested samples surface mass.

Table 5 shows the testing results of the air permeability on both knitted fabrics sides-face and reverse, as well as the medium value of air permeability.

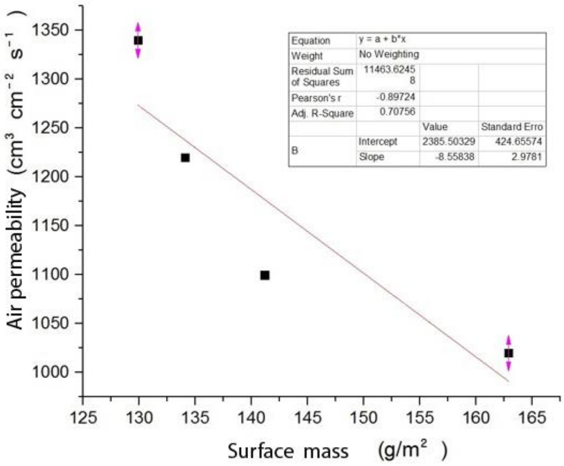
Table 5: The air permeability testing results

Type of testing	Sample					
	U_1	U_2	U_3	U_4	U_5	U_6
Air permeability ($cm^3 cm^{-2} s^{-1}$) - face - reverse	1040 1020	High permeability	High permeability	1120 1100	1300 1220	1350 1340
Medium value	1030	High permeability	High permeability	1110	1260	1345

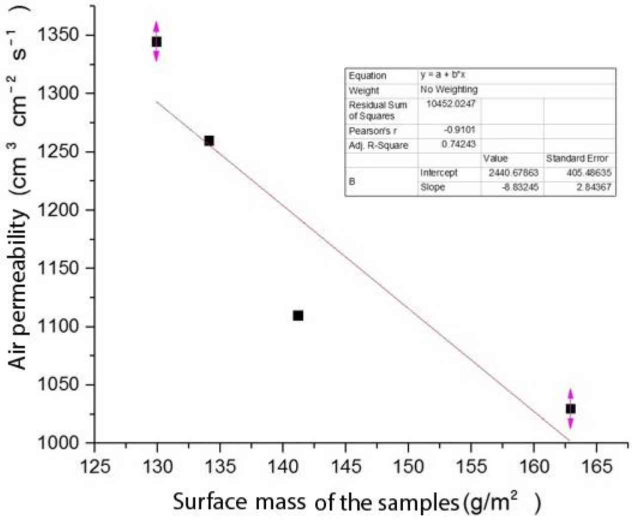
Picture 13 shows the dependence of the knitted fabrics density and the medium value of air permeability with the correlation coefficient R=0.7424, and we can come to the conclusion that the lower surface mass knitted fabrics have higher air permeability. The second and the third sample show high air permeability because of the low surface mass of the sample. From the results, one can come to the conclusion that knitted fabrics have higher air permeability on the face side of the knitted fabric, with the correlation coefficient R=0.74686, than on the fabric's reverse side with the correlation coefficient R=0.70756. Pictures 11 and 12 show the linear dependence of the air permeability and the surface mass on both sides of the knitted fabrics.



Picture 11: The dependence of the knitted fabrics sample face air permeability



Picture 12: The dependence of the knitted fabrics mass and the tested knitted samples air permeability on reverse side



Picture 13: The dependence of the knitted fabrics mass and the air permeability's medium value for tested sample

CONCLUSION

On the basis of the testing of the knitted fabrics with the same fiber composition, but with different surface densities, one can conclude that those fabrics have different fraying resistances. This testing included six samples made of 100% polyester, but with different densities and longitudinal yarn mass. When testing the dependence (its ratio) of the change of the surface density of the samples and its influence on the fraying resistance, there is a conclusion that the increasing of the density increases the fraying resistance. On the basis of the calculated correlation coefficient when knitted fabric frays at/against felt R=0.942 and the correlation coefficient when fraying against a cloth R=0.9663, the conclusion is that knitted fabrics have a higher resistance when they fray against a cloth. We came to a conclusion that the knitted fabrics which fray against/at a cloth have a higher fraying resistance than the ones that fray against felt, which have a higher mass loss. The air permeability results of the tested knitted fabrics showed that the knitted fabrics with a bigger surface mass have a higher resistance to air permeability. From the calculated correlation coefficients of air permeability on the face of the fabric R=0.74686 and on the reverse side R=0.70756, it can be concluded that the knitted fabrics have a higher air permeability on the knitted fabric's face side.

REFERENCES

[1] S.M. Ćortoševa,”Matematičko-statistički model na reološkite svojstva pletenini”,1-19, (2000)

[2] Projektovanje pletenina, dr Dušan Trajković, Univerzitet u Nišu, Tehnološki fakultet u Leskovcu, 2009. god.
[3] D. Stojanova-Krasteva, “Rakovodstvo za labaratorni upraznenija po tekstislni ispitivanja i analizi, Tehničeski unevrsitet, “, (2007)
[4] http://www.iss.rs/la/standard/?natstandard_document_id=18343
[5] Akreditovano telo za ocenjivanje usaglašenost, ,, CIS Institut” d.o.o. CIS laboratorija Beograd, Vojislava Iliča 88, Standard
[6] ISO 9237 Textiles – Determination of the permeability of fabrics to air

DEVELOPMENT OF MODERN FASHION PRODUCTSINSPIRED BYTHE CULTURAL HERITAGE OF SERBS AND ROMANIANS IN BANAT IN THE CASE OF CROSS-BORDER COOPERATION IN THE PROJECT MIS 1427

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ABSTRACT

This paper presents the development of new clothing products that is the modification of existing products, which takes place annually, in the form of an annual development plan, which includes the following segments: spring - summer; autumn - winter and additional collections (inputs of new products during the specified seasons). As a starting point for planning the development of new products or modifying existing products a Decision on preliminary specifications of the product has been shown, which resulted from a marketing analysis of the market and from the observed tendency of fashion trends.
A procedure is also shown on how, from the Annual Development Plan of clothing products, the project task for product development is determined. In relation to this the process of drafting the conceptual design, prototyping, verification of models and decision on production as well as the completion and submission of technical documentation are displayed as well.
In the case of the international project of the cross-border cooperation Romania - Serbia MIS 1427, the planned development of fashion products inspired by the cultural heritage of Banat is displayed.

INTRODUCTION

The problems that the fashion industry in Banat is facing require a thorough approach to finding solutions. Certainly one of the possible solutions is a more serious approach to the development of new fashion products with the focus on design that has become a very powerful and inexpensive weapon in the fight for survival in the market.
Time has shown that dealing with fashion is a demanding and durable process of adapting to the tastes and needs of consumers [1-4]. There are numerous examples of major fashion companies that have experienced a failure in the market precisely because they neglected these facts. It happened that the big fashion companies got infatuated by excellent financial performances as well as by a double-digit growth rate in sale so that they ignored the needs of consumers. In these cases, they usually played on a traditional product. Thereby it has been forgotten that fashion does not present a uniformity of consumers. Many times it seemed that in one part of the product's life cycle, its power had no limits. In doing so, the need for finding the right way to prevent the decline in product's sale was always imposed on in the mature period of the sale of product. The only solution in these cases was to improve or change the characteristics of the product.
As an example of a hard survival in the fashion market, the example of the company Levi Strauss & Company is often stated. The company had its cult product model of jeans Levi's 501® which was created in 1890 and as such was the oldest clothing product with its own brand. The highlight of the sale, this company achieved in 1997, when it achieved a total gross income of 7, 1 billion of USA dollars.

From this year on, there signs of slackening in sales started occurring. Some of the reasons for the decline of sale were: overstocking the market with jeans, rapid changes in the taste of customers, a strong competition of low-cost producers and designer houses, a rapid development of modern distribution and technology of sale that led to a massive decline in market share. It is interesting to note that the emergence of new trends in denim clothes was also influenced by new technologies. The emergence of mobile phones has requested from clothing to facilitate the wearing of such products. There was a need for clothes with bigger pockets. Also, in order to carry a CD player, it was necessary to adjust the shape of back pockets. Producers who did not pay attention to these and similar phenomena experienced a rapid decline in production. As already mentioned, the chances of survival in the fashion market are not guaranteed to anyone, which is best seen in the example of American company Levi Strauss & Company, which had to have its own cult product model of jeans Levi's 501® adapted to the needs of consumers [1-5].

THE PROCESS OF CREATING NEW PRODUCTS AND FASHION COLLECTIONS

Fashion product is the most complex element of the marketing mix from the point of fashion marketing managers. The task of the marketing department of the clothing enterprises is to continuously adapt products to the demands of consumers.

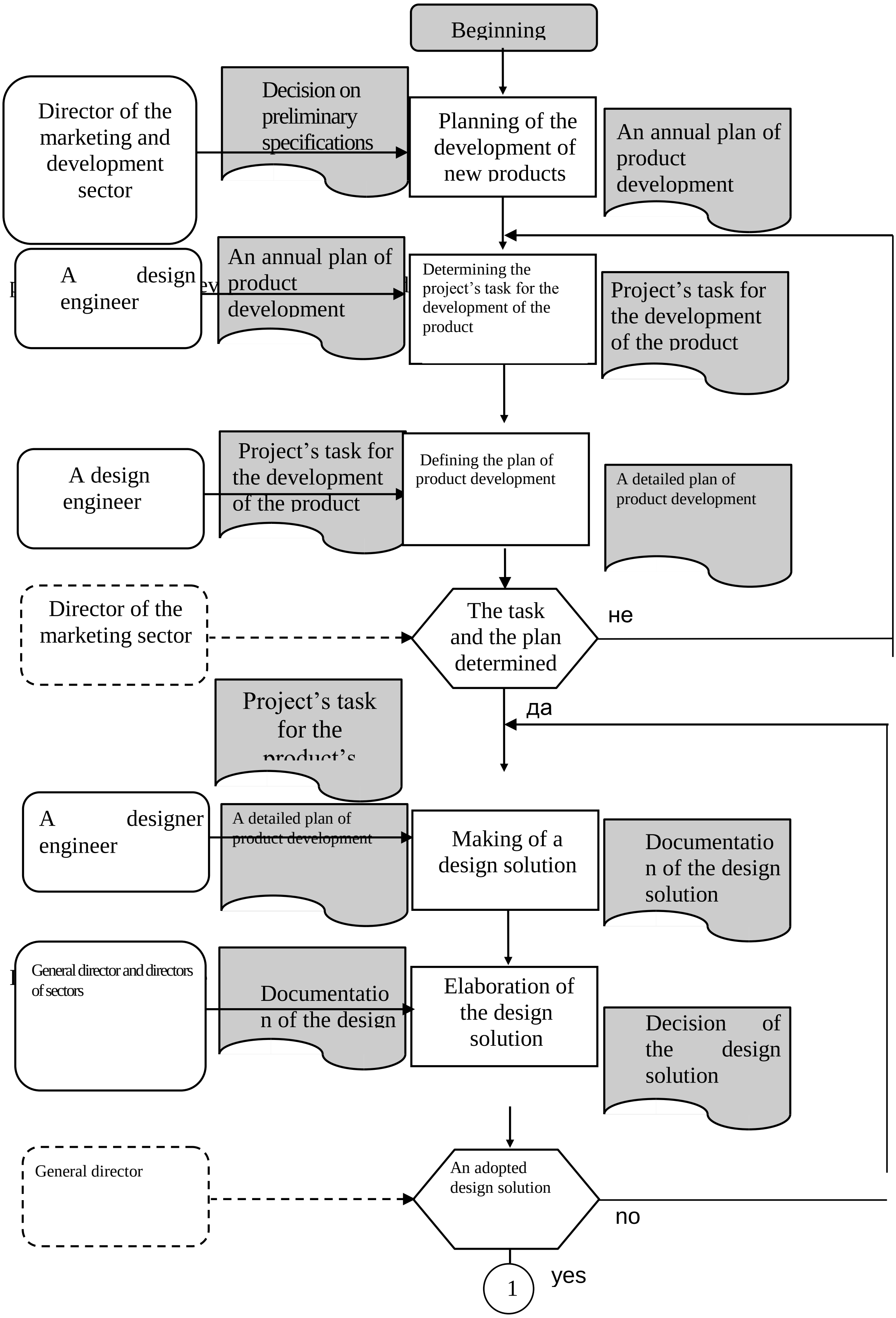
Ideas about new clothing products may develop mainly in two ways:

- Adaptation of existing products and
- Developing new products.

In order to have clothing products available at the right time for consumers it is necessary to harmonize the complex activities of fashion designers, manufacturers and trade. In order to achieve this a fashion calendar is made that defines the arrangement of the work of designing, manufacturing, distribution and retail sales of clothing, usually on an annual basis.
The creation of a new collection of fashionable clothing is conducted even one year in advance. For any of the two collections, spring / summer and autumn / winter, ideas for a new collection (next year) are created in the course of the sale of the existing collection. This enables the collections for a review exposure for the upcoming year to be prepared at the end of the sales period of the old collection. This ensures that good ideas of existing collections, which are accepted by customers, will be applied in the collection for the upcoming year as such or slightly modified [5-11].
For retailers it is important to properly plan the time and arrange products.

PROCEDURE FOR THE DEVELOPMENT OF NEW CLOTHING PRODUCTS

Changes in the market of fashion products are faster and faster. In order to become competitive in the market, clothing company needs to ensure that the acceptable models of clothes are accessible to customers at the right time and at the right place. This requires the harmonization of complex activities of designers, manufacturers and trade.
The most important element in this process is certainly the completion and submission of technical documentation for the solution of a new clothing product. Before the adoption of the conceptual design that is completion of technical documentation, it is necessary to undertake a series of activities such as: planning the development of new products, establishing the terms of the project's task, defining the plan of product development, creating a design solution, preliminary review of the design solution, the adoption of the design solution, prototyping the model, verification of models and decision on production, decision on the acceptance of regular production followed by the completion and submission of technical documentation for regular production. Figure 1 shows a diagram of the flow of the procedure of the development of new products.


Beginning
Director of the marketing and development sector
Decision on preliminary specifications
Planning of the development of new products
An annual plan of product development
A design engineer
An annual plan of product development
Determining the project's task for the development of the product
Project's task for the development of the product
A design engineer
Project's task for the development of the product
Defining the plan of product development
A detailed plan of product development
Director of the marketing sector
The task and the plan determined
не
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Project's task for the product's
A designer engineer
A detailed plan of product development
Making of a design solution
Documentation of the design solution
General director and directors of sectors
Documentation of the design
Elaboration of the design solution
Decision of the design solution
General director
An adopted design solution
no
1
yes

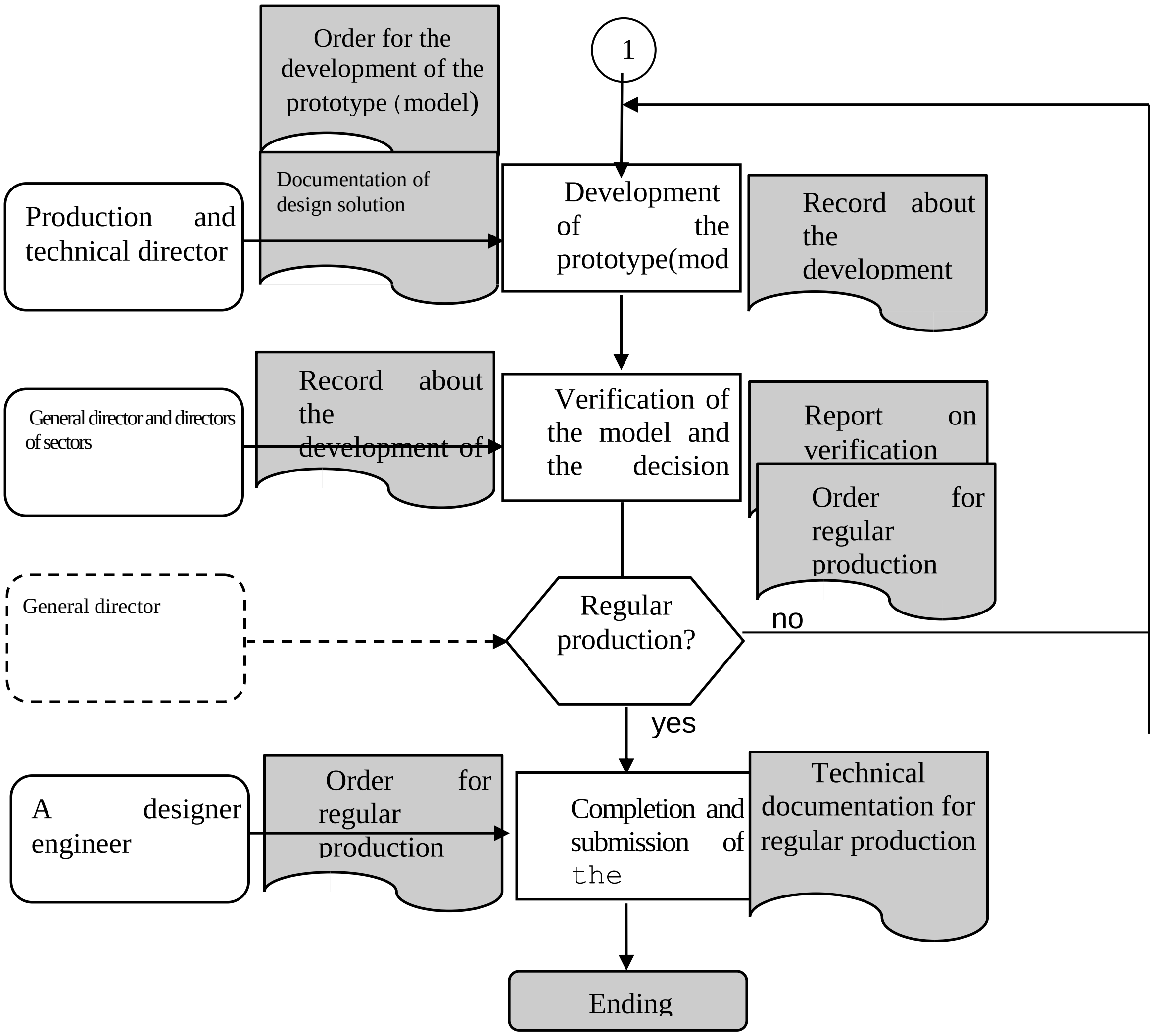

Figure 1: A diagram of the procedure of new product development

Planning the development of new products or modification of existing products, is performed annually in the form of an annual development plan that includes the following segments:
Spring - summer;
Autumn - winter and
Additional collection (inputs of new products during the specified season).

The starting point for planning the development of new products or the modification of existing products is the Decision of preliminary specifications of the product that is made on the basis of a marketing analysis of the market or of the observed tendency of fashion trends.
The necessary document in the development of new products is the Annual plan of the product development that contains information on the planned product, all activities related to its development as well as information on the material and the suppliers of the same for the new product.
From the Annual plan of the product development, determining the terms of project's task for product development is carried out and it presents an activity of further concretization of achieving annual plan.
When approaching to the development of entirely new products, all the necessary preparatory activities are conducted. Preparation is completed when the term of the project's task for the

development is identified. When approaching to the modification of existing products, prior design solutions, cons patterns and documentation related to the project should be provided.
Project task for the development of new products should be recorded on the appropriate form which should contain general information on how many new models the collection will have, what percentage is represented by individual items, who is responsible for what business, implementation deadlines, etc.
Based on the project's task for the development of products a detailed plan for the development of products is defined that must be in accordance with the project's task. It is formed quarterly and monthly. It must contain timelines (deadlines) for all tasks and phases in the implementation of the plan for product development. A plan must be clear about how many new products it will have in the new collection, which lines of the assortment will be represented, what percentage of the collection consists of individual items of clothing, how many old models will be modified and what will be modified on the models. It also states the necessary documentation for old models. For all activities deadlines are stated. In the Detailed plan a priority list of suppliers is defined based on the existing list of suppliers. The plan also provides specifications and an approximate quantity of material for models of clothing. After that it is checked whether the task and the plan are in accordance. If the task and the plan are not in accordance with the requirements, it is accessed to their harmonization that is it is accessed to the new development of the plan. If the task and plan are in accordance then it is accessed to the development of design solutions.

Preparation of the design solution is the main task of the creative team. It is accessed to drawing design solutions and the procurement of similar patterns in the market, so that by observation and elaboration one comes to one's own solutions (ideas). Designers are required to, while passing a new model, always respect the principle of functionality, fashion trends in colors and previous market analysis. Design solution is drawn on the appropriate form in the final stage. It is necessary to draw a completed design solution with all the necessary details (a button, thread, labels, packaging, etc.).
On the basis of documentation on the design solution and market demands, a decision is made on the adoption of the design solution. According to the Decision on approval of the design solution, the order is given to the manufacturing sector to produce cons pattern, which is practically implemented by a designer who gives that form to the construction preparation. If the design solution is not adopted, it is necessary to draw up a new design solution.

The same procedure is applied for the modification of the old model, except that, in the records of the design solution only changes that should be made to the existing cons pattern are stated.
Based on the order of making cons pattern (model) and documentation of the design solution which is to be submitted to the manufacture, it is accessed to the development of cons pattern. Responsible people from the productive sector must comply with precise instructions from the documentation but also propose a new way in the development if they believe that it will enable more efficient and better development, and thus facilitate or simplify the subsequent production process. It is necessary to monitor the development of cons pattern or alternating an existing one, if it is a modification of an existing product, taking into account the specified deadline of the development. Based on the completed cons pattern, except clothing cuts, a record of cons pattern is made as well.

The record of cons pattern and the cons pattern itself will be submitted for a review to appropriate services. After the consideration of the cons pattern and examination of its conformity with the design solution they make the decision about restoring cons pattern to rectify or they approve cons pattern and give order for regular production. On this basis the purchase department receives information about the necessary raw materials and accesses to the procurement of the same by already established procurement procedures.

On the basis of an order for regular production in line with precise deadlines, the working order is made and all development technical documentation necessary for the production process is completed. From the moment of issuing the working order regular production process is starting by a defined procedure.

STATE OF THE TEXTILE INDUSTRY IN BANAT AND PLANNED SOLUTIONS IN THE CASE OF CROSS-BORDER COOPERATION IN THE PROJECT MIS 1427

In the process of transition behind the large textile combines which have disappeared over time, we have the whole array of small enterprises in this area that have the technical quality for the manufacture of products, but they lack the logistical capacity to follow modern fashion trends, creating new authentic products, marketing, rapid adaptation, as well as the acceptance of modern technology, control quality standards, which are the basis for survival in the modern market trends. The consequence of this situation is the low level of the competitiveness of these companies, poor market position, low level of efficiency, decrease of the volume of work and employment, a high rate of bankruptcy of the companies.

As a way to overcome the weaknesses in the management is the linking of scientific and educational research institutions of small and medium enterprises which will improve their performance. Mutual cooperation of the Technical Faculty "Mihajlo Pupin" in Zrenjanin whose educational programs are mainly oriented to the production technology and the Faculty of Arts and Design of Timisoara directed towards art and design of products, will establish a system of support which will provide logistics in expert, technical-technological, research- development and marketing sense to small producers in the textile industry. The implementation of the pilot project of developing new fashion products will further enable MFA in the field of application of the input control of raw materials, intermediate control of technological processes of production, output control of finished products as well as a technical preparation of the production itself.

Unfavorable position of the textile industry is the result of the low competitiveness of small producers in the market, caused by the fragmentation and inconsistency of the manufacturers, the low level of technological equipment for testing and quality control and certification of products, poor monitoring of fashion trends, market trends and the lack of marketing activity. Production is mainly related to service lon works, sewing services, where the competition is huge in East countries, the cost of services low and a high possibility of substitution of the service providers. Small companies due to lack of technical, financial and human resources have not been able to refocus on markets that are not mass production, to smaller series and high quality products, to accept more complex and demanding tasks with a higher degree of processing and quality, to create and focus on products for specific market segments, to smaller series, of the higher degree of processing or to independently develop and create fashion lines, which is essential for the survival of the textile market in the present circumstances. Interconnection of scientific research institutions that have got human resources of technological and creative designer type and MFA in the field of textile manufacturing, technical training of the faculty to monitor and investigate the quality of products and materials, following modern fashion trends and the possibility of fast and economical preparation of production, preparation of the technical documentation of production even in electronic form, as well as of cutting in a modern way, would significantly enhance the research and creative work in creating a new authentic product based on authentic motives of cultural tradition of Banat as well as a marketing activity.

OBJECTIVES AND ACTIVITIES OF THE PROJECT MIS 1427

Defined objectives of the project are:

1. Increasing the competitiveness of business entities, MFA in the textile industry by connecting with scientific - research institutions and using the economy of knowledge.
2. Increasing the level of employment in the area of textile industry and overcoming the problem of women's employment in rural areas.

3. Finding a new product in the fashion industry based on the authentic cultural heritage of people living in Banat.
More important activities of the project are:

1. Creation of the center for research and development of the fashion industry of Banat
2. Research and identification of authentic motives of national culture and tradition of Serbs and Romanians
3. Round tables
4. Creating a database of authentic symbols and elements of fashion design
5. The exhibition of collected authentic symbols that can be used in fashion design
6. A public tender for designing models with authentic symbols
7. Training of MFA and students
8. The exchange of lecturers in the field of design and production technology
9. Implementation of the pilot project of making new clothing products
10. Organizing a fashion show of new products
11. Supply of laboratory, CAD / CAM and equipment for textile printing

Through the implementation of the pilot project of making new clothing products, participants in the project will implement a pilot project of industrial development of an appropriate number of clothing products. The activities envisaged in the implementation of the pilot project will include the implementation of all previous activities in a real realization of the industrial production. Based on the collected, on the competition, design solutions of fashion products inspired by Serbian and Romanian cultural heritage, technical documentation will be developed, by using a new equipment which will be purchased within the project.

All information that are collected as part of project activities will be analyzed in a comparative analysis with modern fashion trends. Nowadays information about contemporary fashion trends are available on global databases. Thus, for example, WGSN trends has over 6000 users who believe in advice and predictions of WGSN, giving them the security of making the best decisions related to the design and retail.

Figure 2: Global data base of fashion – WGSN

As a result of a comparative analysis of the available information the development of new products classified into four thematic sections is envisaged: Ethno magic; Modern fairy tale; Street chic and Sport glamour.
An approximate proposal of thematic unit Ethno magic is shown in Figure 3.

Figure 3: Thematic unit Ethno magic

An approximate proposal of thematic unit Modern fairy tale is shown in Figure 4.

Figure 4: Thematic unit Modern fairy tale

An approximate proposal of thematic unit Street chic is shown in Figure 5.

Figure 5: Thematic unit Street chic

An approximate proposal of thematic unit Sport glamour is shown in Figure 6.

Figure 6: Thematic unit Sport glamour

Within the project activities, in order to direct new products to the target groups, a market research will be done that will answer the question to which groups should new products be directed and what features these new products should contain in order to be accepted by final customers. This research should help in directing creations and proper focus of new products which will be launched by MFA. The analysis of market demands will be conducted with regard to the textile and clothing industry, a report on the need for improving the condition of the clothing industry in the regions will be made. Based on the conducted analysis it will be accessed to the elaboration of the plan for the development of new products.

The main expected result of the project is: An established infrastructure for connecting research institutions and enterprises in order to strengthen competitiveness and sustainable development of the fashion industry of Banat rapidly.

CONCLUSION

Today clothing industry faces an array of problems for the solution of which it is necessary to constantly look for new solutions. One of possible solutions is a more serious approach to the development of new clothing products. Therefore in this study an appropriate procedure for developing new clothing products is suggested, which is the most complex technology segment in designing clothes because it requires the development of new products in a very short time which carries very high risks of making products that customers may not accept due to insufficiently fulfilled demands of customers for new products. To reduce these risks to the lowest measure in the work the procedure has been proposed which involves undertaking the following activities: planning the development of new products, determining the project's task, defining the plan of product development, making the design solution, a design solution review, the adoption of the design solution, prototyping the model, verification of the model and decision on production, the decision on acceptance of regular production followed by the completion and submission of technical documentation for regular production. The paper also presents the possibility of creating new fashion products inspired by the cultural heritage of Banat.

LITERATURA

[1] *Ujević D., Rogale D.,Trtinjak Z.: "Aktivnosti i dinamika uvođenja sustava osiguranja kakvoće u odjevnu industriju prema normnom nizu ISO 9000",* Tekstil 45, 1996., pp.566-573.
[2] *Bunić Ž.:"Strategije uvođenja novog proizvoda LEVI'S ENGINEERED JEANS",* Tekstil 51, 5, 2002., pp.215-223.
[3] *Pavetić A.: "Utjecaj dizajna na konkurentnost proizvoda u tekstilnoj i odjevnoj industriji",* Znanstveno-stručno savetovanje: Tekstilna znanost i gospodarstvo, 23.01. 2009., Zagreb, pp.241-244.
[4] *Rogale D.,: "Odjevna tehnologija na svršetku mulenijuma – stanje i predvidivi pravci razvitka",* Tekstil 47, 1, 1998., pp.2-19.
[5] *Petrović V., Stepanović J., Stojiljkovuć D., Popov –B.D.:"Analiza uticaja opremljenosti proizvodnih linija na vreme izrade odeće",* Menadžment, Inovacije, Razvoj 3, 6, 2008., str. pp.52-55.
[6] *Petrović V.,Martinovuć M., Stojiljkovuć D., Stepanović J., Popov –B.D.,: "Designing well fitting clothes",* 6th International Scientific Conference RIM 2007 Development and mordenization of production, 2007., pp.213.
[7] *Petrović V., Stepanović J., Popov –B.D., Reljić M.:"Optimizacija tehničke pripreme upotrebom CAD sistema",* Međunarodni naučno-stručni skup Energetske tehnologije 2008,<<Srbija solar>>, 22-24 05. 2008., Vrnjačka Banja, (štampan u elektronskoj formi, pp..1-7).
[9] *Petrović V.: „Savremene tehnologije u odevnoj industriji",* II Naučno-stručni skup Tekstilne industrиje Zapadne Srbиje, 2006., Regionalna privredna komora Užice, 21-23. septembar 2006.godine, Ivanjica, pp.14-24.
[10] *V. Petrović:*" *Pravci razvoja odevnih firmi u funkciji osposobljavanja za brze odzive na zahteve tržišta zemalja velikih potrošača odeće*", 2004, I Naučno-stručni skup Tekstilne industrije Zapadne Srbije, Regionalna privredna komora Užice, decembar 2004.godine, Arilje, pp.12-20.
[11] Gašović M.: Modni marketing, Institut ekonomskih nauka, Beograd, 1998.

PAINTING AS INSPIRATION IN FASHION INDUSTRY

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ABSTRACT

Fashion is present in all areas and in all social strata. The phenomena in culture and the arts have always encouraged the creation of new ideas and new fashions.
The link between art and fashion is never interrupted as confirmed by many contemporary designers as a starting point and inspiration when creating clothes using just an art direction, or artwork. Today, advances in technology production is becoming easier, and great opportunities in selecting and combining fabrics and experimenting with cuts.
Every year more and more fashion designers appear on the international fashion events. In addition to the world's fashion capitals (Paris, London, Milan, New York), many other cities also organized a successful fashion shows which give opportunity for future talents. An increasing number of schools for fashion design products more fashion designers who are starting to work in an industry that from year to year spreads. Distribution and branding spread globally; production is changing rapidly, as more and more companies seeking suppliers in places where labor is cheaper. On such a market where there is no place for mistakes companies expose the product that will be unique in design and appearance to stand out from others and attract customers.

Key words: fashion, inspiration, art, painting

INTRODUCTION

Developing way of clothing from leaves of wood, tattoos or fur animals to abstract pieces of clothing that can be seen on the contemporary fashion scene today is long and complex. In parallel with the development of society and civilization has been developing and manufacturing garments. Leaving basic framework of the clothing - protection of the body- clothing becomes a complex system of meaning and an important element of communication. When the basic function of clothing ceased to be protection, there is a need to point out - was the evidence of the courage of the person who wears it, to highlight the beauty and harmony, or to conceal body flaws. Conceptions of beauty and harmony in clothing were often changed, what was considered beautiful and harmonious at one time, completely negates the next order after years or decades once again become ideal. Throughout history, the way of dressing permeated with art. Artists as a precursor of today's designers have had a decisive influence on the fashion of a period even participated in the design of courtly clothes for formal occasions. In the Middle Ages, aesthetics has precedence over other elements of clothes, a share of the painter gives it a special character. Artists were given plans for costumes and choosing the best fabrics. One of them was Michelangelo. The influence of the artist to create fashion continued to the present day.

FASHION AND ART

Fashion and art are often inspired by one another, although it is not always obvious. Fashion and clothing reflect psychosocial identification. If we take into account the fact that the costume can have all the qualities of a work of art, his analysis can be accessed with the aesthetic side.

Viewed through the prism of visual elements, the study of shapes, proportions, valerian and tonal values and textures give the suit a new dimension. As a result of spiritual creativity and artistic inspiration of clothing and clothing reflect the eternal desire for a beautiful and perfect.

Fashion tends to a new and peculiar form translates into an acceptable form. In art, fashion expressed through imitation of certain art forms and styles.[9]

The phenomena in culture and the arts have always encouraged the creation of new ideas and new fashions. This connection lasts for centuries. It is known that Michelangelo worked the draft and choosing materials for making costumes. In the history of art, there are numerous such data. But in the first half of the twentieth century artists increasingly directly involved in the creation of fashion. All the facts relating to the aesthetic or " art " mode, indicating that the industrial development and new relations between art **-** industry, fashion creativity is increasingly attracting artistic movements.
As part of the Vienna workshop in 1903. Secession authors gathered around a program similar ideas of England group Arts and crafts (Arts and Crafts Movement). As part of their activities formed the fashion workshop, led by architect Josef Wimmer, strict forms and functional decoration are the main feature of the production. Characteristics of functionalism are identified at the work of Van de Velde Belgian, who advocates an artistic mode and highlights the relationship between the lines and forms of mobility, which means construction elements of clothes in the function of body movements, and decorative logic, which tends decorating compatible with the structure of clothes.

Elsa Schiaparelli (Elsa Schiaparelli) started the design career of thirty years of the twentieth century as a designer of sportswear and swimwear. Later stands out as one of the designers whose work is closest to the work of the artist. A great influence on her work left her Dadaism, often in their creations adapted the ideas of Surrealism (eccentric dresses and hats). For Elsa art was not only a source of inspiration; It is works of art directly integrated into your design. Sketches of Salvador Dali and Jean Cocteau were printed or embroidered on her skirt. Prompted by the work of contemporary artists Elza experimented

using unconventional materials in the design and decoration of dress, such as photo paper, synthetic silk or cellophane.

[9]Fashion and clothing (Мода и одевање), Marina Kocareva Ranisavljev

1. design of Elsa Schiaparelli 1951.
2. 1937. Elsa Schiaparelli evening jacket, blue silk, velvet, metal details

Artistic tendencies that follow the spirit of the new era of the sixties of the twentieth century recognized in the occurrence and impact of pop-art and op-art. These artistic currents that actually occur as anti-art, are in response to the values of industrial culture of technological achievements to advertocracy and its authentic expression found in fashion.

Dresses with POP art painting prints by Andy Warhol

In 1965, Yves Saint Laurent presented a collection of cocktail dresses "a la Mondrian" inspired by Mondrian paintings. Dresses simple cut dominated by geometric shapes in a battle of contrasts - red, yellow, blue - framed by black bars - became the hit of the moment when they first appear. Soon they found themselves on the front pages of prestigious fashion magazines. "The art of walking " was the first association at a meeting with dresses that are irresistibly reminiscent of Mondrian canvases. Yves Saint Laurent in this way underlines a direct parallel between the painter's creativity and fashion. Collection 'a la Mondrian" is the first act of commercialization of Mondrian’s paintings, and the impact of neoplasticism with fashion spread to architecture, graphic design and many segments of industrial design.

dresses inspired by Mondrian’s painting Composition II

The tradition of using art as an inspiration in fashion design has been preserved to this day, as evidenced by a collection of fashion house Aqiliano Rimondi for spring-summer 2011 inspired by the Vienna Secession and the works of Gustav Klimt, Rodarte fashion house collection for spring 2012 inspired by the paintings of Van Gogh, a collection of Russian designer Ulyana Sergeenko for autumn-winter 2014 inspired by Malevich's paintings and many others.

Aqiliano Rimondi spring/summer 2011. inspiration Gustav Klimt

RODARTE spring 2012. Inspiration Van Gogh

Ulyana Sergeenko fall/winter 2014. inspiration Malevich, Сељанке у пољу 1928

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Atelier Versace 2015 inspiration Anri Matis, Blue nude

The importance of the designer in creating a fashion collection

The process of designing fashion designer begins with the idea and conceptual plan that materializes already making preliminary sketches.
Undeniable contribution to the development of fashion designers in form. The importance of designers as creators lies primarily in its versatile activities and the sophistication with which radiates their creative spirit. Fashion designer is a product of the development of the consumer society, his skill in bringing new ideas facilitates the harmonization of relations between production and consumption, enabling the new creations easily find their way to the customer.
Fashion designer is allways in the investigation of unused possibilities of form, texture, color and ornamentation. Often as inspiration he uses details from art. Appearance solutions or finished product depends largely on the ingenuity of designers, sense of fashion trends, imagination and courage to the clothes that a new form and a new look. Designers are more indicators than its trend forecasters. Inserts makers stems from the ability to recognize all social and cultural events, as well as future fashion trends, and to their own creativity adjusted materialize and put on the best way. The success of each creator manifests itself in the recognition, in the creation of their own brands. In addition to visual sensibility and talent, fashion designer must have the appropriate practice and knowledge. Each of his venture may be decisive for the evolution of fashion. He broke with tradition by copying the original model and not offering their own presentations of future trends.
The genius of the first designers such as Charles Worth, Paul Poirot, Coco Chanel and Madeleine Vione is in their ability to detect impacts and interlacing change in culture and style in order to unite the distinctive personal vision and that is well placed.[10]

The textile industry as the fourth branch of industry by annual revenues represent a significant segment of the world's industry. Production planning at all is not an easy job and includes a number of operational tasks to be solved in order to production to run smoothly and in a timely manner. In January begins seasonal sale stock fall / winter, it reaches its maximum in mid-January that the intensity of sales declined by mid-February. In mid-February began selling collection spring / summer of the current year, which reaches its peak in early May, and the sale lasts until early June. In July begins sale of inventories collection spring / summer, which lasts until the middle of August, and then began selling autumn / winter of this year. The auction usually lasts until the end of December, a new cycle begins next year by selling stock. To follow such a pace it is essential that production is well planned.

The first service of the winter collection beginning in the construction preparation, in planning and design collection, in February and March. In mid-March in the construction preparation begins production cuts and the first test samples of clothing in the collection, which lasts until the end of

[10] Fashion and clothing (Мода и одевање), Marina Kocareva Ranisavljev

April. Based on the patterns made marketing department can start arranging sales during the month of May.
The first contracts could serve as a basis for ordering the operational preparation of materials and construction preparation to begin operations around grading cuts. In mid-July begins receiving and storage of material for the production of clothing, and shortly after production of clothing by work orders. In mid-August start deliveries to customers, after which started selling in the market. By the same token planning starts the summer collection in August and lasts until the beginning of

February. From this description it is apparent complexity and coordination of a large number of operational tasks of preparing the production of clothing. Producers who do not have constant suppliers often encounter difficulties in planning usually related delays delivery of materials and the quality of the ordered material. Successful fashion houses in the current year show collections for the coming year, many of them products of 4 to 6 collections per year (men's and women's summer collection, men's and women's winter collection, the two inter-seasonal collection (resort and pre-fall), besides some house launched a year and a two haute couture collections - haute couture).

Marketing research play a key role in the creation of the collection. The main objective of this study was to assess the needs of the market, deriving from economic, social, cultural and other opportunities in the company. Marketing research involves the acquisition of facts and information relevant to predicting fashion trends, information on the demand of certain products, various fabrics or clothing. For the job in charge special teams in the fashion industry.

Experimental part: collection inspired by Suprematism and Russian avantgarde painting, made by author

SUPREMATISM collection Fall / Winter 2015

Winter collection SUPREMATISM, for autumn / winter 2015 from young Serbian fashion designer Djordje Bascarevic was inspired by the Russian avant-garde painting of the 20th century.
Commercial collection of 12 outfits tells a story (through the forms and prints) of developmental road of avanguard painting from Rayonism to Suprematism .
First part of the collection is dominated by three-part combinations (jackets, blouses, skirts, pants) which are rich in details and designs evoking the rayonistic images. Asymmetry, metalic details, and mixing prints are the basic elements of the collection. In the further course of collection silhouette has been simplified through the two-piece outfits proceed to dress as a basic form - which is associated with simplification the contents of the image after rayonism in painting.
Last part of the collection is dominated by simple silhouette dresses, lack of detail and adjustedness color to a monochrome palette of black and white tones with discrete color accents. Clothes are made from woolen winter materials and combined with knitwear. In contrast to the first part, the second part of the collection is dominated by dresses of thin cotton materials.

Paintings as inspiration incorporated in design

CONCLUSION

Fashion is constantly changing and evolving, is present in all regions and in all social strata. It means the world of illusion, but the harsh world of multimillion very complex industry. These aspects depend on each other; industry is necessary illusion to excite the market, a world of illusion requires the industry, which will embody and realize the new creative ideas, research paper, extravagance and talent. The role of the designer is to identify all social and cultural events, as well as future fashion trends, and to their own creativity adjusted materialize and put on the best way. It is important that the collection tell the story that the collection is comprehensive and has a certain flow. But despite his fantasy essence is in clothing. During the process of creating a collection must be borne in mind that the ultimate goal is that collection must sell.

That such art often was associated with the clothing that is wearable in everyday situations, but rather using art as inspiration designer can make a commercial collection that captures originality.

Fashion market where distribution and branding spread globally, the production is changing rapidly. More and more companies hire cheap labor, trends are changing rapidly, produces a large amount of clothes they can afford all social strata. On such a market should expose the product to attract customers, and following the experience of successful fashion house has just come to the conclusion that the collection, which does not follow blindly the current trends and which mimics a segment of the art can be successful and attractive to customers.

REFERENCES

Moda i odevanje, Marina Kocareva Ranisavljev , Službeni glasnik 2010. Beograd
Tehnologija proizvodnje odjeće sa studijem rada, dr.sc. Dubravko Rogale, red. Prof. , dr.sc. Darko Ujević vanr. Prof., mr.sc.Snježana Firšt Rogale, dipl. Inž., Marijan Hrastinski dipl. Inž.. Zagreb 2005.
Slikarski pravci XX veka, Lazar Trifunović, Jedinstvo /Priština/ Prosveta/ Beograd 1994.
Istorija moderne umetnosti H. H. Arnason, Orion art 2003.
Fashion history of the 20th century, Kyoto fashion institute, Taschen 2002.
Časopis Delo – Apstraktna umetnost - Marko Nedeljković i Zoran Gavrić, Redakcija Beograd Terazije 1979.
Moda danas, Teri Džons i Suzi Rašton, Taschen 2007.

Photography source:

http://theredlist.com/wiki-2-23-1249-1254-view-1930s-profile-elsa-schiaparelli-3.html
page http://www.ibiblio.org/wm/paint/auth/malevich/sup/
page http://cathylockeartblog.com/kazimir-malevich-1879-1935/
page http://www.metmuseum.org/toah/hd/elsa/hd_elsa.htm
page http://beyondmoda.com/2014/06/14/fashion-inspired-by-art/
page http://www.dulciedulcie.com/2013/10/art-as-fashion-lwren-scott-aquilano.html
page http://www.vogue.co.uk/news/2014/11/20/coco-chanel-pictures-and-quotes-douglas-kirkland
page http://fashionbabica.blogspot.com/2012/03/modna-abeceda-hubert-de-givenchy.html
page http://www.russianfashionblog.com/index.php/2013/06/constructivism-russia-1920s/#axzz3PrJ8x1Oy
page http://www.vogue.ru

NEW ADVANCES IN THE PRODUCTION OF WARP OF KNITTING SPATIAL

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ABSTRACT

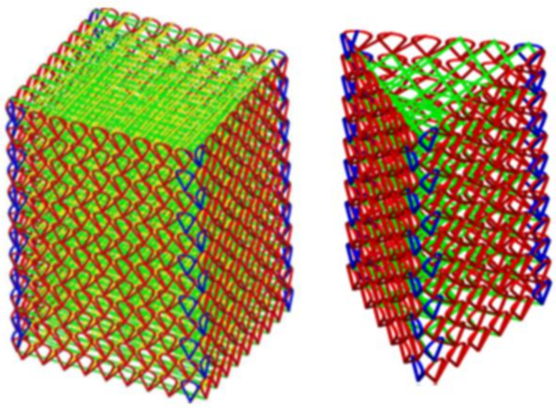
In this paper the Original concept of base knitting machines, which is implemented in the form of a working model with more than two needle bearings with even and odd number of technical and technological parameters of warp knitted fabrics. Based on the geometry of the mutual position of the basic machine elements, including needles, platinum, positioning rails and other devices in the process of forming loops and turns in its entirety, it is possible to produce a product with a more complex structure of the outer layer and produce a good geometric cross-section of the knitted products. A larger number of needle bearings allow to obtain spatial Knit prismatic similar cylinder. The angle α between adjacent needle bearings has enabled us to create a product with different geometric and structural parameters of the outer layers of our products. Unlike conventional warp machine, the new machine is equipped with a negative adding yarn with mechanical or pneumatic devices.

Key words: warp - knitting, needle bearing, needle, platinum, spatially knitting, lege rails.

INBTRODUCTION

Warp knitted products of which had been built so far to Warp knitting machines with three to five layers are already known. Such twists are produced at two front and two rear needle bearings - plates which are arranged parallel to each other in such a way that the pins are positioned opposite each other and their hooks needles are directed outwards. Thickness twists is determined by changing the distance between the plates. The most commonly used six Lege rail or pitting needle warp yarns with which the process of knitting yarn laying is done. Four layers of knitting two on each side are formed with four Lege rail, while one or two form one or two inner layers of knitted knitwear. Today more and more popular complex structure in which the woven yarn, woven fabrics or non-woven form after completing the manufacturing process. 3D twists are presented as finished products that pass through a stage stiffener with epoxy resins. These knitted products can be used in the industrial buildings and construction elements as well as machinery and equipment as a novelty at this stage of research. Another novelty is the spatial warp knit knitwear that has the look and intended for the production of technical textiles. Spacious twists can also have the basis of geometrical figures triangle, quadrangle, or polygon with their cross-section or base (Figure 1). The twists can also be in the form of a complex figure, thus creating a solid matter in the form of spatial relief, which with its structure resemble known building elements such as corridors in bars, or a duplicate grid in bars. On these machines it is possible to knit and circular knit in the form of cancer, left-right knit with recesses and protrusions in the form of berries. There are also variants of spatial twists in the form of physical ports. A review of patent literature have been constructed new warp knitting machines with more than two needle bearings (with a maximum of six or eight).

Good knitted geometry is strictly defined number of external layers. Two different structures can be distinguished in the construction of spatial knitted products, "open", in which the product is not limited to the top or at the bottom by the outer layers, and "closed", in which the outer layers are completely enclosed in the innerknitwear.



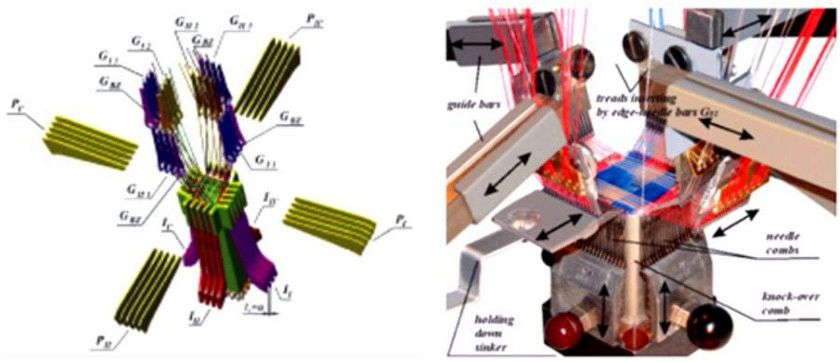
a) b)

Figure 1. Knitted spatial products: a) tetragonal base, b) triangular base

EXPERIMENTAL PART

Warp knitting with an even number of needle bearings in excess of two

At the base knitting machines with an even number of needle bearings, couples these deposits are placed opposite each other to each other on parallel planes or flat with a slight decline in the vertical (Figure 2a). Needle bearings that are used are different levels, which are placed in a certain order, which determines the physical form of a solid section of knitted products. In Figure 2b is given a new concept machine which is realized in the form of a working model. This prototype machine has four needle bearings, six positions rails (four of them work in the formation of the outer layers of the product, while the other two cross inserted on the inner layers), rails of platinum, when struck down forming a closed circuit in which finally takes knitted product. In this way, using a working model with more needle bearings, a fragment of spatial knitted product is manufactured in order to confirm the correctness of assumptions construction.



a) b)

Figure 2. Concept of a four-comb warp-jnitting machine for the formatiion of spatial knitted products: a) a schematic drawing of the structure and component elements of the machine, b) a photograph of a working model

For the new concept proposed a new principle numbering machines, which is shown in Figure 3. Needle bearings are numbered so that the first two needle bearings I_I and $I_{I'}$, are placed nearest machine operator, who stands in front of her. The following pairs of needle bearings are marked I_{II} $I_{II'}$ and I_{III} $I_{III'}$, whose numbering increases in the clockwise direction.

Taking into account the same practical and economic factors generally assume the use of 6÷8 bays maximum. By applying a large number of needle bearings would allow to obtain spatial knitting prismatic similar cylinder. The fineness machine needle bearings may be the same or different. The working width of the machine also can be the same or different.

The angle α between adjacent needle bearings my be same or different values, which means that α_i=constant, α_i≠constant (Figure 4). Changes in the value of the number of needle E, working width S as well as the angles α allows the creation of products with differentiated geometric and structural parameters of the outer layers of knitted products. At classical base knitting machine needle bearings are reduced by a constant values of depth of impact compared to that of platinum a blow-down. On machines that produce spatial knitted products in the form of a geometric solid material it is possible to differentiate the impact of platinum down due to a separate needle bearings, which means that (Z_I≠constant of the different needle bearings), in order to create different structural parameters of the outer layers of spatial knitted solids.

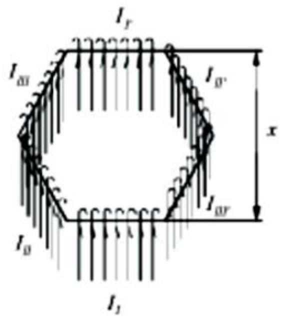


Figure 3. Principle of numbering of the needle combs in a six-comb warp-knitting machine

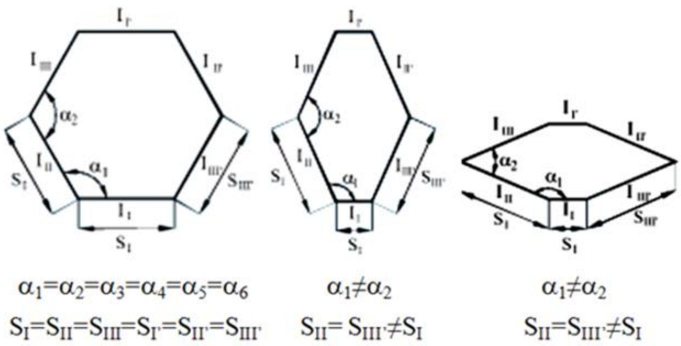


Figure 4. Examples og the mutual arrangement of needle combs in a six-comb warp-knitting machine

To produce technical products commonly used Lege two rails, while the machines with six bays presented in this paper number Lege rail is unlimited. This applies to those Lege rails inserted yarn in the outer layers, as well as those that form the internal layer. Regardless of the complexity of the structure of urban knitting products in the form of geometric matter, Lege number of rails may be connected with the number of systems required for the insertion yarn. Lege rails retreat switch from warp beam for the outer and inner layers are marked with the letter G with two index dots (G_{PK}), where p is subsequently needle tray and k next Lege rail which cooperates with a special pair of needle bearings. The index k=1 refers to the needle tray placed closest needle bed marked with (non "prime") the designation systems include the new description which is consistent with the product and the aim of mutual arrangement of elements for forming loops. This system can serve as a description of the components of the weaving as spatial woven products.

An example of determining the sequence of Lege rail systems I_I–$I_{I'}$is shown in Figure 5.

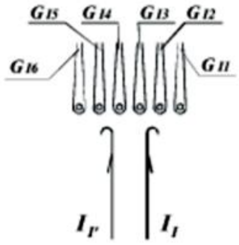


Figure 5. Example og the numbering of needle bars for system I_I-$I_{I'}$

Some of the Lege rails cooperate only with those needle bearings for the formation of the outer layers of the product, while the number of pairs of needle bearings produced inner layer. In addition, in each of the positions of the rail G_{pk}, which fed the yarn to the outer layer of the product, one of the edge plates needle G_{bz} is individually controlled. These needle plates with separate yarns added yarn needle edge adjacent needle bearings (Figure 6). Between neighboring systems Ellement form loops, the needle plate is moving in such a way that its movement closes the foreign firm structure knitting in the place where they are Systems in contact (Figure 7).The number of specially controlled needle plate is precisely dependent forms of the figures that form a solid knitted section and refers to the number of sides of this issue.

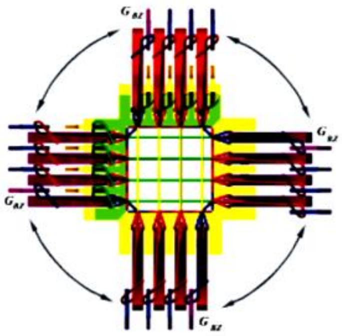


Figure 6. Concept of individual control of the edge needle bars G_{BZ} in a warp-knitting machine with an even number of needle combs greater than two

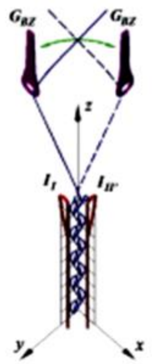


Figure 7. Working principle of the individually controlled needle bars G_B

Warp knitting with odd-numbered positions of the rails exceeding two

Next structural variant base knitting knitting machine described in this paper is one with numerous needle bearings more than two, which is designed to produce spatial knitted product in the form of solid geometric material, see Figure 8. This machine can have a permanent or different values of these parameters as needle number E (fineness machines) all needle bearings, width With certain needle bearings and the angle α between adjacent needle bearings (Figure 9).

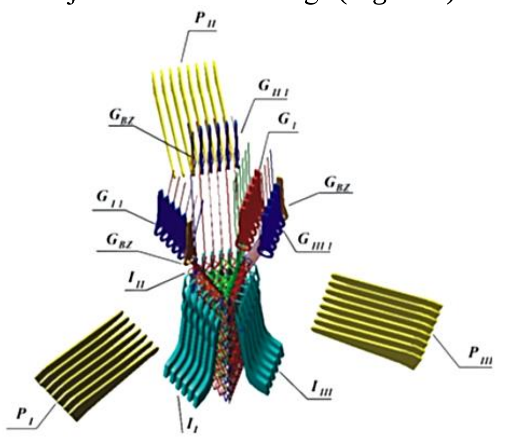


Figure 8. Concept of a tree-comb warp-knitting machine for manufacturing spatial knitted products

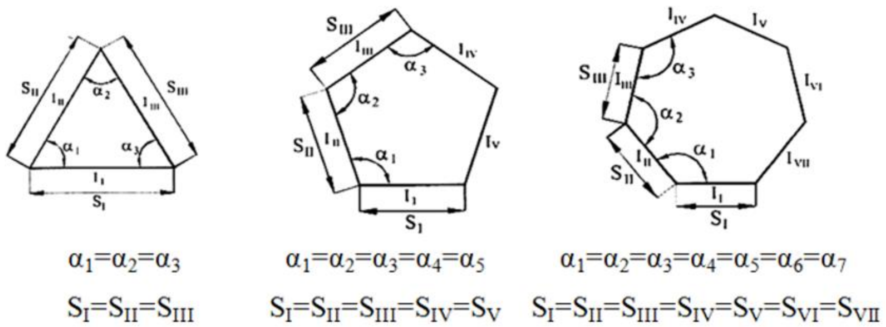


Figure 9. Examples of arrangements of the needle combs of a warp-knitting machine an odd number of these combs

NUMERICAL ANALYSIS OF MECHANICAL PROPERTIES OF WOVEN COMPOSITES

The basis knitted solids in the composite package, a diagram is shown in figure 10, suffered a numerical analysis of the mechanical properties of the bending process on the basis of FEM methodology. The diagram in the figure represents two internal layers. The bundle contains the outer layers in its structure that surrounds the interior of solids. Cross-section beam is 0.1m x 0.1m, length 0.96m and consists of 16 segments each of 0.06m height. The thickness of the individual layers is 3mm. One end of the beam is constant immobilized carriers, and was influenced by the other end with a force P = 414 N.

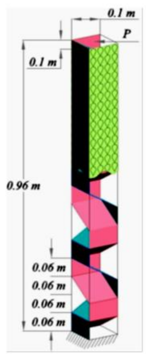
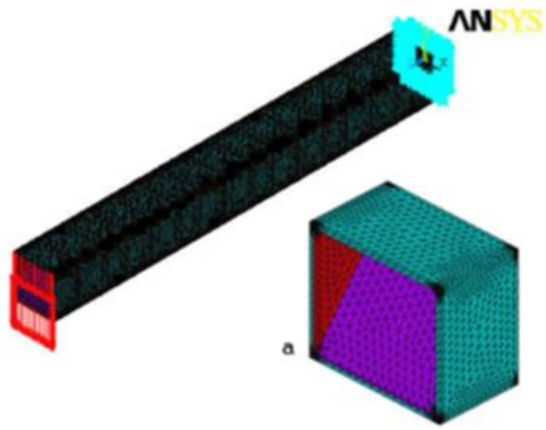


Figure 10. Diagram towards of the knitted beam tested

It is assumed that the materials of the composite layers were isotropic character based on the mood of literature [13, 14]. The following material parameters are adopted. Poisson's ratio = 0.305, tensile strength in the outer layer = 45720 MPa Shear. and an inner layer = 30480 MPa.Analysis model bending process was carried out using ANSYS v.11.0. The model shall be considered net of finite elements generated (Figure 11). For the analysis was used 8-node finite element SOLID 185. In each node there were three levels of freedom, who were deployed in the XYZ directions, according to the globally adopted coordinate system. Figure 11a is a magnified fragment generated network.The inner layers are marked with red and purple colors, and the external layers of the green. The whole structure of the network is divided into triangular elements. Model knitted solid composite is fixed and analyzed at the level z=0 and filled uniformly in all nodes which are located in areas with a=960.



Fifure 11. Tetrahedra net of the product

As a result of numerical calculations obtained diagram is moving towards the axis OY (Figure 12). The maximum value of these shifts was 1,344 mm. Figures 13 and 14 represent the resultant tension model, which ranged from 37.75 to 20711 kPa. The highest values were observed in the tension areas in the vicinity of the fixed beam. Diagram of distribution of the tension in the inner layer (Figure 14) illustrates the distribution of character similar to the distribution of tension in the whole model, the value of which varies from 37.75 to 9347 kPa.

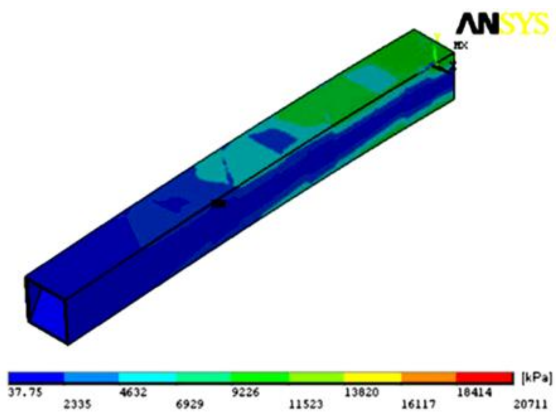


Figure 12. Diagram of displacements the axis OY

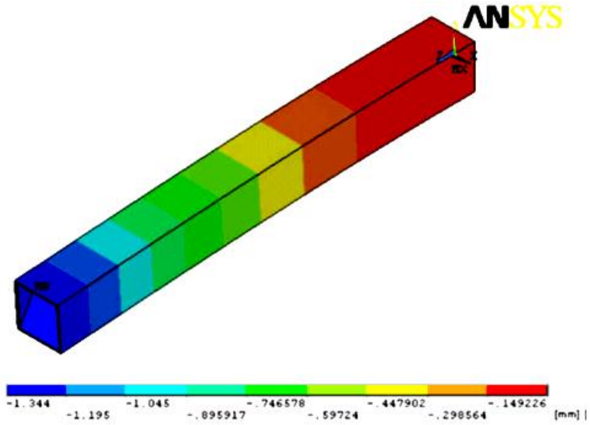


Figure 13. Diagram of resultant tensions of the knitted composite solid

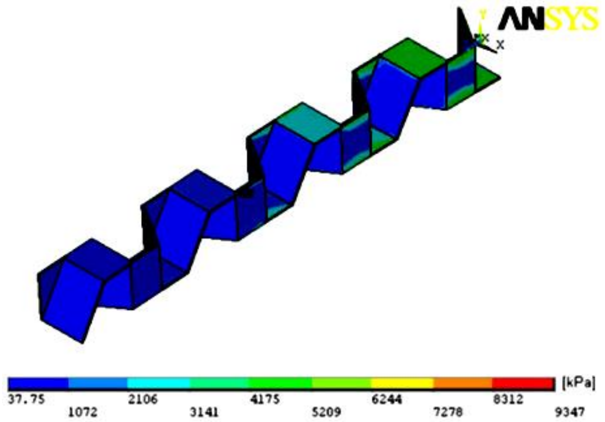


Figure 14. Diagram of resultant tensions of the internal layers

FINDINGS

*The novelty of the new concept of warp knitting machines, which is primarily intended for the production of spatial knitted products, the existence of more than two needle bearings or needle plate. This new koncpet includes two kinds of warp knitted of knitting for the first time with an odd number of needle bearings. Himself geometric shape needle bearings determined explicitly created forms of regular or irregular solids physical product itself as well as the parameters of knitted knitwear.
*Authors (Katarzyna Pieklak, Zbigniew Mikołajczyk) opposed to the current method of knitting on warp knitting machines have suggested equipping the machine with a device that is characterized by a negative addition to the mechanical system, or pneumatic joints with felling platinum and Lege rails. Bearing in mind the specific technology for the production of physical products, Lege rails are pushed - rocking movement, and in the case of machines with an odd number of needle bearings, have an additional rotary motion. Lege rails are additionally equipped with an additional separate edge needle boards, whose purpose is to connect the outer layers of knitting in the marginal zone of knitting. To move the needle bearings, Lege rail and platinum rail, can be applied hybrid drive (mechanical electronic disk).

*Spatial structure of knitted products is characterized by more than two outer layers and at least one inner layer of the structure.Knitting is characterized with different geometric shapes obtained directly during the manufacturing process. 3D structures are twists and products are subject to patent applications.
Innovative group of warp knitted knitwear that form the spatial structure was established solid. These products are characterized by more than two outer layers and at least one internal layer.
Manufactured newly designed machine is equipped with more than two needle bearings -neddle. Knitted knitting is characterized by the variety of geometric shapes directly obtained during the production process to the warp knitting machine. The structures of 3D knitted knitwear and production technologies are the subject of patents [10, 11, 12].
*One of the most important groups of spatial structures are Open work structure which can be straight with outer layers and spatial Open work structure. These structures are the low weight and low coefficient of feelings of internal layers, less raw materials compared to the full structure.
*Treatment of knitted products with epoxy resins can be generated composite products in the form of beams or beam, or a frame that can be applied in construction and as elements of machines and devices as they are lightweight and at the same time highly resistant and can be competitive wood, steel or concrete products.
*An attempt was made to model the mechanical properties of bending process spatial beams knitted with the use of ANSYS software. Other parameters are defined by moving segments of beams designed to the axis OY, and distribution of components of tension on the shaft in its inner and outer layers.
*A novelty in the proposed structure of the machine is downloading - pulling down and storage devices. Characteristically download - up device is a group of rolls that does not deform the structure of knitted products produced. Thanks to the relief structure of the surface of the rolls during rotation, the product being manufactured are taken - up and can be stored on the screw shaft or in the machine with vertical system underneath.
*Based on the defined structure of the assumptions of the new concept with more needle bearings warp knitting machine knitting, working model was built. The model is equipped with four rail position and six needle bearings - neddle and was used to confirm the validity of the assumptions accepted by the author (Katarzyna Pieklak, Mikołajczyk Zbigniew), as part of the verification possibility of producing spatially knitted product in the form of a rectangular prism.

REFERENCES

[1]. Pieklak K., Mikołajczyk Z.; Model of the Spatial Structure Warp-Knitted 3D Fabrics, FIBRES & TEXTILES in Eastern Europe, Vol. 16 2008, No. 5 (70), p. 83–89.
[2]. Kopias K.; Technologia dzianin kolumienkowych. WNT. Wa-wa 1986, 180 p.
[3]. Pospelov E. P.; Dvukhlojjnyjj trikotazh. Moskva 1982, 208 p.
[4]. Grębowski J.; Tree-layer knitted fabrics (in Polish). Przegląd włókienniczy. No 9, 2000, p. 37–38.
[5]. Zweiwandgewirke–interessante Stoffe für die vielfältigsten Einsatzgebiete. Kettenwirk – Praxis. Nr 2, 1989, p. 55–60.
[6]. Mikołajczyk Z., Pieklak K., Golczyk A., Wiater Z.; Warp-Knitting Machine for Manufacturing Spatial Warp-Knitted Fabrics, Patent Application No. P–386073, Polish Patent Office, 12.09.2008.
[7]. Schwabe D., Möhring U.; Melliand Textilberichte, 2005, No. 6, pp. 444–446.
[8]. Ceken F., Pamuk G.; Technical Textiles, 2006, No. 1, pp. 29–31.
[9]. Pieklak K., Mikolajczyk Z.; Fibres & Textiles in Eastern Europe, 2008, No. 5, pp. 83–89.

[10]. Mikolajczyk Z., Pieklak, K., Golczyk A., Wiater Z.; Warp-Knitted Spatial Fabrics, Patent application No. P–386074, Polish Patent Office, 12.09.2008.
[11]. Mikolajczyk Z., Pieklak K., Golczyk A., Wiater Z.; Warp-Knitted Spatial Fabrics, Patent application No. P–386075, Polish Patent Office, 12.09.2008.
[12]. Mikolajczyk Z., Pieklak K., Golczyk A., Wiater Z.; Warp-Knitting Machine For Manufacturing Spatial Warp-Knitted Fabrics, Patent application No. P–386073, Polish Patent Office, 12.09.2008.
[13]. Krolikowski W., Klosowska-WolkowiczZ., Penczek P.; Polyester resins and laminates, WNT, Warsaw, 1986.
[14].German J.;Macroscopic description of composite laminates endurance, Available from: http://limba.wil.pk.edu.pl/~jg/,
[15] Vojislav R. Gligorijević: Projektovanje pletenih materijala,Tehnološki fakultet, Leskovac 2010;1 elektronski optički disk (CD-ROM); 12 cm., ISBN 978-86-82367-86-4.
[16] Vojislav R. Gligorijevic: Tehnology of Knitting with the Theoretical Experimental and Analysis: a comprehensive handbook and practical guide; 1st ed. in English. - Leskovac 2011, ISBN 978-86-914211-3-7.
[17] Vojislav R. Gligorijević: Tehnologija pletenja sa teorijskom i eksperimentalnom analizom, Leskovac 2011, ISBN 978-86-914211-2.

TESTING OF PARAMETERS WHICH AFFECTING ON THERMAL PHYSIOLOGICAL COMFORT KNITTED MATERIAL

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ABSTRACT

In this research, testing of thermal properties of white and navy blue knitwear, 100% PES fiber composed, is shown. Testing was made by using the device KES-F7. Testing results serve for determinating of thermal-physological comfor of the knitted materials. The analyses were conducted at the Laboratory for clothing engineering, physiology and clothing construction, Faculty of Mechanical Engineering, University of Maribor.

Research was focused on determination of hot-cold feeling, determination of thermal process, and on determination of material's heat ressistance (dry flow) – contact method; air movement speed $v=1ms^{-1}$ by using KES-F7 device. Analysis of the samples was carried out under standard conditions: air temperature 20±2°C and the relative air humidity is 65%. Before the cutting process, samples are condicioned acording to the ISO 139 standard, in order that results are as more accurate as possible. Amount of one dimension of white and navy blue tested samples are the same. Conclusion of researching shows value differences between white and navy blue knitwear, such as that the results are different that it was expected.

Keywords: PES knitwear, thermal properties, KES-F,

INTRODUCTION

Physiologhical comfort is defined as the influence of the thermal balance on the normal physical temperatures in the minimal amount of the physical regulations. When comfort exists, mind is awake and awared, and body functions on its maximum level. Clothes comfort during its wearing represents result of balanced process of temperature among the bodies, clothes and surrounding, and it depends from special thermal clothing characteristics, which represent their abilities for temperature and moisture transfer from the surface of the body towards the suroundings.

Clothes must enable a special thermal isolation, a high level of moisture permeabillity, good ventilation so that optimal thermal regulation of human's body could be kept. Result of the balanced interactions, in the system „human-climate" – „clothes" expose in human's comfort while wearing clothes. [1] When the condition for comfort exists, mind is awake and body functions on the maximum efficience. When there are temperatures changes of the surroundings, body tries to aclimate to the dfferent mechanizams for temperature regulation – clothes also help in aclimazation. The body must throw away heatness and must keep body temperature constant. [2]

Materials type and structure have a direct influence on the thermal clothes isolation. Clothing items which are weared every day, are attached with physiologhical functions on the body temperature regulation. Clothes are disturbing sweat vaporization from the skin surface, and an insuficient sweat vaporization ussualy leads to uncomfortness. Conclusion of the research shows the difference between white and navy blue knitwear.

MATERIAL FOR TESTIN

Examined knitwear samples are of white and navy blue colours, 100% polyester PES fyber composure. Knitwear are made on circleing sewing machines. Samples examining is done in standard the conditions: air temperature 20°C and relative air humidity 65%. Before the cutting samples process, it is neccessary that white and navy blue samples conditionate according to the ISO 139 standard(standard atmosphere T=20°C, RH=65%) so that the results could be more accurate. Durring the samples cutting, it is neccessary to take care about the direction of base and weft. For determination of the hot - cold feeling it is necessary to takes 5 samples of white and 5 samples navy blue material dimensions (50mm x 50mm), for determination of the heat flow 5 samples of white and 5 samples navy blue material dimensions (∅ 110 mm), for determining the thermal resistance of materials it is necessary to 5 samples of white and 5 navy blue samples of materials dimensions (200 mm x 200mm). [3]

KES - F7

Testing the thermal characteristics of knitwear is done using a KES - F7 (Thermo Labo II) which is used for determination of thermal properties of textile materials such as: [3]

- hot - cold feeling q_{max},
- heat flow ϕ,
- Determination of thermal resistance material (dry warm flow) - contact methods; air speed $v = 1ms^{-1}$

KES - F7 is used for easier research of the thermal characteristics, which are very important in the accuracy of the physiologhicaly-thermal results. Durring the research, conditions of the room, in which research is conducetd, are very important. Standard atmosphere temperature is T=20°C, relative air humidity RH=65%. In addition to use the device like KES-F7, it is neccessary to have experience with working on that device.

Measuring device "Thermo Labo II" for measuring thermal properties consists of 5 basic components [2]:

* Measure body T - used to measure hot - cold feeling
* Measuring body BT - used to measure the thermal conductivity constant
* Larger measuring body BT - used to measure heat loss
* Measuring body with water VT is used to maintain a constant temperature in the measurement of hot - cold sensation and thermal conductivity
* The wind tunnel - it is constantly present air movement speed of 1 ms-1 at a constant air temperature of 20 ° C ± 2 ° C. In the wind tunnel measured heat loss ie heat flow, which is used to determine the coefficient of heat retention capability, heat resistance and resistance to the flow of steam

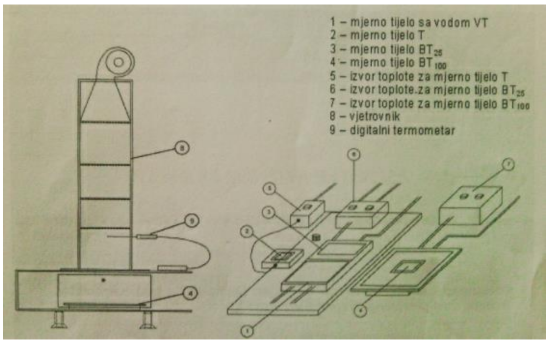

Figure 1: Parts of the measuring device KES -F7 [3]

DETERMINATION OF WARM - COLD FEELING

For determination of hot - cold sense it is used: BT plate with heat source which is heated up to 35ºC, in order to simulate the temperature of the human skin, measuring body T and measuring body with water VT works so that the on measuring point puts a sample dimension 50 mm x 50 mm. On heated BT plate we put measuring body T which was heated at 35ºC. When measuring point reaches a certain temperature at which the sample is placed on the measuring point with water, lay the measuring point T, and there after reads value. $q_{max.}$

q_{max} values may be higher or lower, and it depends on testing material. If the obtained values are higher, that mean that clothes, which is made from material that we are testing, gives a cooler feeling and opposite. [3]


Figure 2: The measuring device with a sample

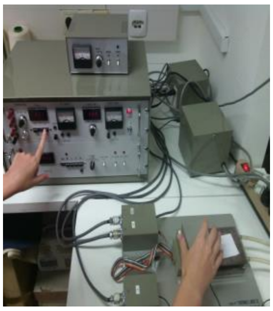
Figure 3: Measuring hot - cold feelings

DETERMINATION HEAT FLOW Φ

Heat flow measuring is based on the transition of heat from the warmer to the colder part. Heat flow represent the amount of heat in W/ m K, which flow in 1h through a surface of $1m^2$ and with thickness 1m, temperature difference on both sides is 1K. Thermal flow coefficient is measured by using the measuring body BT with a heat source which is heated on 35ºC and measuring body with water VT. The sample is placed on the measuring body with water VT and when the temperature of the measuring body BT reaches 35ºC measuring body BT is placed on the sample which is laid with face on up. The value of heat flow can be read on the digital device.

The formula for calculating the constant thermal conductivity: [4]:

$$\lambda = \frac{\Phi \cdot h}{A \cdot (T_{TB} - Ta)} * 100$$

Legend:

A – surface of BT plate ($25\ cm^2 = 0{,}0025 m^2$)
h – material thickness at force of $6cN\ cm^2$ (weight BT plate is 150g)
λ– coefficient of thermal conductivity (W/mK),
T_{BT} – temperature BT plates (K)
Ta - ambient temperature (K)
Φ – heat flow (W)

Figure 4: The measuring device with a white pattern (Ø 110 mm)

Figure 5: measuring device with navy pattern (Ø 110 mm)

Figure 6: The digital housing for the reading results

DETERMINATION OF THERMAL RESISTANCE (DRY WARM FLOW) - CONTACT METHODS; AIR SPEED V = 1MS^{-1}

When a man is in stationary state the thermal resistance is the greatest because the air is also in stationary statement under the clothes. Thermal resistance can be determined with contact and contactless method.

The formula which used for the calculation: [4].

$$Rct = \frac{(T_s - T_a) \cdot A}{Hct}$$

Legend:

Rct – thermal resistance of textiles (m^2K/W)
Ts – temperature BT plate (ºC)
T_a - air temperature in the wind tunnel (ºC)
A – surface of Bt plate (m^2)
Hct – dry heat flux (W)

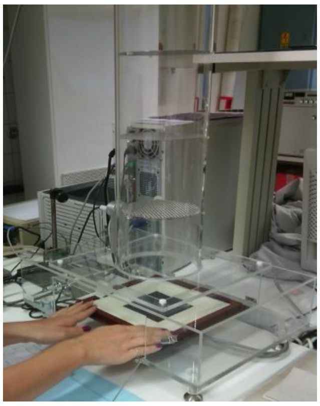

Figure 7: The measuring device with a sample (200 mm x 200mm)

Figure 8: The measurement of thermal resistance of materials

RESULTS

DETERMINATION OF WARM - COLD FEELING

Table 1 The results warm - cold feelings white material

Mark of measurement	Warm - cold feelings q_{max} $[W\ cm^{-2}]$		Ambient Temperature Ta [ºC]	Air humidity RH [%]
	Face	Naličje		
1	0,172	0,065	20	60
2	0,170	0,067	20	60
3	0,170	0,067	20	60
4	0,168	0,065	20	60
5	0,166	0,066	20	60
Average	0,169	0,066	20	60

Table 2 - The results warm – cold feeling navy material

Mark of measurement	Warm - cold feelings q_{max} $[W\ cm^{-2}]$		Ambient Temperature Ta [ºC]	Air humidity RH [%]
	Face	Naličje		
1	0,164	0,079	20	60
2	0,163	0,076	20	60
3	0,166	0,077	20	60
4	0,163	0,075	20	60
5	0,160	0,075	20	60
Average	0,163	0,076	20	60

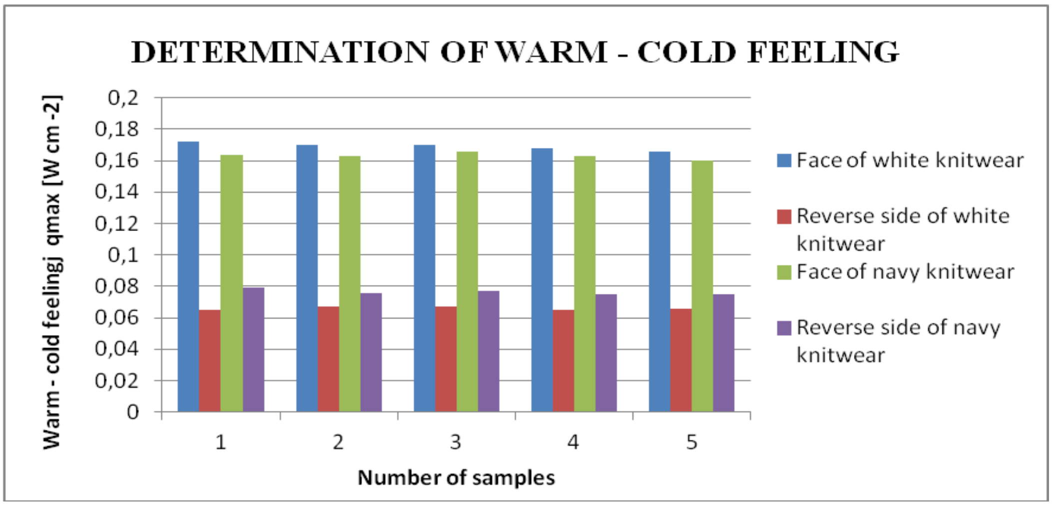

Figure 9: Determination of the warm - cold feeling of the face and reverse of white and navy knitwear

DETERMINATION HEAT FLOW ϕ

Table 3 - The results of heat flow of white material

Mark of measurement	Heat flow ϕ [W]		Ambient Temperature Ta [°C]	Air humidity RH [%]
	W	$\overline{W}$		
1	1,36	1,34	20,10	60,5
2	1,36	1,34	20,05	60,2
3	1,35	1,33	20,03	60,5
4	1,39	1,37	20	60,4
5	1,32	1,30	20,05	60,5
Average	1,35	1,33	20,045	60,4

Table 4 - The results of heat flow navy material

Mark of measurement	Heat flow ϕ [W]		Ambient Temperature Ta [°C]	Air humidity RH [%]
	W	$\overline{W}$		
1	1,50	1,48	20,05	60,2
2	1,50	1,47	20,05	60,4
3	1,50	1,48	20,0,3	60,5
4	1,53	1,51	20,04	60,5
5	1,47	1,45	20,05	60,4
Average	1,5	1,47	20,04	60,4

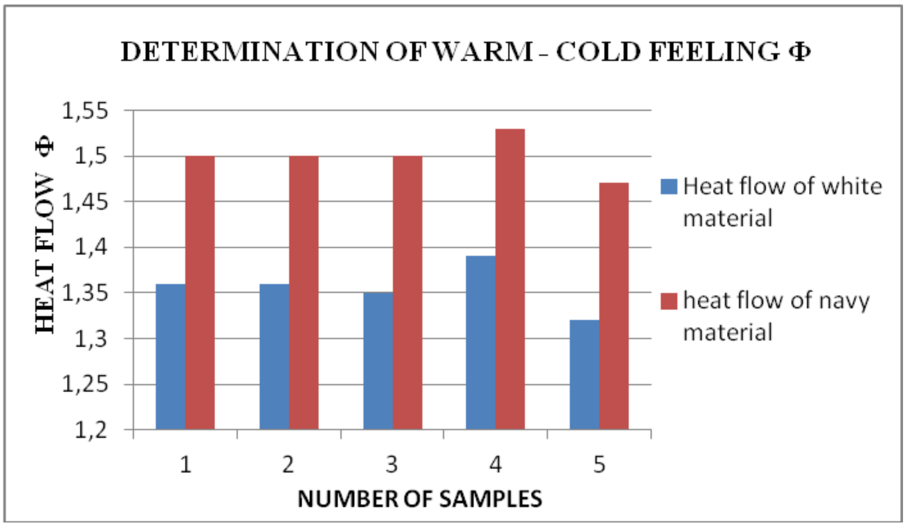

Figure 10: graphic heat flow Φ

DETERMINATION OF THERMAL RESISTANCE (DRY WARM FLOW) - CONTACT METHODS; AIR SPEED V = 1MS^{-1}

Table 5 - The results of the heat resistance of the material, white material

Mark of measurement	Heat flow ϕ $[W]$				Ambient Temperature Ta [ºC]		Air humidity RH [%]	
	W		$\bar{W}$					
	Face	Reverse	Face	Reverse	Face	Reverse	Face	Reverse
1	1,78	1,70	1,83	1,79	20,17	20,15	61,3	60,5
2	1,81	1,67	1,91	1,79	20,29	20,07	59,9	60,8
3	1,79	1,65	1,82	1,77	20,28	20,02	60,7	61
4	1,80	1,69	1,95	1,79	20,20	20,05	60,7	60,5
5	1,73	1,65	1,86	1,78	20,34	19,99	60,3	60,6
Average	1,78	1,67	1,87	1,78	20,25	20,05	60,58	60,68

Table 6 - The results of the heat resistance of the material, navy material

Mark of measurement	Heat flow ϕ $[W]$				Ambient Temperature Ta [ºC]		Air humidityRH [%]	
	W		$\bar{W}$					
	Face	Reverse	Face	Reverse	Face	Reverse	Face	Reverse
1	1,72	1,76	1,70	1,72	20,17	20,06	61,5	61,3
2	1,85	1,77	1,83	1,73	20,29	20,06	60,8	61,5
3	1,92	1,78	1,89	1,83	20,28	20,23	60,6	60,4
4	1,90	1,73	1,86	1,83	20,20	20,23	60,9	61,1
5	1,95	1,78	1,92	1,80	20,34	20,25	60,9	61,2
Average	1,86	1,76	1,84	1,78	20,25	20,16	60,9	61,1

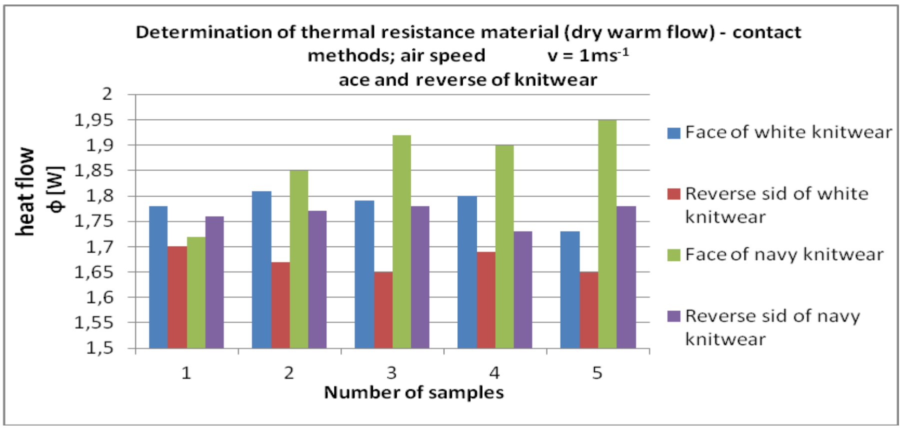

Figure 11: Graphical presentation of the determination of the thermal resistance of the material (dry warm current) - contact methods; air speed v = 1 ms-1

DISCUSSION OF RESULTS

Durring the material's thermal resistance research, on the KES-F7 device, white and navy blue knitwear were examined. After the research was completed, differences are visible between front side and reverse side of the white and navy blue knitwears. In the – determining hot-cold fealing, it is shown that there are diferences betweend front and reverse side at 100%. Also, at the graphycons, it is visible that there are diferences between white and navy blue knitwear, which showsus that the white is colder than the navy blue*, and by that results are biger. Durring the research, thermal graphycon flow is bigger at navy blue than at white's graphycon. Determining the thermal resistance of materials showed that in this case*, too, navy blue material has a bigger thermal flow na front and reverse side than the white knitwear.

CONCLUSIONS

In this document, research of the parameters, which have influence on the thermal-physiologhical comfortness of the materials, is conducted. Research is done both for the white and the navy blue knitwear on the KES-F7 device. Differences between white and navy blue knitwear are pretty small. One of the most important differences in research has been shown in front and reverse side of knitwears. Conclusion is that the front side of the white and the navy blue knitwear, colder than the reverse side of the knitwear, with a difference of 100%. Also, research has shown that the navy blue knitwear has a biger thermal flow than the white knitwear.

REFERENCES

.
[1] Technical information KES systems.

[2] " Improving comfort in clothing", Woodhead Publishing Limited, 2011

[3] Technical Information of Institute for Textiles at the University of Maribor, 2015.

[4] K. Nishikujo Minami- ku; ," KES-F7 thermo Labo II- precies and prompt Thermal Prosperity Measurement Instrumen " , Kyoto 601, Japan.

TRAINING OF PERSONNEL IN MODERN CONDITIONS OF BUSINESS ON THE EXAMPLE OF PROFESSIONAL PRACTICE AND PROFESSIONAL TRAINING IN GERMAN COMPANY "PIRIN-TEX"

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ABSTRACT

The paper presents an example of professional practice which major companies realize with higher education institutions. The paper is done within professional practice and it shows the way of doing business in major company "Pirin-tex" EOOD, company of modern clothes with high quality for men and women, world-wide major brands such as "Hugo Boss", "Tommy Hilfiger", "ESPRIT", "GUCCI", "Givenchy", "Laurel" and many others. The paper shows how this company has been managing for 20 years, as well as managing with great success. The company has developed a range of companies in Bulgaria and it has been managing successfully for 60 years in the design, manufacturing and trade of fashion clothes. The results that we have got through work based on research, as well as data of business for the daily production capacity are shown in the paper. Also, we shown their report about managing, measures for environmental protection according to the regulations of the European Union, sustainable business development with reduced primary energy consumption. The company "Pritin-tex" has developed their system and created their center for professional training theory and professional practice for acquisition of professional operators, employees and experts for manufacturing clothes.

The paper shows the way of how our students done their professional training in Bulgaria. The paper was done under a contract of business and technical operation by company "Pirin-tex" and Technical Faculty of "Mihajlo Pupin" – department of Textile Science and clothing design.

INTRODUCTION

Manufacture of garments need to be efficient. Major companies such as "Pitin-tex" must satisfy modern requirements, overcome delays and shorter terms. This requires the adoption of modern functional skills, ability to navigate independent in specific knowledge systems and activities. This is caused by the rapid development of science, technology, engineering and others. All requirements the company can fulfill with professional employees and modern equipment.

PORTFOLIO OF THE "PIRIN-TEX" COMPANY

The company "Pirin-tex" EOOD, is a company of modern clothes with high quality for men and women, world-wide major brands such as "Hugo Boss", "Tommy Hilfiger", "ESPRIT", "GUCCI", "Givenchy", "Laurel" and many others. For more than 20 years of great success, the company has developed a range of companies in Bulgaria. "Pirin-tex" company is a brunch office of "Rollmann & Partner Fashion Management" company which has been managing successfully for 60 years in the design, manufacturing and trade of fashion clothes.
There are over 3060 employees. So "Pirin-tex" company is the largest employers in the region. The base of manufacturing and storage extends to over 27 500 square meters total area. The value of the investment rises to 25 million euros.

Picture 1: "Pirin-tex" Company EOOD – Goce Delchev Bulgaria

"Pirin-tex" EOOD company is equipped with full high-tech machinery and specialized in the production of all garments, efficiently execute all orders of its clients and optimization of their costs. The company also receives and processes the orders for the traditional costumes with handmade details. It has highly qualified employees, which ensures quick realization and quality of all the complex orders of clothing for men and women. The company invests 3-5% of all annual turnover in the machine operator qualification and employees management an all sectors. The company operates in two teams whit a flexible timetables in order to perform costumers orders in the shortest possible time.

Thanks to the atmosphere, trust, cooperation between management and employees and excellent communication with clients, the company is among the most dynamic company in Bulgaria and beyond.

Picture 2: Manufacturing of "Pirin-tex" EOOD company – Goce Delchev Bulgaria

MANUFACTURING OF "PIRIN-TEX" COMPANY

The company has high-tech machinery and system of information production. Guarantee the highest quality of each manufacturing process and finished products. The results obtained through work based on research and all data of manufacturing for the daily production capacity are shown in the paper. Based on obtained data and the results, all the information we can conclude that the daily production capacity looks something like this:

- 2 manufacturing lines for costumes of 250 pieces per daily capacity
- 1 manufacturing line for pants of 250 pieces pre daily capacity
- 1 manufacturing line for blouses of over 600 pieces per daily capacity
- 1 manufacturing line for dresses of 250 pieces per daily capacity

In analysis of women's clothing in the event of "Pirin-tex" company, particular emphasis is placed on that because the students made originals designs clothing for women's company and brand "Laurel", whose collection for spring-summer and fall-winter are made in the company at the time.

"PIRIN-TEX" – CENTER FOR PROFESSIONAL TRAINING AND SPECIALIZATION

The system of alternating training in German knowledge, which provides young people a quality job at which they can connect allows them to acquire and fulfill their professional responsibility.
The company "Pritin-tex" has developed their system and created their center for professional training theory and professional practice for acquisition of professional operators, employees and experts for manufacturing clothes. The training is provided by highly qualified trainers and technicians with long professional experience. During the training, participants receive a scholarship, manuals, work clothes and free transportation.

After the examinations for acquiring professional qualifications, young people have the opportunity to work in the "Pirin-tex" company. The company also offers several months professional practice training for students from other countries where they next to professional training also have a scholarship, provided accommodation and after completing training they acquired professional qualifications, certificates and recommendations. The center also organizes language courses and seminars for management employees.

Picture 3: The system of "Pirin-tex" EOOD training of young people and professional development - Goce Delchev Bulgaria

PROFESSIONAL PRACTICE IN BULGARIA FOR STUDENTS OF TECHNICAL FACULTY OF "MIHAJLO PUPIN" – DEPARTEMENT FOR GARMENT ENGINEERING

The paper was done under a contract of business and technical operation by company "Pirin-tex" and Technical Faculty of "Mihajlo Pupin" – department of Textile Science and clothing design. Whit this contract, students of Technical Faculty – department for garment engineering, has been enabled professional training and practice for at least three months in which students are allowed professional training, acquisition of professional experience and training.
In this case, two students had the opportunity to go on the professional training in "Pirin-tex" company. They had been working eight-hour per day. They had provided free accommodation and were paid for the duration of the training. They were given a special plan and program access to complete documentation, technical drawings and fashion sketches, old and new collections, as well as the opportunity to see and learn a lot and to show their creativity, ideas andskills.

Students were trained to work in different programs, such as “Auto-CAD”, “Lectra-Modaris” and “Diamino”. They independently manufactured various garments and presented them to managers of company, where they next to acquired knowledge and experience, had receive a certificate for successful completion of their professional training and professional practice with recommendation of other employers about their high abilities in the field.
Students of this type of cooperation have the opportunity to become part of a great team and great company. They have opportunities to apply the knowledge gained at the University as well as to gain new knowledge and skills and extensive professional work experience.

Picture 4: Students with their mentors during the professional training in “Pirint-tex” company

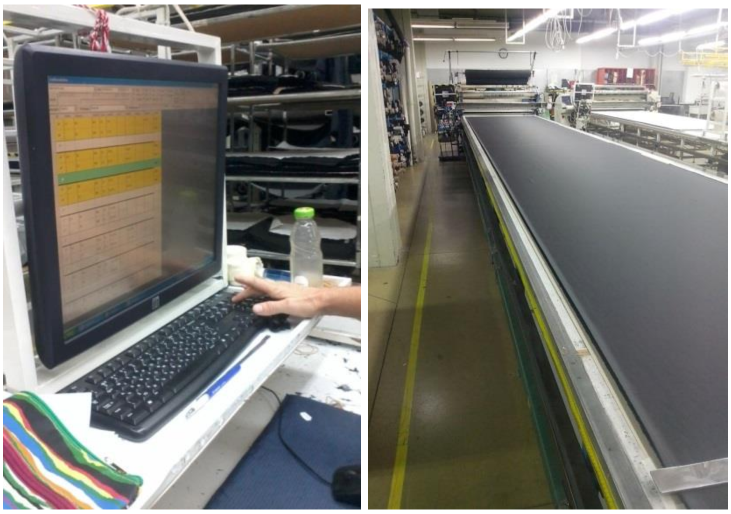
COMPUTER DESIGN CLOTHES

All large companies and companies for manufacturing clothes applied computers and modern equipment to achieve high productivity of manufacturing in shorter period of time and to achieve better quality and great profit. Computer system, or its configuration is similar to the electronic data processing. Its main characteristic are high speed and reliability and the periphery of the system typically consists of input, output and input-output units through which the data are entered into computer, printed and plotted. This provides two-way communication with the computer. Electronic devices for grading cuts and making cutting patterns in the world of clothing: Lectra, Gerber, Assyst, Cuttex, Eurolog and others who are constantly working to innovate and improve their devices and programs to achieve the best possible results. The company “Pirin-tex” has its own classification and optimization of structural preparation, supported by CAD/CAM system manufacture “Lectra” and “Assys”.

LAYING DOWN THE FABRICAS BEFORE CUTTING IN “PIRIN-TEX” COMPANY

Control of fabrics may be qualitative or quantitative. The stabilization of fabrics is process which aims to increase dimensional stability; increasing resistance to shrinkage fabrics during construction of finished clothes in use. In larger companies, such as “Pirin-tex”, preparation is done in special sectors.

Preparation of fabrics includes the following tasks: fabrics stabilization, separating the fabrics according to the length, width, color or pattern. Qualitative or quantitative control of fabrics, fabrics stabilization is a process that aims to increase dimensional stability; increasing resistance to shrinkage fabrics during construction of finished clothes in use.



Picture 5: Modern Equipment – laying down the fabrics before cutting

CUTTING OFF LAYERS, CUTTING AND SEWING

Rough cutting is performed mostly by vertical machine with rotating cutting knife. Depends of fabrics and its thickness of cut-out layers and the technical capabilities of machines for rough cutting, they are using rapid machines with vertical, angular and round knife. In the fine cutting they use bansek machines with movable circular knife. This machine performs millimeter accurate cutting contour cutting part because of its stability.

The most commonly sewing machine which is applied is simple sewing machine which sews grain sting speed of 2500-6000 stitches per minute. To create garments in the textile industry in small sections, as well as large companies, such as “Pirin-tex”, the most used machine is also simple sewing machine which use two threads, looper and upper thread, needle.

Picture 6: Working section in “Pirin-tex” company

PREPARING, SORTING, LABELING PARTS OF CLOTHES, GARMENTS AND DISPOSAL IN THE WAREHOUSE

During completing wearing parts, parts of clothes in the sewing room and finishing department, in no way they end up at the same time due to the different capacities in the production units. Sorting and labeling of all finished, refinement garments is made according to work orders, both producers and costumers, and consumers, garment sizes, colors and other requirements.

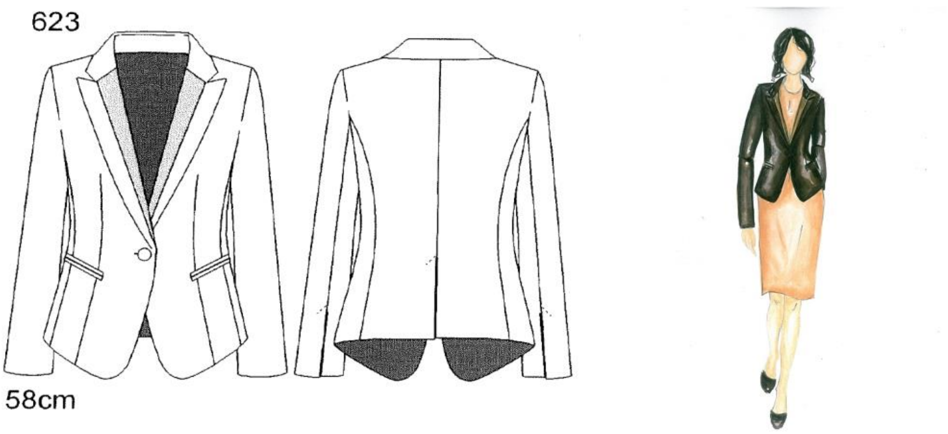
Sorting must be carried out according to the quality of manufacture, namely in case of damage to garments or garments that are defected. Such clothing must be separated and sorted in order to work on eliminating these errors, defects and deficiencies.

Garments that have passed through all stages and are ready to deliver on the market, to customers, it must be properly labeled according to current regulation. Must contain information on the composition of the raw materials, the capacity of the garment, instructions on maintenance and chemical cleaning, which are located in the label, so that potential buyer had an insight into the quality of purchased goods and ways of its maintenance.

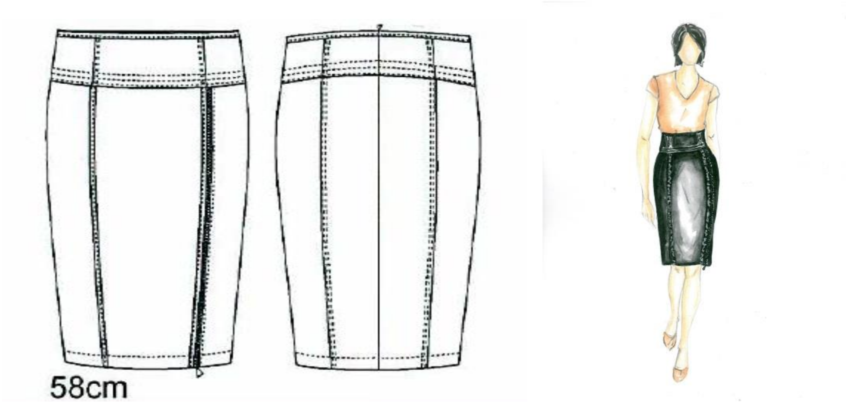
Warehouse is a place where they dispose all finished garments, with full completed and appropriate documentation. When the clothes, as well as the technological production process is completed and everything is ready for further delivery and consumer.

Picture 7: Labeling, sorting and disposal to warehouse

OVERVIEW OF TECHNICAL SKETCHES AND FASHION SKETCHES THAT STUDENTS DONE DURING THE PROFESSIONAL PRACTICE IN ”PIRIN-TEX” COMPANY



Picture 8: Fashion and technical sketches – women's blazer



Picture 9: Fashion and technical sketches – skirt

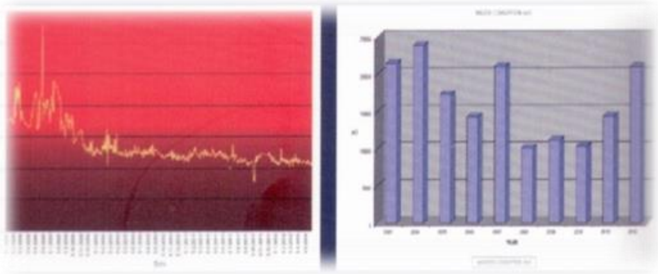
Picture 10: Fashion and technical sketches – women's pants

ENERGY EFFICIENCY AND RESOURCE IN "PIRIN-TEX" COMPANY

"Pirin-tex" EOOD company has established concrete measures to protect the environment in accordance with regulation of the European Union. They have developed an innovate system for monitoring energy efficiency. So to guarantee sustainable business development with reduced primary energy consumption by 30%, thereby successfully optimize their energy efficiency with which the students are introduced during the professional practice.

Based on accumulated experience in the field of energy efficiency and resource "Pirin-tex" company offers professional advice for you:

- Planning and installation of a system based on WEB monitoring and remote management of all systems of energy efficiency in the business
- Creating an action plan with measures to increase the energy efficiency of your business
- Special insulation solutions for presses and irons.
- Installation of special controllers for energy efficiency in existing presses and irons and training of personnel to work on them.
- The development budget required energy.



Picture 11: Preview of reduced primary energy consumption by 30%

RECYCLING

Environmental protection, Bulgaria's beautiful nature, is an everyday concern of company. Within the professional practice, students had the opportunity to familiarize themselves with that process as well. "Pirin-tex" company is a company that is authorized for the collecting and processing of textile waste. They collect and process their waste, but also provide the ability to do work for other textile companies.
When singing the contract (agreement) they offer:

- The annual report on the quality of the collected waste operations
- Logistics and transport in their facilities and packing if necessary
- They guarantee professional treatment of waste in strict accordance with the law of the European Union on the environmental protection

CONCLUSION

The paper presents an example of good practice that well-known companies achieve in cooperation with higher education institutions. It is made by the context of professional practice and it shows the way of business larger companies such as "Pirin-tex" EOOD, a factory of high quality fashion clothing for women and men, the world-known fashion brands.
We presented basic information of the company "Pirin-tex" EOOD, where is presented for how long it operates and with who they cooperate. Students reports are presented as well as measures implemented to protect the environment with regulations of the European Union, sustainable business development with reduced primary energy consumption by 30%. This way it is successfully optimized energy efficiency. It is shown and explained their business, as well as the collection and processing of textile waste and recycling textile material in the company which they contribute to environmental protection.
The company "Pritin-tex" has developed their system and created their center for professional training theory and professional practice for acquisition of professional operators, employees and experts for manufacturing clothes.

REFERENCES

1. PIRIN-TEX EOOD-Quality made in Bulgaria/EU- ROLLMANN – Brošura kompanije, 2015
2. www.rollmann.pirintex.com
3. http://www.pirintex.com/index_en.html
4. V. Petrović, J.Stepanović, M.Stanković, M. Reljić, S.Stefanović: Modern developments in the textile industry in Europe, Management, Innovation, Development
5. V. Petrović: European Textile Platform for the Future of clothing and Textile, Regional Textile conference "Sustainable development of the Textile Industry in Republic of Macedonia", Ministry of Economy of Republic of Macedonia in cooperation with Faculty of Technology and Metallurgy, University "Ss. Cyril and Methodius", 04 - 05 October, 2012., Skopje, Macedonija, (rad objavljen u Zborniku radova u elektronskoj formi).
6. D.Rogale, D.Ujević, S.F.Rogale, M.Hrastinski: Garment Manufacturing Processes, 2011, Textile - Faculty of Technology, University of Zagreb.
7. V.Petrovic, M. Stanković, I. Skoko, A.Zdravković, S.Stefanović: Optimization of cutting patterns using CAD system, Общotekstilna konferenciя'2012, „Inovacii v tekstila i oblekloto, oktobar 2012, Sofiя, Bulgaria.
8. M.Vinković: Artistic Clothing Design, Textile - Textile Technology, Zagreb, in 1999.
9. M. Vasiljevic: Design, Faculty of Design, Belgrade 2005.
10. M. Stanković, V.Petrović, A.Zdravković, I.Skoko: Technical documentation using industrial design software Kaledo Style in the case of women's sweaters, Textiles and practice, XLVI, DITT Leskovac, 2012.
11. V. Petrović, J. Stepanovic, M. Stanković, M. Reljic, S. Stefanović: The recent developments in the textile and apparel industry in Europe, scientific E-forum: "Development and Management 2012", Vrnjačka Banja, 22nd and 23.11. 2012, ISBN 978-86-86677-10-5, COBISS.SR-ID 2760086791, (paper published in the Proceedings in electronic form).
12. V. Petrovic (2004), Development Directions clothing companies in function of training for rapid response to requests from the market of the large consumers of clothing, I Scientific conference Textile industry in Western Serbia, Regional Chamber of Commerce Uzice, in December 2004, Arilje,
13. B. Prince: The technological processes of clothing production, TTF, Zagreb, 1994.
14. Paunović, D., CAD in the design of clothing, DTM, 2009.
15. http://global.tommy.com/
16. https://getschooled.com
17. http://brand.laurel.de/en/
18. http://www.peterhahn.co.uk/laurel-ladies-fashion
19. http://www.net-a-porter.com/Shop/Designers/Gucci
20. http://www.esprit.com/
21. http://www.esprit.co.uk/
22. https://en.wikipedia.org
23. https://www.hugoboss.com/
24. http://www.reuters.com/
25. http://group.hugoboss.com/

STUDENTS PAPERS

INFLUENCE OF ARCHITECTURE ON future FASHION

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ABSTRACT

The study refers to the observation the influence of architecture on fashion and textiles to architecture in the 21st century and in future in 2017. When we look on the area, fashion simultaneously connects and separates from the architecture. Fashion and architecture also, both offer shelter to man for centuries and that is one of the main similarities. Regardless of their differences they intertwine and drown in places where fashion designers use architecture to create clothing, while architects use textile materials in their architecture design. This article highlights a mostly simple shapes and colors in fashion as a trend in 2017. and indicates that one tiny detail can change the whole picture, and to impress in one very different way in both disciplines.

Keywords: fashion, S/S 2017, architecture, trends, simple forms…

INTRODUCTION

BRIEF HISTORY OF ARCHITECTURE INFLUENCE ON FASHION

There are plenty of artists who study the relationship between architecture, fashion design and fashion in general. The relationship between architecture and fashion is based on common postulates, because both have similar theories and concepts and the same structure as multidisciplinary activities. Both are found in the middle between science, technology and art. One of the biggest contact surfaces between fashion and architecture is that both activities dealing with the protection of the human body. On the one hand architecture, providing shelter, and on the other side of fashion, is clothing directly envelops and protects the human body, which is the primary cause of inventing clothes in history. Combination of architecture and fashion is also visible by the use of materials, membranes, lightweight glass, plastics and lately i wire and wood. This can be seen in the work of many designers and architects such as Rem Koolhaas, Zaha Hadid, Frank Gehry, Junya Ishigami, in collaboration with fashion designers like Alexander Mc Queen, Comme des Garçon, Hussein Chalayan, Junya Watanabe, Issey Miyake, Yohji Yamamoto indicate a close connection between architecture and fashion. In these examples, it is possible to explore the correlations, relationships and mutual interaction, and through them to analyze and reflect on the specifics of that symbiotic relationship.

In the eyes of the common man there is no connection between architecture and fashion, but when he starts to study these two disciplines, he reveals strong bond between them. Relationship between fashion and architecture is reflecting in many fields, ranging from art, aesthetics, shape, texture, form, and structure. Architects, artists, fashion designers, designers of exterior and interior together trying to find the ideal solution. They experiment, combine different areas, technology ... The result of such relations obtain new techniques and innovative solutions. The application of new technology comes to everyday junction architecture and fashion, this compound can be seen in the works of many designers, artists and architects.

For the development of fashion as it is known today, is credited with one of the most innovative designers of the 20th century, Paul Poiret. The title of the first fashion designers in history gained its experimentation and introducing innovations in fashion. Today, after 100 years, serves as an inspiration to many designers. His career began when he showed drawings of his creations Madame Cheruit, one prominent Paris fashion designer, who bought them. Poiret proceeded to sell their creations until 1896. He has not hired Jacques Doucet, the creator at the helm of the fashion house

Doucet. His main inspiration was distant and exotic countries such as Turkey and Japan. His client was turned into a harem creating turbans, harem pants, hobble skirts and kimono-like coats.

His creations, like the works of art produced from the rich oriental fabrics, beads decorated, rustling velvet, lace as a memorial to times past - all with a touch of oriental spirit. Paul Poiret created the first clothes that a woman could put on without the help of maids. At the beginning of the 20th century freed women corset, imposing airy fabrics, clothes that fall, and where women can move freely.

The beginning of the 20th century was marked by movement, progress, and innovation in the field of fashion industry. Paul Poiret introduced innovations in the world of fashion provided a completely new vision on fashion. In the field of innovation has continued and designer Issey Miyake, who gave a new dimension to fashion.

Designer Issey Miyake is one of the first Japanese fashion designer who expresses his creativity by connecting originality, converting the traditional design of the modern and contemporary design. His design is special on Japanese traditional clothes turning, shaping the modern form, with the help of modern materials and technologies. It is known for its elegant simplicity, his work exudes dynamics, movement, and color. Issey Miyake is distinguished by experimenting with unusual materials, such as plastics, paper, rope, braided grass using these materials has developed a new method of drapery and folds that his work gives you the flexibility of movement. One of the key factors in the work of Issey Miyake's is to create clothing that is universal but not standardized, and therefore creates its own, special, universal clothes. The universality of the creations gets design clothes on the human body, and is closely linked to the material with which it works. His creations are made from one piece of material one color, using various techniques such as shirring, pleating, draping.

In this article we will mention his dress called Minaret dress. Minaret dress is a dress with mostly circular shapes with 3D structure, and it can be said wearable art. It was created in 1995, almost 100 years after Paul Poiret's gowns. Unlike Poiret's gowns that is made of natural materials, the Issey Miyke's dress is made of polyester (plastic) with the use of new technologies where exactly can see the progress of the textile industry. Dress Poirat was adapted to his time, and yet it was innovative, and showed the future design. The inspiration for this dress is a work of architecture Minaret, to dress the notice circular shapes that resemble the shape of a minaret balcony. Issey Mykey made garment based on new technologies, the use of steam press with which he received the folds of her dress. On the creation noticed the unique design, rugged construction, and geometry. The design of garments has an emphasis on materials, their sets and plastic rings. The dress was created in 1995 and is located in Tokyo, Japan.

Picture 1. Minaret dress, Isseyy Miyake, 1995

In early 2008, Hussein Chalayan designed a series of laser LED dresses in collaboration with Swarovski. The collection, which symbolically announces the end of winter and the coming spring is made of more than 15,000 LED lights complemented by thousands of Swarovski crystals. His collection represents the right balance of fashion reverb and views on contemporary world events and wearable wardrobe. Evoking the problem of global warming, the magazine began gushing steam from the runway to be, then, the scene in which a mannequin in a dress, using LED technology, lights and broadcast video footage nocturnal panorama of the city from bird perspective.

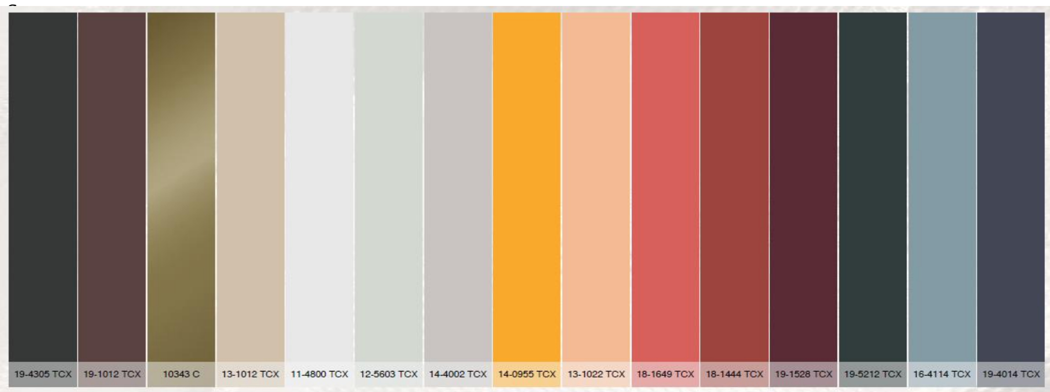
Picture 2. Dress with Swarovsky cristals and LED diods, Hussein Chalayan, 2008.

FASHION IN S/S 2017, AND ARCHITECTURE INFLUENCE ON IT

Lately, the fashion clothing appearing based on simplicity, as well as in architecture, emphasis is placed on the shape of clothing, and tends to be luxuryious. Designers uses wood as element from the architecture. For example, in WGSN forecast we can read some elementary facts about 2017 future fashion trends:

- In August 2017. We can expect to see light silks, mesh and fine jerseys take form on wide volume shapes that allow the body to move. In September comes preparing for the colder months, with close-to-body silhouettes in faux fur and plush velvets. The message is comforting, with a focus on quality and simplicity.

- Hemlines flare and top halves narrow, moving the A-line silhouette into the more extreme cone shape. Movement and dance elements feature as a subtle undertone.
- Quality is key. Elevated basics focus on comfort and use luxury blends to take loungewear and classic wardrobe staples to the next level
- Technology takes on a visually pleasing aesthetic with well-styled apparel and accessories having secret technological advantages
- Colour palette that will be offering in SS 2017 i quite mysterious. White and grey provide a pure, calming effect, as does warmer apricot and deep coral. There is a freshness for summer, though this is countered by the deeper shades of ebony and mangosteen, and deep black as an accent, taking this palette through to autumn for the final part of the summer season, phase four. Muted gold and champagne enhance the feeling of luxury, while horizon yellow brings a



wist to Pause's more serious side, lightly lifting the palette.

Picture 3. Colour palette for S/S 17, WGSN forecast

- Focus moves to the importance of craftsmanship. A focus on the art of craftsmanship highlights the beauty in Sophie Buhai's wooden choker (below, picture 4.), where the time spent polishing a simple piece of wood to turn it into a desirable luxury item becomes a signal to the future of luxury. Attention to detail is key as simple finishes such as handmade Rouleux loops and hand-pleating can elevate the ordinary.

Picture 4. Sophie Buhai's wooden choker

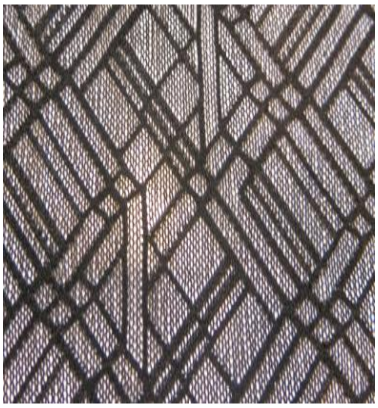
- Everyday objects such as the hair comb surprise in polished gold, turning the mundane into exquisite objects to treasure. Studio Drif's statement light (beloe, pictures 5 and 6) uses hand-plucked and glued dandelion clock plumes applied to a gold cubist silhouette pendant frame that changes how we view luxury.

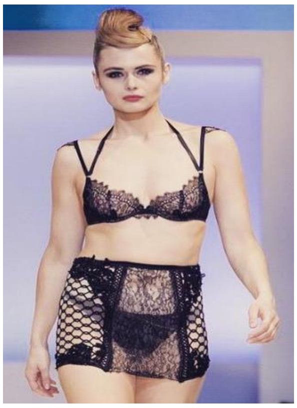

Pictures 5. and 6. Studio Drif `s luxurios statement light

- Keepsakes and heirlooms use new technologies to create precious connections to loved ones with a more refined vision. (below, picture 7) Cameo silhouettes take on a new form at Cameo by RUX while hidden lockets sit in beautiful wooden slide cases at Ramshackle Studio.

Picture 7. One of wooden slide cases created from girl profile, has a hidden meaning for person who wears this bracelet, and looks simple and luxurious

- Fabrics become seemingly as light as air and cosmetic tones appear reminiscent of movement around the body, both in ultra-fine mesh and delicate organza. The fragile quality connects modernism with classic femininity.
- Caging is referenced heavily in a modern approach to lace, working particularly well in lingerie as seen from Ellie Balwako. Grid patterns are deconstructed and take on a subtle form on fine woven bases





Picture 8. *Lingerie from Elli*

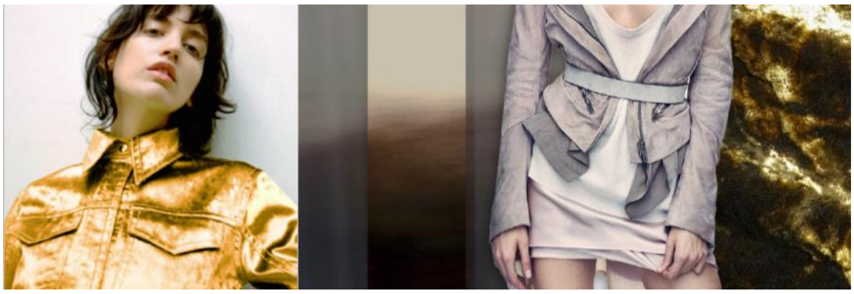
The health of the mind is becoming a key element in general wellbeing, with mindfulness at its heart. Connect mind and body with loose floor-skimming summer dresses, allowing the body to become free from restriction as seen at(pictures 9, 10) Amit Israeli. Relaxation is important, shapes are flowing and feel comforting on the skin.

Picture 9 and 10. Amit Israeli dresses

- Hi-tech turns lo-tech, giving a sleek sophistication to functional design. Wrist cuffs blur the line between style and function with vibrating elements to alert the wearer when they get a phone call. The Light Phone takes the basic necessity of a mobile phone and strips it back to its original purpose.
- Refined accessories and apparel are perfectly framed with simple line detailing that adds graphic appeal. High-shine gold metal tipping and borders exude luxury, with Acne applying this to update the classic aviator shape (below, pictures 11 and 12). Simple top silhouettes are given contrast edge bindings at Ports 1961 for subtle graphic appeal.

Pictures 11. and 12. Acne Mask Junior Sunglasses

- A key volume for S/S 17, the cone shape uses extreme form in a minimalist and wearable way. It works as a midi length for a commercial take, or as a maxi for a more extreme translation. Melitta Baumeister uses outsized armholes and a deep V-neck to give the illusion of an extreme parachute-style hemline.



Picture 13. Melitta Baumeister deep V-neck dress

- Tailoring is stripped back and raises the bar on design by minimising features and sharpening edges, as seen from Matthieu Belin (right and below, pictures 14 and 15). The finished product is gracious yet functional. Quality is key and a focus on fabrics takes the story to the next level.

Picture 15. Mathieu Belin, coat

- Utility details take a more sophisticated approach with patch pockets becoming oversized yet simple. Eyelets are enlarged and popper closures are seen in clear and rubberised finishes. Dungarees look dressed up with beautifully stylised edges and tab strap details, as seen at Nomia (below, picture 16).

Picture 16. Oversized pockets and strap details, Nomia`s collection

- Restfulness and relaxation are taken into account with subtle comfort details that snuggle up to the body. Wrapping and draping as shown by Ajla Ayidan add a subtle beauty in viscose and sand-washed silk that feel calming on the skin.
- Core items are injected with luxurious thermal yarns giving an underwear as outerwear vision. Close to body roll-neck ultra-fine sweaters have soft wrinkles created by extra-long silhouettes pushed up to fit the body as seen in Nadine Goepfert's subtle pieces.

- Fabrics and textures normally seen in the depths of winter such as crushed velvets and suede are made lighter and work as a luxurious start to the season as transseasonal layers. This modern take on luxury is enhanced through the addition of metallic fibres for both high-shine effects and crease effects (below, picture 17).

Some high-shine and crease effects we can expect in 2017 in fashion

CONCLUSION

With the development of science, culture, art, fashion and architecture and technology of dressing and Construction, the bond between architecture and fashion became stronger. Identical concepts, the utility of a more human and aesthetics as reflects the spirit of the times have made fashion and architecture ofteninseparable. Of course this relationship is changing its shape and was is subject to constant change of taste and style. Intersection of fashion and architectures and their interaction is interesting traced to their diversity. Architecture is inexhaustible source for fashion inspiration, so in 2017, we expect new gargements inspired by architecure objects.
There are plenty of colours and forms we can expect in 2017. This article is one small piece of what will be real trend in s/s 2017, but, we could be sure that one of the trends will be simple fashion, pure fashion design, white colour, golden details, oversized gargements or their particular parts like pokets, belts...

REFERENCE

[1] Bogovac, M.: Boutique sinteza arhitekture, modnog industrijskog dizajna, TEDI, 2011.
[2] https://www.wgsn.com/content/board_viewer/#/62967/page/8
[3] https://www.wgsn.com/content/board_viewer/#/55796/page/17
[4] https://www.wgsn.com/content/board_viewer/#/59472/page/13
[5] https://www.wgsn.com/content/board_viewer/#/52743/page/12
[6] https://www.wgsn.com/content/board_viewer/#/64309/page/3
[7] https://www.wgsn.com/content/board_viewer/#/56015/page/16
[8] http://www.metmuseum.org/toah/hd/poir/hd_poir.htm
[9] http://www.dans.org.rs/index.php?option=com_content&task=view&id=376&Itemid=1

THE MILITARY INFLUENCE ON FASHION

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ABSTRACT

This work is about how military of the world have had an unmistakable impact on fashion. Whether it be the varied terrain, weather encountered, or nature of living in one's uniform, over the last several hundreds of years these factions have become responsible for pieces that don't just merely take up real estate in the closet, they are cornerstones of menswear. Here are but a few staples that deserve a crisp salute.

Key words: Military, fashion,origin..

The Necktie

According to The New York Times, "During the Thirty Years' War (1618-1648), Croatian mercenaries arrived in Paris dressed for battle with bright scarves tied so tightly around their necks that the men often fainted during maneuvers. The French, naturally, adapted the look, looping the scarves rather more loosely in a style that became known as "La Croate" and later 'La cravate."' Though the cravate is regarded as the true forerunner to the modern tie as a fashion statement, it would take a few hundred years for the tie to evolve to the narrow strip of cloth we think of today as a necktie.

Photo1: Necktie

Khakis

Following their defeat to the United States in the Revolutionary War, the British continued to wear brightly-colored outfits of their "Redcoat" brethren despite many clamoring for a change in tactic. It wasn't until the 1840s when Harry Lumsden, a commanding officer in a unit of the Bengal irregular cavalry, introduced the highly unorthodox notion "that a tight scarlet tunic with a high stock was not the most suitable garment in which to wage war in the plains of the Punjab in the hot weather." According to The New York Times, "Lumsden gave his men coarse cotton smocks and pajamas, wrinkled cotton jackets and turbans all dyed with mazari, a local plant that turned everything a sort of dull brownish gray. The leather goods were dyed with mulberry juice, which produced a more yellowish tone, but both colors became known as khaki, from the Persian word "khak," which means earth, dust or ashes. Once institutionalized, khaki's official name became "drab."

Photo2: Khakis trausers

Ray-Ban Aviators

As new airplanes of the 1930s were allowing people to fly higher and farther, so too arose a problem associated with the advancement in altitude: Many U.S. Air Force pilots were reporting that the glare from the sun was giving them headaches and altitude sickness. Thus, a new type of eyewear/goggles was commissioned by the Army Airs Corps to Bausch & Lomb, which was then ultimately brought to the public for consumption in 1937. It featured plastic frames and the classic aviator shape, which reduced the sun's intensity on pilot's faces and instruments. A year later, a slight remodel in the form of metal frames and the official designation as "Ray-Ban Aviators" solidified what is now considered both a utilitarian and stylish statement. Over the years, research and development resulted in innovations such as the gradient mirror lens – which featured a special coating on the upper part of the lens for enhanced protection, but an uncoated lower lens for a clear view of the plane's instrument panel – further suggesting that they're every bit as tactical as they are practical.

Photo3: Ray Ban sunglases

Trench Coats

No other item of outerwear embodies heritage British style as much as the trench coat. While the piece has become synonymous with the Burberry brand, the roots are debatable and include another label, Aquascutum. For the latter, the history goes back to 1853, when the company produced practical coats for officers fighting in the Crimean War using its patented waterproof wool. For Burberry, Thomas Burberry entered a design to the War Office in 1901 for an officer's raincoat made using his very own patented cotton gabardine fabric and featuring large lapels, convertible collar and epaulets.

Photo4: Coat

Cardigan Sweaters

The name "Cardigan" is attributed to James Brudenell, 7th Earl of Cardigan and British Army Major General, who led the Charge of the Light Brigade at the Battle of Balaclava during the Crimean War (which as you may have guessed it, also birthed the creation of the balaclava – a town near Sevastopol in Crimea). From a fashion perspective, 17th century fishermen in France and the British Isles are said to be the early adopters of heavy knits which could withstand blustery conditions, but still retained a regal silhouette inspired by the British waistcoat

Photo5: Cardigan sweater

Dr. Martens

Designed by Klaus Martens – a German doctor in World War II who was on leave from the army due to an ankle injury suffered while skiing in the Bavarian Alps – who noticed that his bum foot needed extra comfort that his military-issue boots couldn't provide. After tinkering with softer leather and cushioned soles, his partnership with Dr. Herbert Funck may best be remembered for counterculture connotations, but their roots were indeed authoritative in the company's infancy.

Photo6: Martens boots

Camouflage

The word camouflage is said to have originated from the Parisian slang term camoufler (meaning "to disguise") after the French army began employing artists to paint their artillery and observation posts in the now ubiquitous pattern, instead of their more traditional white gloved and pantalons rouges attire in World War I. In a 1917 Op-Ed in The New York Times pertaining to the relatively new practice of camouflaging oneself, they offered, "It is a wonderful opportunity, this game of hokus-pokus."

Photo7: Military texture

Pea Coats

The “pea” in pea coat is derived from the Dutch word “pije,”which refers to the type of cloth used – a coarse kind of twilled blue cloth fabric with a nap on one side, first made popular in the 16th century and favored by the Dutch who were a naval power. It was aesthetically pleasing, but durable and warm thanks to the double-breasted nature of the construction, large lapels and vertical pockets. The coat was quickly mimicked and modified slightly according to the amount of wool needed, depending on the region where one was sailing.

Photo8 : Pea coat

Bomber Jackets

During World War I most airplanes didn’t have enclosed cockpits, so the daring sharpshooters of the sky had to be outfitted with coats suitable of the high-speed and icy climates at altitude. While the Royal Flying Corps – the air arm of the British Army – favored long leather coats, the U.S. Army established the Aviation Clothing Board in September 1917 and began distributing heavy-duty leather flight jackets. They featured high wraparound collars, zipper closures with wind flaps, snug cuffs, and waists, which we now equate with the instantly recognizable bomber. According to Midwest Vintage, “In the early 1930’s, years before WWII, the U.S. Air Corp was issued the A2 Bomber Jacket and it became standard issue in 1931. These jackets were made of seal skin leather and cotton lining. However, as the requirement for these jackets grew, supplying seal skin was considered impractical. The department of war went on to start making the Type A2 Bomber Jacket out of horsehide which at that time was plentiful. The A2 was a waist length leather jacket that featured two front patch pockets, and webbing attached to the bottom of the jacket and at the end of the sleeves to close out the air in addition to shoulder epaulets.”

Photo9: Bomber jacket

The White T-Shirt

The white T-shirt was officially designated as a part of the U.S. Naval uniform in 1913, as a means to both beat the heat in tropical climates and aboard submarines, and to avoid soiling their uniform while doing dirty jobs.

Photo 10: white T-shirt

Fishtail Parka

The concept of the fishtail parka design was to offer flexible protection during extreme cold weather through the detachability of all parts, with the “fishtail” designed to be tied around the legs for extra insulation. Used by U.S. troops during the Korean War, the M51 (named after the year it was put into mass production) was the result of previous attempts to create the perfect version of the coat during WWII, such as the OD-7 and the M-4. Needing to be warm but not cumbersome due to the wet climate they were encountering, the resulting waterproof nylon and cotton construction certainly did the trick.

Photo 11: Fishtail jacket

The Wellington Boot

While the Duke of Wellington instructed a shoemaker, Hoby of St. James' Street, to make modifications to his 18th-century Hessian boots, production of the "Wellington" was dramatically boosted during World War I due to the flooded trenches in Europe and the need for a boot that would be suitable for the conditions. Crafted out of technology invented by Charles Goodyear, who had managed to understand the vulcanization process for natural rubber, (instead of employing knee-high leather like the earliest versions) the success of the prototypes in keeping soldier's feet dry resulted in 1,185,036 pairs being made to meet the British Army's demands.

Photo 12: Wellingot boot

Desert Boots

The Clarks Desert Boot was designed in 1949 by Nathan Clark and launched at the Chicago Shoe Fair a year later. While he was stationed in Burma as an officer in the Royal Army Service Corps in 1941, he couldn't help but notice the shoes favored by off-duty Eighth Army officers, who were keen on crepe-soled boots made from rough suede from Cairo's fabled Old Bazaar, and which performed well in the arid climate. While other pieces of footwear with military influences relied on their rugged versatility, the birth of the Desert Boot was distinct in that it drew from "off-duty" sensibilities.

Photo 13: Desert boots

Cargo Pants

According to Ben Grant of the University of Oxford, “Cargo pants were first worn in 1938 by British military personnel. These cargo pants were part of their Battle Dress Uniforms (BDU). The original cargo pant style featured one pocket on the side thigh and one on the front hip. Cargo pants were first worn in the United States on military uniforms in the 1940s. The side cargo pockets initially were only on paratroopers’ uniforms, providing them with easy access to ammunition and radios.”

Photo 14: Cargo pants

The Cartier Tank Watch

Louis Cartier created the Tank watch in 1917 and presented the prototype as a gift to General Pershing – an officer in the United States Army who led the American Expeditionary Forces in World War I – some years before the watch was introduced into the market in 1919. Designed after the modernistic Renault tank, the watch’s brancards are undoubtedly like the parallel treads of a tank, making it “the first elegant wristwatch destined for the modern man of action.’’

Photo15: Carties watch

Because the military style has become such a staple in the fashion community,
it provides a creative challenge for designers to “re-interpret military-inspired designs while incorporating their signature design elements to invent a style that is uniquely their own.

REFERENCE

https://www.artinstitutes.edu/blog/military-fashion-ranks-high-in-style

http://commons.emich.edu/cgi/viewcontent.cgi?article=1167&context=theses

http://www.nytimes.com/1998/12/13/magazine/influence-soldiers-of-fashion.html?pagewanted=all

MODERN DESIGN AND PATTERN FOR DRESSES AND SKIRTS FOR YEAR 2017/2018

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INTRODUCTION

Fashion is everywhere. She rules clothing and clothing details, shoes, product design, advertising, shops... Changes are inevitable, and the key to success is to investigate what is new and desires of consumers. Fashion is changing. We will show you the fashion designs and the patterns of dresses and skirts for the year 2017/2018.

DREES 17/18

MINIMALIST MIDI-DRESS

This modern midi-length shift dress has elbow-length sleeves and crew neckline. Use a minimal seam sitting under the bust, giving way to a central seam running up towards the neck. A concealed zip at the center back sits within the clean,steamline silhouette.

Picture 1. Midi-dress

NEGLIGE DRESS

This item is inspired by classic bedroom dressing and mixes textured silk for a luxurious feel. Add a wide band of sheer lace to the neckline and hem for a peek-a-boo fell. Skinny strapping details create an elevated look.

LACE PARTY DREES

This is strong silhouette for the winter party season. Add mesh inserts, silk underlayers and luxe lace overlays for a multi-textured look. A bandeau sits at the bust for modesty and allows sheer elements to work over the top.

PLUNGED MAXIDREES

The plunged maxidrees has a lean, elegant silhouette and works as a great winter piece with the addition of long sleeves. Add glamour to this item with open back panels, a split leg seam and plunged neckline. A slim strap details adds interest at the bust.

TUXEDO DRESS

This dress is inspired by classic tuxedo style, and features large pack pockets at the hem. The double-breasted front detail allows access, and exaggerated lapel mixes satin and suiting for a refined look. Darts shape the waist and subtle shoulder pads sharpen the waist and subtle shoulder pads sharpen the silhouette.

LEATHER PENCIL DRESS

The details and streamlined silhouette of the luxe leather pencil dress give it a post-retro quality. Use a hidden zip at the front for access and add large but minimalist pockets for a military undertone.

Picture2. Lace party dress

Picture3.Neglige dress

Picture 4. Tuxedo drees

Picture 5. Leatherpencil dress

SKIRTS 17/18

RUFFLE MINISKIRTS

This cute silhouette with abstract ruffles offles an element of fun and movement. Mix varying fabrics of textured crepe, mesh and lace to create ruffled asymmetric layers. A hidden side zip provides access. Apply a large draped panel to the front to add a minimalist element.

SUEDE BOXY PENCIL SKIRTS

Widen the classic commercial pencil silhouette to give it a more boxy form, and add a deep high waistband. A concealed zipper at the center back provides access, and a central split to the front hem enables easier movement. Topstitched seams and vent pockets are key details.

HI-LO FULL SKIRT

This commercial skirts sits on the natural waist features an elastic waistband and discreet side pockets. A hi-lo hemline works perfectly with the full and gathered shape.

BOUCLE MINISKIRTS

Inspired by classic power dressing, this item features bright colors on textured boucle to appeal to a younger market. Use a double layer detail with frayed edges and vertical metal zip pocket and a mini silhouette for a fun winter skirt shape.

Picture 6. Ruffle miniskirt

Picture 7. Suede boxy pencil skirt

Picture 8. Hi-lo full skirt

Picture 9. Boucle miniskirt

COLOR

Year 17/18 will be a season of monumental shifts in how we define ourselves, how we interact with each other, and what we expect from the products we use, as technology becomes more seamless, sustainability becomes more imperative, and old social signifiers are eroded. We're calling it The Great Reset.

For color, this will see a notable shift from the bold bright and pop palettes of recent seasons to tones that are more nuanced, more ambiguous, and much more complex. Navy blues appear almost purple, purples appear almost black, and pastels have a smudged, greyed-out quality. These are colors with an inherent depth and intensity. The following pages outline the four essential palettes for you to start working with for year 17/18, in line with WGSN's four Vision trends for the season – Design Matters, Earthed, Nocturne and Infusion. In addition – for the first time ever – we have created an indispensable palette of core colors to give you a definitive foundation on which to build your collections.

SEASONAL STATEMENTS

Mid - tones replace bright

This season takes us away from the obvious bright of past seasons, which are replaced with mid-tones that work harder, and give more. These shades have changeable, layered qualities and inherent depth. The more you look at them, the more interesting they become.

Autumnal colors are sharper

Autumnal colors are essential, as always, but with a more high-definition focus, resulting in intense, natural tones such as grassy evergreen, sunny saffron, and earthy ochre.

Reds are key

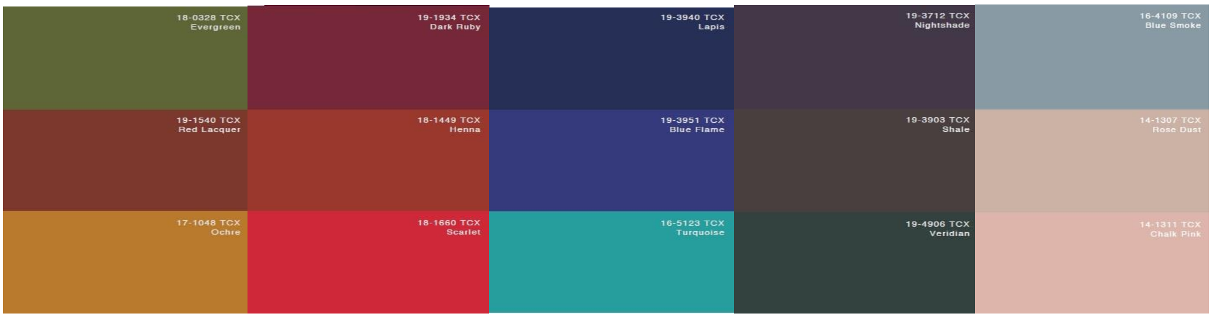
Reds move away from primary tones to appear in a range of sophisticated and off-kilter shades, from fire, which has the intensity of a winter bonfire, to dark ruby – a deep maroon.

Blue becomes a fashion color

This core color is elevated with standout tones such as blue flame – a dark cobalt – and inky lapis, which work as a feature color for casual and eveningwear.

Introducing the core palette

WGSN presents a core palette, ranging from ivory to navy and black. The palette will be adjusted seasonally. Core colors are suggested within each palette.



Picture 10. Colour palete

MATERIALS AND TEXTURE

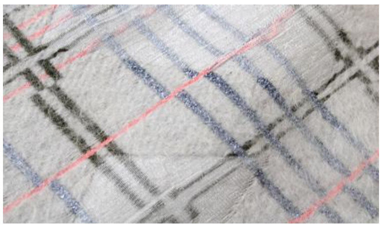
SILKY VOLUME

A balance between maximalist and minimalism sees sportif padding elevated through ultra-sophisticated silky yarns and sumptuous dimensions. Micro and macro quilting and rib structures work together in subtle , tonal, color-blocking or ombre shades, enhanced by a flawless surface finish.

Picture 11. Silky volume

INDULGENT SOFTNESS

Extravagant tactility defines indulgent, sensual wools, which have an inherent plush volume. Brushed and napped coatings exude a simple classicism through simple color pairings, or have a more exuberant character, off-setting suble geometric patterns with iridescent shimmer or balanced pleat constructions.



Picture 12. Indulgent softness

SUMPTUOUS PLUSH

Velvet pile and plush offer sensuous luxury and tactility, with decadent retro interior settings referenced through color and pattern. Brocade textures are emulated in embossed, devore or pile jacquards, and quilted pane velvets reference house coats and bed jackets for a louche long wear look.

Picture 13. Sumptuous plush

LUXE TEXTURE

These textured jacket and coating weights have a lofty, almost quilt-like volume and a silky touch. Novel, rounded tweed, cord and suble space-printed yarns are worked into dense dimensional constructions, creating exuberant surfaces in refined pastel shades.

Picture 14. Luxe texture

ASSURED SIMPLICITY

A single statement color, discreet texture, and a compact or more runny hand-feel are key for these confident semi-plain separates fabrics. They range from matte to more lustrous silky blends of cotton, polyester and viscose, with stretch to enhance dimension and comfort.

Picture 15. Assured simplicity

DECADENT FLORALS

Sumptuous full-blown floral decorate feminine silk and cotton jacquards, or printed silks, taking their cue from elegant room settings and damask upholstery. Styles range from abstracted watercolor impressions to formally figured scattered blooms, and texture is enhanced by thready cut-float effects or darker grounds.

Picture 16. Decadent florals

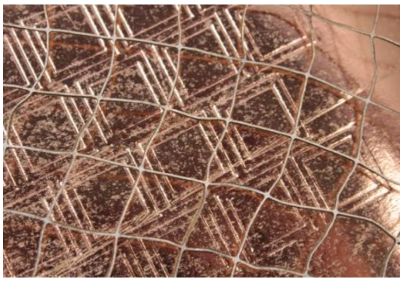
TWEED CLASSICS

Classic tweeds feel inherently chic, with waffle structures, jacquard and dobby patterns, or twill or herringbone striped wovens offering a reassuring sense of retro luxury. These textiles come in wool, cashmere, mohair and touches of silk or cotton. Warm mid-tones are teamed with white or black for a more defined look, which is softened by brushing.

Picture 17. Tweed classics

POLISHED LUSTRE

Ultra-sophisticated gleaming surfaces are found or runny silks an satins, as well as metallic leathers, imbued with a glossy almost enamel-like sheen. Geometric textures are engraved, etched, heat-pressed or embossed onto plain surfaces, or appear dimensional in shiny cloque and matelasse weaves.



Picture 18. Polished lustre

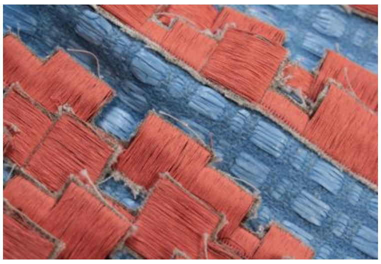
ADAPLABLE DIMENSION

Technology and craft are seamlessly integrated to create sophisticated materials. Innovative origami-inspired multi-dimensional folds, pleats and structures are recreated, both by machine and hands, elevated with luxurious silky yarns to create couture-like creations.

Picture 19. Adaplable dimension

SPORT COUTURE

A youthful direction drives these sport-influenced couture fabrics. Oddly balanced color, spliced stripes and mixed-media decoration updates silks, wool tweeds and viscose crepes, with trapped threads, sheer coatings, and digitally embroidered or printed surfaces adding a sense of novelty and fun.



Picture 20. Sport couture

5.11. OMBRE LAYERS

Translucency combines with visual and tactile interest for technical sheers super-lightweight shirting fabrics. Sugary synthetic voiles and crepes have delicate ombre striping, while matte and shine organza warp colour-wovens are enhanced by iridescent inclusions or sheer geometric overlays.

Picture 21. Ombre layers

5.12. PATTER COORDINATES

Discreet foulard patterns synonymous with menswear ties and cravats lend a sartorial elegance to both fluid and structured dobby or jacquard silks. Neat, close-toned geometrics are reminiscent of retro interiors, and conversational motifs and fancy stripes work together for a stylish, coordinated pattern look.

Picture 22. Patter coordinates

PRINTS AND GRAPHICS

BESPOKE BLOOMS

Inspiration

Moving away graphic cutous,blod floral become softer with pitted textures and imperfect floral forms. Naïve silhouettes of flower

Bespoke blooms-original artwork

A fluid is used to draw a range of floral, as scales range from mid, to oversized and the point of abstraction. Forms are simplified and negative space is embraced with loose repeats. Interest is adding with sparingly used textual pattern fills. Chalky mid-tones offer softness with touches of cream and power pink, counterbalanced with black and navy.

Picture 23. Inspiration

Picture 24. Inspiration

COMPOSITE MIX

Composite mix-inspiration

New approaches to recycling see sustainable fiber mixes, as scraps are mulched, falted and blended into fresh composites. These textual surfaces inspire prints design for the autumn transitional drop, elevating re-used materials to luxury status. Patterns resemble terrazzo flooring containing chips of creamy marble, rose quartz and granite.

Composite mix-inspiration

Fleck and specks of color are layered and pressed tightly together in bold solid shapes, resembling composite materials. Large sweeping brushstrokes are softened with small papered markings for a contemporary texture story. Chalky pastels complement bold blue and teal, while black and white add sharp contrast and graphic edge.


Picture 25.Inspiration *Picture 26. Inspiration*

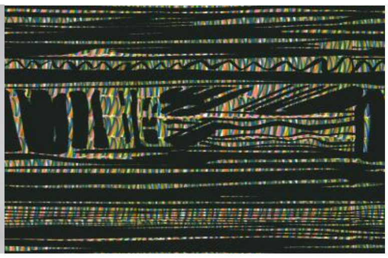
EARTHED

Nature's veins-inspiration

The untamed nature of the wild countryside provides print direction for the Autumn drop, with irregular patterns and forms offering an appealing tactility. Roots, bark, leaves and sediment layers inspire a collection of linear patterns, as nature's veins weave and undulate. This story is the new animal skin for women wear: nature skins.

Nature’s veins-original artwork

Zoom in on nature's patterns to inspire unruly stripes, organic lines and textual repeats. Use bold structured lines to mimic earth’s layers, leas veins and tree roots, introducing subtle textures into the background to soften to look. For a graphic twist, combine black and white an earthy palette and splice prints into new geometric formations.

Picture 27. Inspiration *Picture 28. Inspiration*

CONCLUSION

Fashion is inexhaustible source of inspiration and novelties, it changes all the time and sets new standards. By each year, the fashion is changing and improving in the way of fitting into modern way of living. 2017/2018 collection is very various and it allows to women's body to move more freely. Wide assortment of models, cuts and materials is available to everyone.

REFERENCE

[1] GLOBAL NETWORK WGSN
[2] GLOBAL COLOUR 17/18 ; Retrieved from
[1] http://www.wgsn.com/content/board_viewer/#/62693/page/4

SUBURBIA

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ABSTRACT

The paper describes and explains how and in which way the fashion and fashion trends affect youth leaving the major cities to the suburbs and surrounding villages .It is also explained a way of dressing in these environments , the young adapt to new environments. The techniques such as co- crocheting , embroidery, decoupage , which are the most common .
It is also displayed an inspiration to young people taken from urban areas , and the way in which they combine with the rural and suburban way of clothing.There is also a list of represented colors used in this fashion direction, and materials that are in use.

INTRODUCTION

Nowdays the big amount of young people decides to move from big cities to small cities, suburbias and villages, looking for cheaper life. Leaving the major cities people are carrying with themselfs fashion , and variety of fashion combinations and fashion garments with them.
As they come to new cities, they bring new fashion ideas in new environment.For example, a lot of people from the big cities in foreign countries, such as London, Paris, go to coastal cities and carry there own creativity with them , which causesdifferent styles to mix.We look up and take inspiration from the east , and from this we derive new ideas.

They are trying to make their outfits adapt to the new environment , so they combine them with the local way of dressing, that is the modern way of dressing fit with the traditional. They mix various types of materials, fit interesting colors and different parts of the clothing, and therefore get a different and interesting fashion line .

The way of dressing

In suburban dressing they, practiced lightly dressed outfits, sporty design, floral design and fauna design. They also used the mixture of various interesting prints , which are obtained in imitation of interesting wallpaper and different prints of antique furniture .

Picture 1, 2 and 3- Suburbian way of dressing

Also used as inspiration are various walls of interesting buildings, as well as mixtures, of “nice” and “hard”, and “soft” and “rough” . These mixtures were a variety of coarse , soft and flowing materials, to show the brutality of the environment .

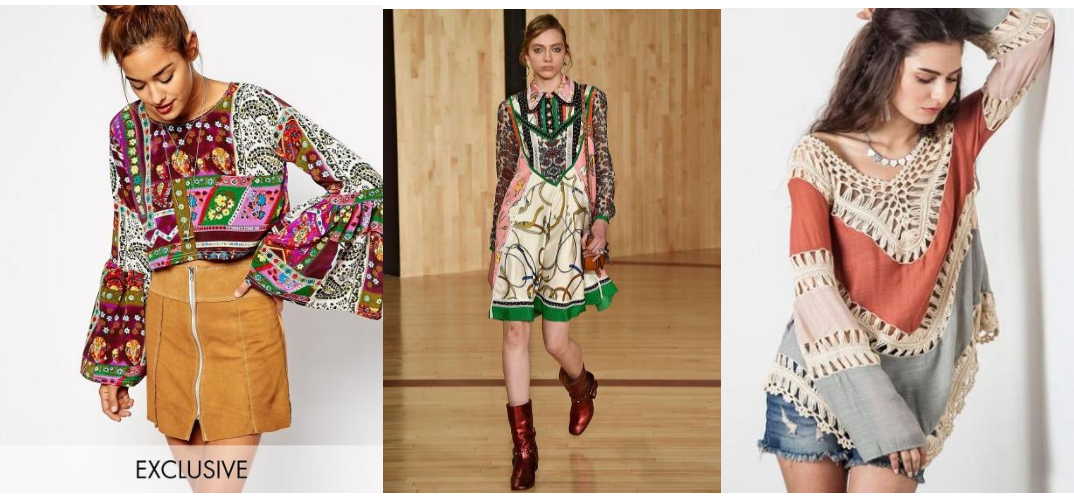
Picture 4 and 5- Inspiration taken from the walls of buildings

They also use a lot of embroidery, which is very important , and he was taken as inspiration from various home textile, and it is desirable that the embroidery looks like it was hand- made. Embroidery is the art of decorating cloth with needle and thread, and the basic techniques include cross- stitch and quilting . Embroidery gave interesting retro and vintage look to the new clothing items, although it’s not handmade.

Picture 7 and 6- Hand embroider

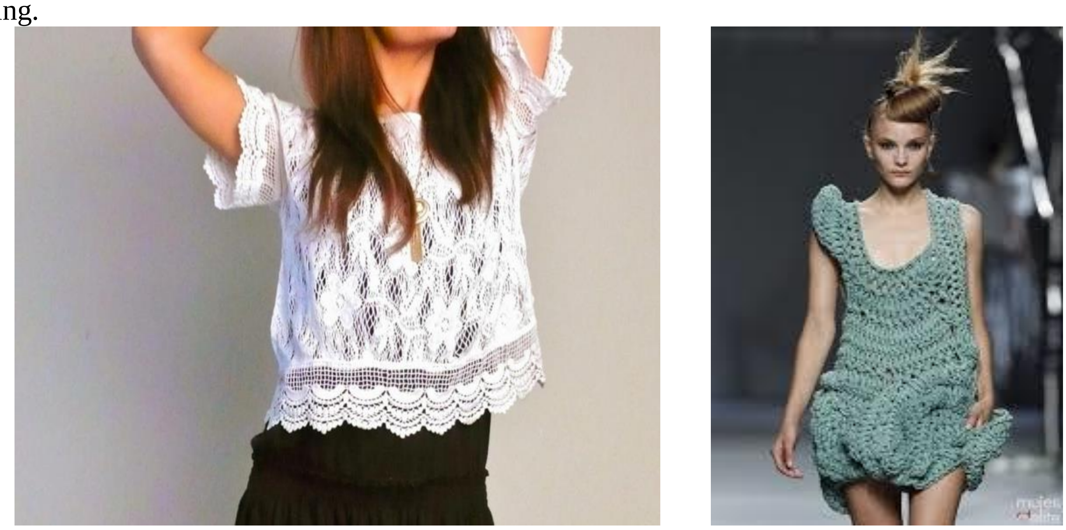
FABRIC

It combines a number of different types of materials that are bonded together and that is how they get a new item of clothing from old materials. Patch work is the name of style- making new clothes from old, used materials, thereby providing a visually interesting look garment that’s combinations of various prints and textures.



Picture 8, 9 and 10- "Patch work" designe on clothes

On garments they stitched and add crocheted parts, to contribute to the appearance of antique clothing. Crochet is a process built up the fabric from yarn or thread, and is a very important part of this way of dressing.



Picture 11 and 12- Crocheted parts of clothing

They use a transparent, translucent materials in several layers. The overall appearance is like a "Second hand" shops, secondhand or chic and retro. Materials have battered and antique look. For the materials they use different kind of yarns, flock (fluffy material that is applied to the garment, in order to get the various inscriptions, paintings ...), velor (scratched wool fabric, capsized skin). Different textures of materials forclothes- give the contrast, so that clothing has a look that was "soft," but at the same time "rough". In use is also faded denim, different transparent (translucent) materials with different floral designs, feminine, but at the same time sporty dress code.

We also use the decoupage technique. Decoupage technique use decoupage glue, acrylic paint and other adhesives to glue pretty certain napkin, with the desired design on the garment, that is later ironed and fixed, in order that napkins with motives remain fixed. This technique is also used in various household items, accessories (handbags, jewelry, shoes ...) so they are decoratedand get a new "fresh" look. They mix floral motives for incorporation of new and interesting colors, which give a more beautiful and better contrast, which further emphasizes the individual pieces of clothing.



Picture 13, 14, 15, 16- Display of decoupage techniques on home and items and garments

DRESSING

For different occasions, dressing is different, so we have clothing for young people, for sport, "casual" clothes, clothes for sleep, to go out ... For example: for pajamas, that is for the clothes to sleep, is characterized by "country look",wWe are using lighter, comfortable, "soft" materials, comfortable and practical to wear during sleep; to go to the stores, markets- in a use is a green color; for fun, that is for young people, inspiration is retro cards, which are used for various bags, T-shirts, while in meantime that garments have the appearance as if they were painted with polaroid color etc.

COLORS

For the color of garments that are worn during the day, in use are the "soft", "dirty" colors that are not "pure", such as color-yellow color of apricot, gentle purple, combinations of these colors, sunset colors, combined with pink color, polaroid, neon colors. Also, the color of inspiration is drawn from a variety of colors with buildings, walls of buildings.
While for evening is worn a combinations of light and dark colors, such as, for example, light-dark green, bright-dark blue, and this presents a contrast, "soft" - "rough".


Picture 17: Display of contrast "Soft"-"Swaying"-"Rough" *Picture 18:Display of contrast colors*

DESIGNERS WHO ARE ENGAGED IN THIS KIND OF FASHION

Reneli Su- is a Chinese designer with an MA from the London College of Fashion. Introducing a sustainable approach to her collection „came naturaly“ to Su, she says: „I visited many small villages in China and discovered beautifull handwoven fabrics and handcrafts made by locals. Unfortunatly these villages are poor and the majority of the young population move to bigger cities to work in large factories“. Su decides to bring business to them creating a long-standing relathionship in order to keep them in their home, and keep their crafts alive.

Picture 19, 20, 21- Models of designer Reneli Su

Karolina Klimczyk- Edinburg Collage of Art- Karolina Klimczyk’s collection is inspired by Koniaków, a Polish village, famed for crothet and narratives of Bruno Schulz a 20th-century prose stylist. She created her own interpretation of the stories in her illustrations and combined colour and pattern to bring to life.

Picture 22, 23-Art on canvas by designer Karolina Klimczyk

CONCLUSION

Over the time, this style will be increasingly developed, and with this we will get the blend of tradicional-of rural, suburban and urban style. With this style of individuals who came from the city trying to fit into the new environment, we will have the opportunity to see new and interesting outfits, which will become more frequent on our landscapes.

Interesting mix of different materials, obtained a style that until now has not seen, and which will continue in the future to develop, because more, and more of young people are moving from big cities to small cities, suburbias, and villages.

REFERENCE

Web page:

1. http://www.academia.edu/5992997/What_is_suburbia_An_analysis_of_its_cultural_representation_in_popular_literature
2. https://en.wikipedia.org/wiki/Suburb#In_popular_culture

Article:

3. B a l d a s s a r e (M.). “Suburban Communities” In Annual Review of Sociology , 18 (1992), pp. 475- 494.
4. WGSN

GLOBAL COLOUR AUTUMN/WINTER 2017/2018

WGSN

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INTRODUCTION

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SEASONAL STATEMENTS

Mid - tones replace brights

This season takes us away from the obvious brights of past seasons, which are replaced with mid-tones that work harder,and give more. These shades have changeable, layered qualities and inherent depth. The more you look at them, the more interesting they become.

Autumnal colours are sharper

Autumnal colours are essential, as always, but with a more high-definition focus, resulting in intense, natural tones such as grassy evergreen, sunny saffron, and earthy ochre.

Reds are key

Reds move away from primary tones to appear in a range of sophisticated and off-kilter shades, from fire, which has the intensity of a winter bonfire, to dark ruby – a deep maroon.

Blue becomes a fashion colour

This core colour is elevated with standout tones such as blue flame – a dark cobalt – and inky lapis, which work as a feature colour for casual and eveningwear.

Introducing the core palette

WGSN presents a core palette, ranging from ivory to navy and black. The palette will be adjusted seasonally. Core colours are suggested within each palette.

GLOBAL COLOUR TREND INDEX A/W 17/18

This trend homes in on sustainable design and the imperative for products that will last a lifetime. Colours take their cue from materials that have been through processes – altered by time, or recycling. The palette of smudged, grey-toned pastels is ideal for Autumn Transitional Drops, gently easing towards the colder weather.
Technological advances are changing the way we see the world, giving us macro and micro views of nature like never before. This results in colours with a high-definition intensity, with particular inspiration coming from the golden hours of dawn and dusk. Golden ochre and saffron work for Autumn Drops, while dusky tones of blue flame and dark berry work for the darker days of Mid-Autumn Drops.
Disruption and discomfort are central themes of this trend, which embraces the darkness that comes before light. For colour, this translates to a palette of moody night tones and moonlit brights, with inky blues, deep purple and berry tones. These are perfect for casualwear in Winter Drops, and eveningwear and tailoring for Holiday & Partywear Drops.
This trend focuses on convergence, examining intersections between the virtual and the real, and opulence and minimalism. This results in a sense of everyday luxury, drawing on diverse decorative influences, and inspires a range of off-key colours, from smudged light blue to stark orange. This optimistic palette is perfect for Winter Transitional Drops, as spring comes within touching distance.

Design Matters

Design Matters taps into themes of sustainability, with mid-tones that appear to be softened by natural processes – faded by time, oxidised by weather, washed out after recycling, or smudged with chalk. The hazy quality and grey undertones of these colours gives them an unusual depth. It's all about calming down, and embracing the first chill in the air.
Steel grey and uniform blue anchor this palette, which then slides towards gentler mid-tones of light mouse grey and dark celadon – a slate-toned green that perfectly exemplifies the subtle complexity of this season's colours. Purple haze and saddle brown work as richer base colours, while pear and chalk pink offer understated highlights.

Picture 1: Colour palette no. 1

Earthed

The colours of Earthed embrace the onset of autumn, as the leaves begin to turn, but with a higher-definition quality. This is a palette inspired by microscopic views of nature, and macro perspectives of Earth viewed from space. The result is a collection of colours with an inherent brightness, as though lit from within – colours that seem realer than real.

Picture no. 2: Inspiration for colour palette

Saffron yellow and fire red sit at the brightest end of this palette's spectrum, offering a burning intensity reminiscent of dawn or dusk, when nature is heightened. These are tempered by earthier tones such as ochre and bronze green, and richer colours such as dark berry and henna. Evergreen has a vivid grassy quality, while dusk blue mirrors the in-between state of the sky as day turns to night.

Picture no. 3: Colour palette no. 2

Nocturne

Nocturne explores themes of darkness from a positive perspective – the beauty in melancholy, the benefits of disruption, and the wonderment of stargazing. Colours have a tinted quality, as though viewed at night, with the occasional bright flash, like an unexpected headlamp through the trees.

Picture no. 4: Inspiration for colour palette

This is a palette of darker tones, including deep viridian green, the night-sky blue of lapis, and nightshade, a purple that appears almost black. Lighter colours such as amethyst and citrine have a muted quality on their own, but take on a heihgtened intensity when set against the palette's moodier tones.

Picture no. 5: Colour palette no. 3

Infusion

INfusion is a trend of unexpected pairings, exploring the convergence of the real and the virtual, and the restrained and the opulent. This results in an eclectic mix of colours that feels edited and luxurious, and is notable for its absence of darks. It offers a sense of optimism as winter transitions to spring.

Picture no. 6: Inspiration for colour palette

This palette is characterised by a sense of balance, with colours that are varied but complementary: soft blue smoke is counterbalanced by weightier teal; rose dust sits comfortably next to coral; green jasper – the palette's darkest colour – is offset by lighter billiard green. These are colours that tap into a feeling of optimism as days grow longer.

Picture no. 7: Colour palette no. 4

KEY COLOUR MESSAGES - SATURATED NATURALS

Natural colours are saturated for A/W 17/18, with a richness and depth in line with the season's wider shift, which sees brights replaced by mid-tones with an inherent complexity. Shades such as evergreen, red lacquer and ochre work well across product categories, particularly as autumn sets in.

Picture no. 8: Inspiration for colour palette and colour palette no. 5

KEY COLOUR MESSAGES - RECLAIMED REDS

Reds set the tone for A/W 17/18, when colours will derive their interest from being off-kilter, rather than obvious. Shades such as dark ruby, henna and scarlet have a romantic and nostalgic quality, reminiscent of maple leaves turning in autumn, or a cherished hand-me-down sweater.

Picture no. 9: Inspiration for colour palette and colour palette no. 6

KEY COLOUR MESSAGES - ELEVATED BLUES

Blue transitions from a core colour to become a key fashion tone. Dark lapis blue, purple-tinged blue flame, and upbeat turquoise are all important tones for moving this colour to the foreground of fashion this season.

Picture no. 10: Inspiration for colour palette and colour palette no. 7

KEY COLOUR MESSAGES - TINTED DARKS

Darks exemplify the complexity of colour for A/W 17/18, which sees a shift towards more nuanced, layered tones. This duality is apparent in colours such as nightshade, an almost-black purple, and shale, which hovers between black, brown and grey. The effect is similar to looking at colours with the lights off.

Picture no. 11: Inspiration for colour palette and colour palette no. 8

KEY COLOUR MESSAGES - GREY-INFUSED PASTELS

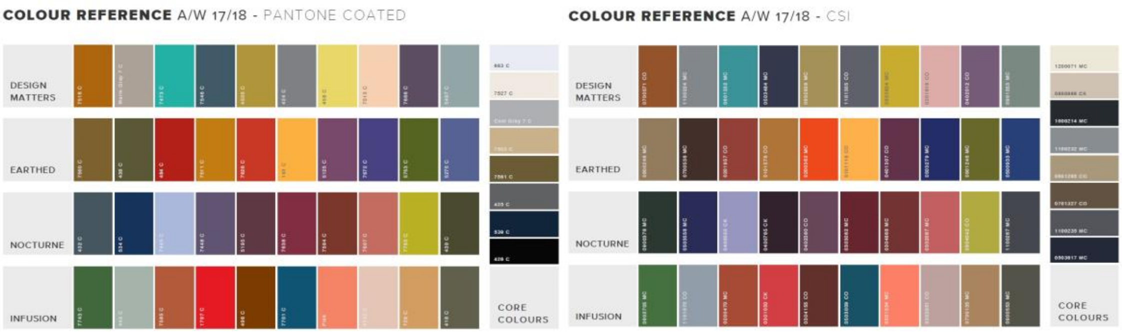
Pastels have a hazy quality, with colours such as blue smoke, rose dust and chalk pink featuring subtle grey undertones. These soft tones make a quiet impact, and also offer a sense of texture, making them perfect for the transitional periods between summer and autumn, and winter and spring.

Picture no. 12: Inspiration for colour palette and colour palette no. 9

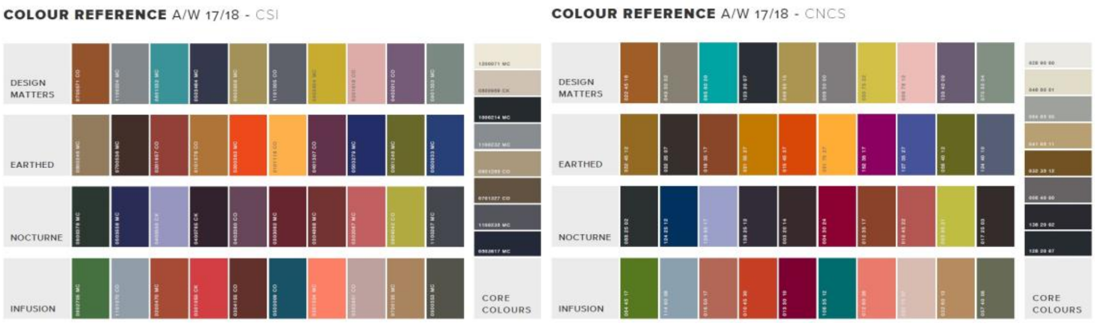
CORE COLOURS A/W 17/18

For the first time, WGSN presents a palette of core colours, giving you a definitive base to build your collections around. This palette will be adjusted seasonally. For A/W 17/18, the lighter neutrals have a natural, earthy quality, from the off-white of ivory to ecru and sand. Olive khaki sits somewhere between brown and green, in line with this season's wider focus on colours with dual qualities. Limestone and slate offer a transition towards the darkest tones of navy and black.

Picture no. 13: Colour palette no. 10



Picture no. 14: Colour palette no. 11 and 12



Picture no. 15: Colour palette no. 13 and 14

CONCLUSION

This paper presents a color palettes with their inspirations and fashion colour trends that will be globally present for autumn/winter 2017/2018.

REFERENCE

[1] GLOBAL COLOUR A/W 17/18 ; Retrieved from
[2] http://www.wgsn.com/content/board_viewer/#/62693/page/4
[3]

DIGITAL WAVE

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APSTRACT

In an era that is increasingly tech-driven, people will simultaneously embrace the digital wave while developing a nostalgia for analogue technology and design. The corporate use of digital technologies will be increasingly called into question, with consumers demanding radical honesty and ethical hackers working to make the internet a safer place. Young Generation Z activists will be driving change and social protest, as well as a stronger culture of race and gender tolerance. Inspired by Post-Internet art, powerful graphics, high-octane colour and creative customisation will turn the anarchic spirit of 1980s New Wave music into digital wave design.

Key words: digital, wave, technology, design.

INTRODUCTION

Digital Wave, examines how technology is affecting culture. In a tech-driven era, people are embracing digital convenience while also developing a nostalgia for analogue technology and design. This is a trend characterised by powerful graphics, high-octane colour and creative customisation, taking inspiration from the Post-Internet art movement and the anarchic spirit of 1980s New Wave music.

KEY IDEAS

- A desire for radical honesty means that brands and corporations will need to start thinking of ways to connect with consumers – or they will simply block out their existence,
- It's cool to care: tolerant and realistic, Generation Z gets increasingly political, whether about race, gender or sexuality,
- Brevity will rule: reduced attention-spans mean more bite-sized news and information.
- Mixing both analogue and digital elements, Post-Internet art will drive a new direction for digitally-led design. At the same time, nostalgia for 20th-century technology will bring back analogue elements,
- Experimental and highly tactile, design will become infused with the look and feel of the internet,
- Blurred work/life boundaries and a strong sense of self will create demand for reworked city casuals: power dressing for the web generation
- Inspired by 1980s new wave, design will be injected with high-octane colour, bold graphics and creative customisation.

DIGITAL WAVE MEN FASHION

Sharp tailoring and graphic colour contrasts cleanse and reset the seasonal mood and palette, while urban casualwear has an active utility feel with a focus on modern materials.

KEY POINTS

- Silhouettes for tailoring and casualwear alike exhibit a stark, modern austerity with subtle 1980s undertones, sharp, angular lines, and a minimalist appearance underpinned by a high-contrast monochrome palette and intense primary brights
- Younger casual and streetwear looks have a rebellious urban feel, drawing on Japanese 1980s biker references and a midnight club atmosphere to inspire contemporary utility looks augmented by hi-tech materials
- Print and pattern designs combine abstract, geometric graphics with a more textural approach to evoke the nostalgic warmth, tactility and textures of the early, perfectly imperfect days of the electronic age.

MATERIALS

For yarns and fibres, cotton, silk, and viscose types have a silky polished sheen, with extrafine merino wool for a transseasonal aspect. Technical polyester and stretch filaments add luxurious performance, while chintzed and gloss coatings provide a tonic sheen. Textiles play on graphic contrast colour or highdefinition construction. Colour-woven shirting, noisy interference-pattern suiting, and graphic blocked sportive shell weights balance ombré colour with subtle grainy texture for optical overlays. Texture is emphasised through raised surface embossed-look fabrics, along with lasercut and perforated techniques.

GLITCH MONOCHROME

Graphic black and white suiting fabrics transition into S/S in transseasonal weights. Pixel patterns, sound-wave stripes and contour mapping define optical micro dobby, jacquard and double-cloth suitings, adding extra dimension for monochrome checks, twill or herringbone structures.

EXTREME TEXTURE

Three-dimensional constructions provide intriguing updates for S/S as textured cloqués and matelassé fabrics explore raised and padded surfaces. Bold singular colour in matte and shine form is a key fabric message for outerwear weights and performance fabrics.

MONOCHROME SUITING

Tailoring silhouettes exhibit a laser-sharp, monochrome austerity in textured blacks. Stark, angular cuts and and soft volume are explored for lightweight suiting fabrics, exploring micro-scale patterns and textures as well as a polished, calendered finish.

HI-TECH SHEEN

Electronic music, dance floors and strobe lights in the dark inspire hi-tech fabrics for young, urban sportswear styling. Reflective coatings and high-shine yarns and heighten the feeling of hyper-reality for active tops, jackets and separates fabrics with a casual but technical look.

PIXEL PATTERN

Digital and analogue electronics join forces to inspire new kinds of 'digital' tweeds for contemporary casualwear. Applications from simple print graphics to complex, noisy jacquard designs resemble computerised glitches and distortions, enhanced by high-contrast optical colour effects for shirtings and suitings.

YOUTHFUL CHECKS

Newsprint grey tones and technical finishes provide a younger spirited casual urban update for classic suiting types. Extrafine merino blended with linen or cotton is key for tonal windowpane or Prince of Wales checks, working well for youthfully styled soft tailoring and summer separates.

SHARP GEOMETRICS

A sharp-edged 1980s spirit is evoked through hard angles, glossy finishes and high-energy colour, played out in bold graphic pattern and spliced colour-block form. Prints and jacquards create a sharper finish and bird's-eye structures adding texture overlays for casual, formal or sportif outerwear and jacket fabrics.

GRAINY TEXTURE

The grainy textures of early black and white photocopies inspire a noisy surface update for modern classic separates and jacket weights. Jaspe yarns, dobby textures, broken patterns and grainy jacquard effects provide a nostalgic, speckled tactility.

CAGED CONSTRUCTION

Architectural and caged constructions inform graphic monochrome fabrics. Technical sportif meshes have a grid-like appearance while supple lightweight leatherettes explore punched or laser-cut techniques. Woven cottons deploy extraweft contrasts to create visual overlays or play on opaque and sheer contrasts.

MOOD AND COLOUR

The look and feel of the early digital age in the 1980s inspires the colour palette for phase one of the season. For the menswear market, purples have been consolidated to hot pink and black plum, and the range of classic men's colours has been expanded with dark blue, black olive and high-rise grey, widening the commercial base of the palette for transitional tailoring. Accent brights such as blazing yellow and Amazon green have been tweaked to increase their versatility as sporty highlights.
A new wave of smartness mixes a minimalist approach to tailoring with 1980s digital prints. Electric pops of hot pink and blazing yellow serve as accent colours for prints, underpinned with a high-contrast monochrome palette of high-rise grey and stark black ideal for transitional tailoring.

OVERSIZED TAILORING

Recalling the stark, angular suiting of the 1980s, double-breasted blazers are upsized with broader shoulders and elongated to serve as transitional jackets. Digital printed shirts and T-shirts add an electric pop to the otherwise minimalist look.

Image 1: Oversized transitional jacket

Image 2: Technical sketch of oversized transitional jacket

ANGULAR PATTERNS

Angular graphic patterns are interpreted into fine-gauge knits to recall a feeling of analogue nostalgia. Tucked-in styling emphasises the new-wave reference with trousers that are full through the thigh and taper with a full break at the ankle.

Image 3: Sweater with angular pattern and tucked in trousers

Image 4: Technical sketch of sweather with angular pattern

STYLES

- **Soft Angular**
- **Neo Nautical**
- **Deconstructed Checks**
- **Pattern Interference**
- **Street Racer**
- **Cyber Nights**.
- **Electric Tweeds**
- **Ombre Effects**
- **Bonded Surfaces**
- **Grainy Geometric**
- DIGITAL WAVE WOMAN FASHION

Two drops break up Phase one. Drop one celebrates power dressing and updates the look with softer statement shoulders and relaxed tailoring. January's drop two reworks 1980s sportswear and champions the new generation of fashion pioneers ready to start the new year with a strong active focus.

KEY POINTS

- Praising the work of 1980s Armani, the return of comfort dressed tailoring sees silhouettes become less structured. Sharpness and strong forms are still important but the look is updated with an oversized relaxed zoot-suit feel
- Caged, sculpted, and cutaway – body-con dressing has the perfect mix of gloss, glamour and sex appeal. Inspiration sees a vintage Cindy Crawford-influenced element placing swiminspired silhouettes alongside eveningwear
- Gender is neutral and style is diverse, with attitude the key anchor. Elements of punk, new romantic and prettiness and fuse together to create a mismatch of subcultures.

MATERIALS

For yarns and fibres, cotton, silk and viscose types have a silky polished sheen, with merino wool for a transseasonal aspect. Technical polyester and stretch filaments add luxurious performance, while sparkling metallic or iridescent inclusions add shimmer and sheen, along with chintzed and gloss coatings. Textiles play on graphic contrast colour or high-definition sculpted construction. Colour-woven shirting, glitchpattern suiting and graphic-blocked jacket weights balance ombré colour with subtle extra-weft techniques for dimensional optical overlays, while texture is emphasized through raised surface cloqués and matelassé fabrics, along with laser-cut and perforated techniques.

HATCHED EFFECTS

A refined suiting direction emulates the 1980s pared-down sophistication of Giorgio Armani for a return to modern classics. Textural hatching updates herringbone jacquards or subtle weaves, using grainy jaspe yarns for subtle textural variation.

DIGITAL MAPPING

The realms of the internet inspire radical digital-look design. Pattern becomes disruptive for full width jacquards using multiple weft colours to create complex, noisy designs that resemble computerised glitches and distortions, enhanced by high-contrast colour for optical effects.

BOLD PLAINS

Lightweight shirting, blouse and dress-weights make a confident statement with chintzed and calendered finishes giving a lustrous finish. Silk and polyester blends have gleaming sheen and a silky drape, with enhanced performance stretch.

GLITZ METALIC

The 1980s New Wave influences a fresh take on day-to-evening glamour. Lamé jacquards, printed all-over sequins, and lightweight cotton shirtings with metallic or iridescent stripings against dark grounds add a scintillating touch to everyday dressing.

MOOD AND COLOUR

Colour will be infused with the look and feel of the digital age. Classic 1980s tones will return, and black plum will emerge as a key tone. Electric magenta, jelly bean green, hot pink and machine red will get things off to a bright start. Bold shoreline blue and horizon yellow are introduced as accents. This palette works for both dressier and active led looks that start off the summer season, beginning for phase 1.
The hard-edged glamour of the 1980s is infused with digital-age aesthetics, reflected through a sharp but updated and softened silhouette. Spliced and blurred prints with a future-tech feel are transferred into loungewear pieces. Black plum along with electric magenta, green, yellow and hot pink get things off to a bright start.

BODY LINES

Architectural straps and a body-con silhouette shape this sports-inspired nightdress. Stretch jersey in vibrant colours features elastic straps in contrast colour across the chest and peek-a-boo panels.

Image 5: Body line dress

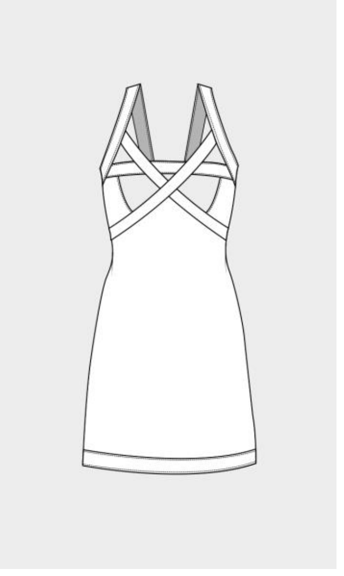

Image 6: Technical sketch of body line dress

ROLLER DISCO

This set features sexy high-waisted short shorts cut in velvet and a printed boxy T-shirt with rolledup sleeves. A spliced and blurred placement print creates a digital feel.

Image 7: Roller disco shorts and shirt

Image 8: Technical sketch of roller disco shirt and shorts

1980's GLAMOUR

A short seductive silhouette and a deep plunge define this eye-catching all-in-one. It is cut in velvet or glossed silk for a lustrous, sexy effect.

Image 9: 80's glamour overalls

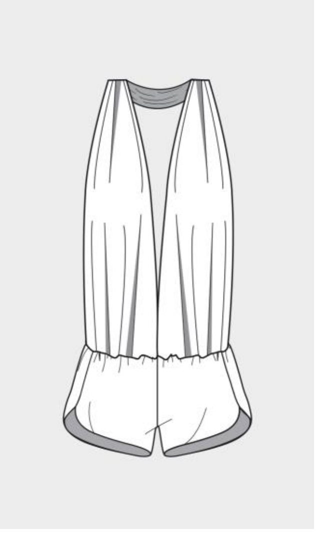

Image 10: 80's glamour overalls technical sketch

ANGULAR SHIRT DRESS

A softened triangle silhouette with sharp outlines delivers the shape for this nightie. A straight, deep plunge neckline and tonal geometric pieced fabric offer a digital-age vibe.

STYLES

- **Soft Angular**
- **New Wave Style**
- **Eastern Girl**
- **Armani Classics**
- **Ship Shape**
- **Wet Look**
- **Nightlife**
- **Body Line**
- **Beta Max Generation**
- **Smash Hits**
- **Activate '87**
- **Pretty Punk**
- **Pinball Wizard**
- **Sound Waves**

CONCLUSION

Digital wave showes connection of technology and culture and their influance. With thechnology rapidly growing people still lean towards past time and nostalgic. Digital wave is infusion of past and beggining of technological development and past time and nostalgy. Digital Wave combines classic materials with more technical fabrics and details to create new contemporary looks. Contrasting bonded trims and neon piping lend a modern touch to pinstripes and flat-weave suiting fabric.

REFERENCES

www.wgsn.com

DENIM

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INTRODUCTION

Denim become popular in the middle of XX century and held until today. Denim is worn by men and women, because of its customizable use. Accordingly, denim clothes can be worn in most different situations.
The first garment witch is unavoidable in clotheing are jeans. There are many models, whether wide or narrow, long or short, jeans are properly for bussenes meetings in combination with shirt as well as for evening ours and parties on high heels. Jeans of different collors are very interesting. In addition to jeans, skitrs of denim are unavoidable, dresses, waistcoats, shirtss, shorts, jackets.
Important elements for Spring/Summer 2017 are eco friendly attributes remain an essential element for almost all vendors , and communication and education are even more apparent. Key collections include Garmon Chemicals's Green Screen programme, Calik's Oxygen technology, and Royo's Ambi-Wash. There are market's demand for multifunction and multipurpose products that offer enhanced attributes for the wearer wich drives mills to explore the new frontiers of technology more deeply. Mills integrate highly functional fibres into traditional denim weaves for UV-ray sun protection, liquid resistance properties and moisture-wicking qualities. One of the most commercial trends of the moment is the market's current obsession with all-American vintage. Mills are responding to this with a range of modern constructions that offer this vintage feel with the added functionality of comfort stretch and soft touch**.**
Key words: denim, trend, pants, jackets, vintage...

Key elements for upcomeing season

Digital Wave will look to the style-driven 1980s through new eyes, overlaying this decade with modern fabrics and reworked colour and silhouettes. Anarchistic style and subculture clashes from the Punk and New Wave era will provide exciting design references for denim, contrasting gender-neutral dressing with hard-edged but feminine looks, with the anarchistic style from punk and skinhead subcultures informing tonal denim dressing. Silhouettes focus on sculpted and cutaway form, with gender-neutral attitude the anchor. The New Wave style of the 1980s informs sharp, angular lines and high-impact geometric piecing. Decorative needlework and hand-drawn doodles nod to Punk's anarchic style. Black bases allow primary and secondary brights to stand out while fluorescent and chrome tones add drama to metal trims. The look of graffiti is recreated with tie-dye, shibori and new colour masking techniques. Coatings move forward with metallic looks.
Reflecting on a trend seen on the Spring/Summer 2016 catwalks, vendors present a range of artistic indigo applications for Spring/Summer 2017. Traditional indigo crafts such as batik or shibori inspire all-over patterns as well as placement tie-dye stripes. Blue Farm experiments with random bleach applications for cloudy effects, as well as polyester weave patterns that resist dye absorption.

Picture 2: Using of bleach for getting effects

Picture 1: Poliester effects

Using a range of sustainable wash techniques to make new print and pattern, a new sustainable corrosion process called Indisol to achieve a group of high-resolution motives on high quality fabrics. Jeanologia continues to refine its laser technology with precise burn-outs. Experimenting with intricate jacquards that replicate laser effects.

A key trend highlighted for Spring/Summer 2017 is indigo panelling moves in clean and sharp blocked iterations. Indigo masking techniques create precise lines between panels, while more commercial applications highlight removed patches to create a contemporary take on vintage patchwork. A 50/50 split on jeans or simple tonal indigo patches at the knee are the most effective looks within this approach.

Picture 2: Vintage style patchwork trousers

Indigo looks evolve beyond Americana workwear and towards late 18th-century European and Japanese peasant looks. Arvind presents its range of hand-dyed/spun/woven Khadi denims and Cone showcases its first natural indigo collection that is grown and dyed in the US. Other mills explore the range of deep and dark nuances of natural indigo, as well as the vintage purple-cast shades seen at Artistic Fabric Mills.

Picture 3: The eticet

A key trend also noted for Spring/Summer 2017 edition of Kingpins Amsterdam increasingly look to military-inspired fabrics and shades as a fashion alternative to indigo. Particularly relevant within the men's market, fabrics focus on archive-inspired gabardine, sateen and selvedge updates. Rugged waxed and oiled-finish canvases offer functional waterproof and breathable attributes. Moss and cargo tones are softly laundered for vintage look.

Picture 4: Millitary style pants

Washed out colors of denim and bleaching effects are trendy too. Royo introduces its sustainable Ambi-Wash project with Italian wash specialist Montega Verde, whose surfactants are obtained through natural and renewable ingredients. Bossa looks to natural dye-stuffs such as acorns. Sun-faded and dirtied shades are explored through extreme bleach-outs and earthy tints. Contrast brown or black wefts make for interesting fades.

Picture 5: Denim with effect of washed out color

Picture 6: Denim with bleching effects

Improved bistretch solutions offer denims that lift and sculpt to update skinnies, while new coated knits, polyesters and seersuckers offer fresh takes on active silhouettes. Pattern is disruptive, using jacquards and colour effects to create designs that resemble computer glitches.

The continued importance of activewear in denim drives mills to develop technical-looking coatings. Lightweight denims and chambrays are given high-gloss resin applications that imitate technical windbreaker styles. Blue Farm looks to ripstop style prints or mesh-bonded faces for true activewear style. Atlantic Mills and Nihonmenpu look to water-resistant coatings such as British Millerain. Arvind plays with matte coatings that boast a leather shine when buffed.

Picture 7: Materials treated with coatings for water-resistent

Key items for women collection - spring/summer 2017

Denim is defined by the overarching theme of reinvented vintage for S/S 17, with emphasis on new cut and fit modifications and hybrid designs that give timeless classics a renewed appeal.

Key points:

Skewed Seams **-** core items such as the skinny jean, flare and miniskirt are pushed forward with clever denim design details such as skewed seaming, optical-illusion and decorative panelling. Upsized silhouettes come to the forefront for the summer season with exaggerated takes on boyfriend silhouettes such as the buttondown shirt and cargo pant.

Hybrid Design **-** traditional denim silhouettes combine fashion items with utility and workwear references this season, giving feminine pieces a more rugged aesthetic.

Twisted skinny - The rise of re-tooled vintage jeans drives new cut and fit modifications on the skinny jean. Look to skewed and twisted seams that panel together contrasting wash intensities. Open-end constructions are key for the look.

Picture 8: Pants with skewed and twisted seams

Skater flare **-** As the flare gains commercial appeal and increasingly becomes the go-to boyfriend alternative, there are showing up elements such as staggered rips to create newness.

Picture 9:Pants with staggered rips for creating newness

Vintage culotte **-** Fast becoming a summer staple, the culotte is given a renewed identity for S/S 17 with all-American vintage laundries. Fits take on a cropped boyfriend fit with straight, wide legs and square top blocks.

Picture 10: Vintage boyfriend pants

Patched mini - A core juniors' item for the festival season, the miniskirt is updated for S/S 17 with new piecing techniques and details such as graphic overlock seaming, contrast patch pockets and mixed indigo wash intensities.

Picture 11: Mini skirts

Apron dress - Blending humble pinafore dress styling with utility detailing, this item sits well in both women's and juniors' categories. Key details include button fronts, apron-style straps, stitchthough pockets and back embroideries.

Picture 12: Apron dress

Raw edge tank- An evolution of the denim tee, new cropped and boxy shell styles emerge for high summer. Festival season calls for a flash of skin with midriff-baring tops that are often worn as a set with coordinated pants or shorts.

Picture 13: Raw edge tank

Longline chore shirt - Season after season, the denim shirt proves to be a wardrobe essential. Look to update this timeless classic with flowing elongated lengths that make it transitional as a layered shirt, or button up as a longline dress.

Picture 14: Longline chore shirt

Shrunken rider - The vintage trucker is given a new lease of life with cut and fit modifications. Seam manipulations on oversized 1980s fits create new shrunken and fitted shapes, while haphazard-cut hems add interest.

Picture 15: Short trucker style jacket

Belted chore - Kimono styling remains an essential design reference for outerwear this summer, with obi belting and widened sleeves giving the chore coat new direction. Worker-style collars and cuffs keep it looking rugged.

Picture 16: Belted chore

1.1.17 4. Key items women autumn/winter 2017/2018

Pleated skirt - Update the high-waisted multi-pleated skirt in raw denim to add volume to this classic silhouette. This below-the-knee skirt is defined by a higher waist and pleated volume.

Picture 17: Pleated skirt

A - line skirt - Use raw denim to give 1970s A-line dress styles a more sophisticated look. Patch pockets, zip fronts, and high collars are updated with tonal thread colours, front buttons, and contrast-colour panels.

Picture 18: A - line skirt

Poncho - Update classic outerwear looks with denim poncho-style truckers featuring hoods and patch pockets, trucker styling, button or zip fronts.

Picture 19: Poncho

All in one - Belted waists and flared silhouettes add a feminine form to this mannish item. Sophisticated fabrics and cleanly tailored construction details create a refined streetwear look.

Picture 20: Combinezones

Wide croped flared - Wide-leg, cropped trousers make a statement and evolve from the loose-proportioned models of previous seasons. Cropped just above the ankle for a midi-length. Pleats help control volume

Picture 21: Wide cropped pants

High waist flare - The cropped flare remains an essential shape for the women's market, but can be updated with super high-rise fits and subtle flares.

Picture 22: High waist denim pants

<u>Key items men - Spring/Summer 2017</u>

Key points:

Contemporary Utility - Vintage denim and surplus military items inspire an urban explorer look with practical multi-pocketing and DIY patch and repair in elevated fabrics.

Retro Resort - A relaxed take on the 1950s inspires easy silhouettes such as boxy resort shirts and the Bermuda boardshort.

Elevated Basics **- A** premium basics such as the trucker jacket and skater pant come in modern fabrics with softer silhouettes and functional aspects.

Cropped skater pant - The classic 5-pocket gets a sharp remake for summer, evolving with slim straight-fit and elevated hemlines. Top-blocks have a fitted low-rise shape, new stretch selvedge fabrics that add comfort while maintaining an authentic look.

Picture 23: Short skater pants

Repaired skinny - The skinny jean is updated with exaggerated patch and repair applications. For statement surface, an eclectic mix of remnant materials layered create a textural collage. More commercial markets should reference contemporary takes on Japanese boro using tonal indigo patchworks in geometric form.

Picture 24: Repaired skinny pants

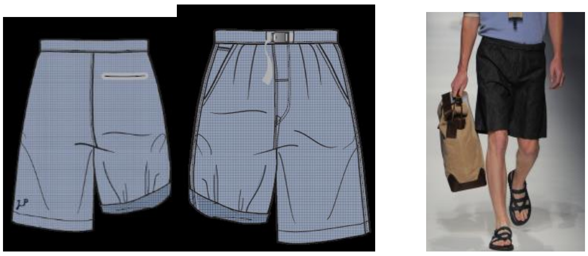
Patched pantaloon - An item for the purist denim market, this vintage-inspired pant nods to authentic turn-of-the century work pants. Silhouettes and details stay true to the era with a straight wide fit, pleated front and trouser pockets. Keep a strong vintage sentiment with time-worn and weathered washes along with DIY patch repairs and hand-applied stab stitching.

Picture 25: *Patched pantaloon*

1990s wide leg - Wide-leg jeans reminiscent of 1990s skater boys are the younger casual cousins of the pantaloon. Fits are straight with pumped-up wide volume and high-cut waist accentuated with tucked-in styling. Crisp raw denims add structure with full break legs or deep cuff styling for a subtle 1950s reference.

Picture 26: Pants with wide leg

Boardshort - Tailored takes on casual boardshorts are a new summerfriendly must-have - longer shapes with a big and roomy fit for a contemporary feel. Pleats help control volume while adding a more refined appearance. Raw denims or compact sateens keep the shape structured. Chunky knits create a more relaxed beach attitude.



Picture 27: Boardshort

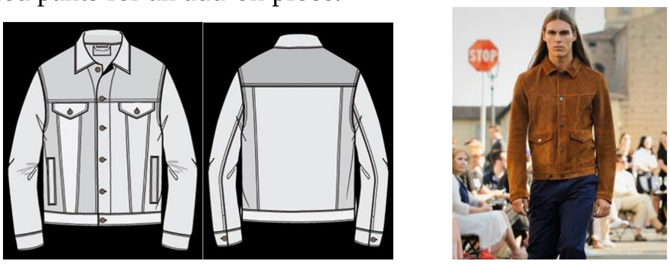
Patchwork short- A key item for high-summer, the patchwork short has a bold presence. A festival season favourite, this item comes laced with character through eclectic patchworks and hand-drawn doodles. Layered mix of textures, patterns and colour create a vibrant surface effect.

Picture 28: Patchwork short

Loco jacket - The chore coat evolves with collarless styling referencing vintage loco jackets. Borrow collar detailing from baseball or kimono styles to add a more contemporary feel.

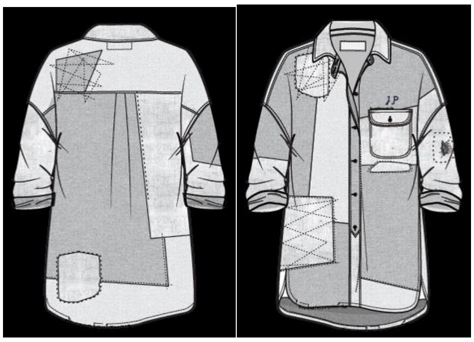
Picture 29: Loco jacket

Luxe trucker - The classic denim jacket is transformed into a luxury piece. Designers continue to explore alternative materials to move the item out of its traditional denim realm with luxurious materials such as plush suedes and glossy sateen. Look to non-indigo shades for a more fashion direction and coordinated pants for an add-on piece.



Picture 30: Luxetrucker jacket

Boro shirt - An array of patchwork effects provides an eclectic update for casual denim shirts, using diverse techniques and applications. Cultured folk influences, textured tapestry and interior textile patterns are creatively blocked, printed, laser-laundered or patchworked together on denim bases.



Picture 31: Boro shirt

Picture 32: Patchwork details on boro shirt

<u>Key items in men colection - Autumn/Winter 2017/2018</u>

Cropped pleated pant - This relaxed trouser shape offers a modern take on vintage workwear, with raw denims complimenting traditional tailoring details. This silhouette is defined by a higher waist, slight dropped crotch and pleated volume, which is tapered through the leg with turn-up cuff.

Picture 33: Cropped pleated pant

Pleated chino - Tapered chino silhouettes appeal to a broader menswear market with the now ubiquitous cropped hem or 'mankle' styling to update the look.

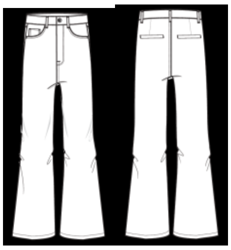
Drop-crotch chino - Drop-crotch proportions move the classic chino into a casual youth-inspired context. The style has a tapered silhouette with cropped hems that showcase important footwear. Trouser pockets nod to classic chino style with a slight cropped length.

Picture 34: Model of drop „Chino" pants

Wide crop - Elevated hemlines to the ankle, or above it, are key for making larger trouser volumes practical, and help to make the silhouette a younger, more streetwise alternative to tapered styles.

Picture 35: *Wide crop*

High rise cropped hlare - As retro pant fits become more widely embraced in the market, the flare emerges as a viable alternative to classic five-pocket style. The fit is high-rise, with a tapered thigh and gradual flare through the leg. An anklelength hem gives the item a more contemporary style.



Picture 36: High rise cropped hlare

Modern field jacket- A standard issue favourite, the M-65 jacket finds a new place on the street through refined fabrics and contemporary form. They stay true to classic details with multifunctional pockets, buckle-fastened collars, concealed hoods and a combination of zip and snap fastenings.

Picture 37: M-65 jacket

Denim transformation tote- The tote has become an accessible style across the menswear market and raw denim alternatives are a contemporary update. The design is simple and practical, making it a go-to item. Demand for multifunctional bags drives transformation options that offers a shopper and rucksack style. Antique zips, thick orange thread and white binding are key.

Picture 38: Denim bag

CONCLUSION

Garment made of denim are always current. Because of their practicality and easy fitting with others materials denima is ideal cgoose for every opportunity. Technology and design of jeans are accomplished so they can be found in the most different varints to everyone's taste.

REFERENCES

1) www.wgsn.com
2) V. Petrović, J.Stepanović, M.Stanković, M. Reljić, S.Stefanović:Savremena kretanja u tekstilnoj i odevnoj industriji u Evropi, Menadžment, Inovacije, Razvoj
3) Internet

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