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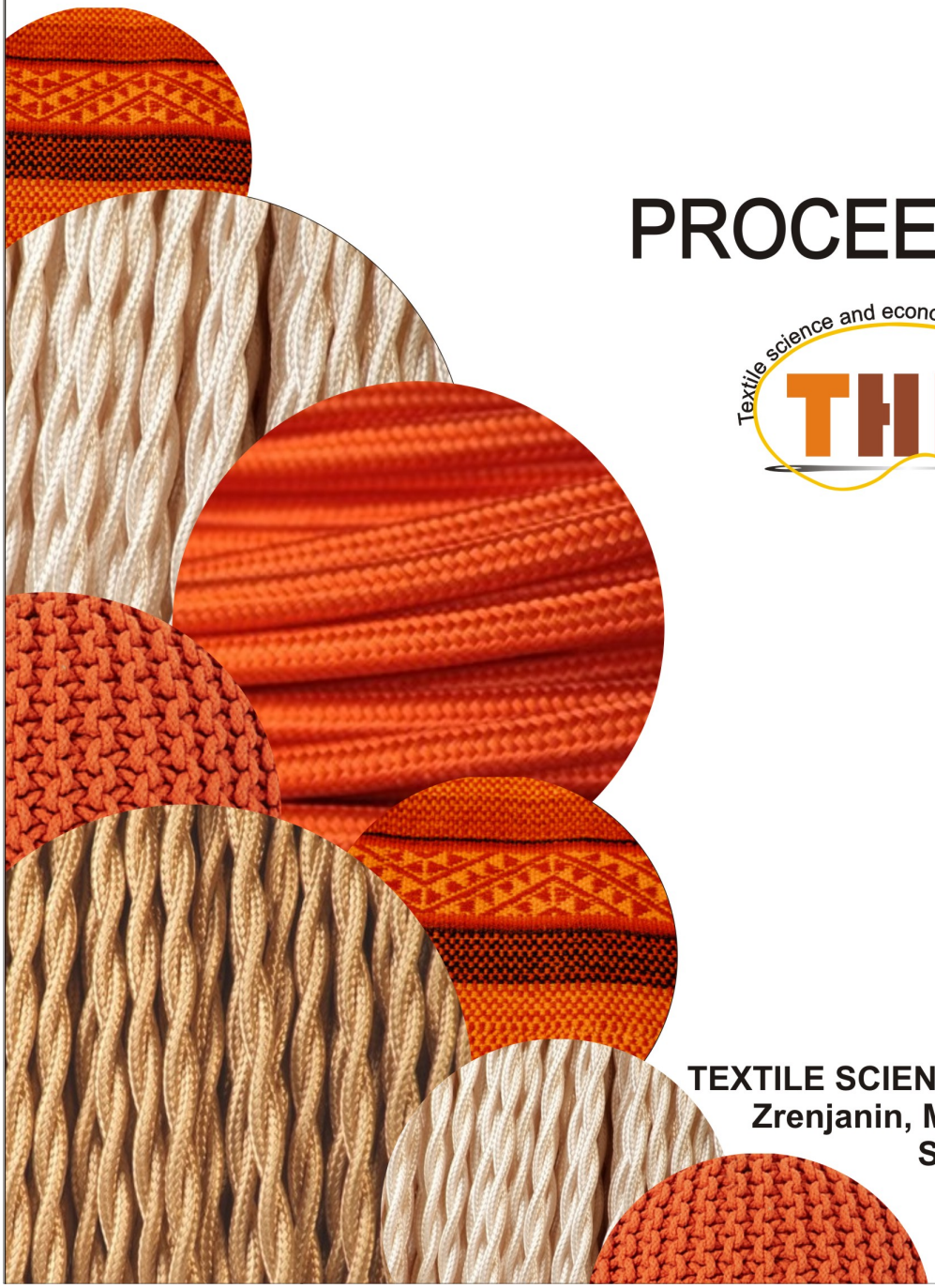

PROCEEDINGS

Textile science and economy 2015

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Zrenjanin, May 25-31, 2015.
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TECHNICAL FACULTY „MIHAJLO PUPIN“
ZRENJANIN, REPUBLIC OF SERBIA

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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 VII" - TNP2015.

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 seven 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. This year two of our students will be 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" includes new activities related to stronger links 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.

The Organizing Committee would like to thank all those who helped organize this Conference, particularly the Provincial Secretariat for Science and Technological Development, Republic Ministry of Education, Science and Technological Development and municipalities of Arilje, which financially supported the work of the Conference.

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- **Faculty of Engineering, Pamukkale University, Denizli, Turkey.**

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- **Municipality of Arilje, Republic of Serbia.**

CONTENTS

PAPERS

ASSEMBLY LINE BALANCING USING AN ANT ALGORITHM IN THE GARMENT INDUSTRY: A CASE STUDY

Can B. Kalayci*, Ece Kalayci
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ABSTRACT

Today, the productivity and efficiency of production operations for garment industry is getting more important than ever before since the global competition is on the rise. This paper focuses specifically on balancing of a bathrobe production line in a garment industry. The aim of assembly line balance in production lines is to assign tasks to the workstations, so that workers can perform the assigned tasks with a balanced loading. An ant algorithm has been employed in this paper to tackle this problem. The technique is able to quickly improve the line efficiency.

Key words: assembly line, faster assembly, ant algorithm

INTRODUCTION

In the garment industry, price and quality competition of textile manufacturers and global trading has given rise to the need of not only increased quality, but also shortened production times and minimized costs. In particular, products with high customer demand are required to be assembled as fast as possible in an efficient manner that will result in cost and time savings. In order to satisfy such desires, a famous problem called assembly line balancing should be solved at the best possible performance, so that the machines or the human workers in the line can perform the assigned tasks with a balanced loading. This problem involves the assignment of tasks to workstations by satisfying a set of constraints with the aim of achieving different objectives. Assembly line balancing problem (ALBP) is known as an NP-hard problem, meaning that it cannot be easily solved in practical time. Therefore, many researchers have tried to tackle this problem since it has been given birth in 1950s. Even today, different models and extensions of assembly line balancing problem are studied. In practice, balance control depends on the manager's experience and prediction of the line performance. Unfortunately, the line balance performance cannot be guaranteed from one manager to another and it is not easy for a model of the supervisory behavior in line balancing to be formulated. Unequal workload among workstations will cause an increase in waiting time, indicating the increase of both production cycle time and cost. Many other companies in different industries have adopted to use systematic approaches through continuous improvement. However, the textile industry has been slow to adopt rapid technological advancements in production lines. This paper focuses on a case study of assembly line balancing in a garment industry. An ant algorithm is applied to solve the problem. This technique is able to improve the line efficiency with a quick response.

METHOD

The assembly line balancing problem (ALBP) is a combinatorial optimization problem and metaheuristics are particularly suited to solve such problems. Metaheuristic algorithms have been very popular in the area of ALBPs over the years. As a type of metaheuristics, ant algorithms are also recently applied to solve assembly and disassembly line problem variants (Agrawal & Tiwari, 2008; Akpinar & Bayhan, 2013; Baykasoglu & Dereli, 2009; Ding, Feng, Tan, & Gao, 2010; Kalayci & Gupta, 2013; Kucukkoc & Zhang, 2015; McGovern & Gupta, 2005; Sabuncuoglu, Erel, & Alp, 2009; Simaria & Vilarinho, 2009; Vilarinho & Simaria, 2006; Yagmahan, 2011; Zheng, Li, Li, & Tang, 2013). Ant algorithms use the idea of real ants' shortest path finding capabilities from a food source to their nest. Ants deposit pheromone on the ground while walking and the other ants probabilistically follow the pheromone previously deposited by other ants. A way ants exploit pheromone to find a shortest path between two points is shown in Figure 1. Once ants come across to an obstacle, they

have to decide whether to left or right. Firstly, a pure random choice is made at the decision point since they have no clue about which is the best choice (Dorigo & Gambardella, 1997). It can be expected that, on average, half of the ants decide to turn left and the other half to turn right with a %50 and %50 random choice. Let us assume that two ants choose to move up and down, respectively as demonstrated in Figure 1. The ant which chose the upper (longer) path will not be able to come back by the time the other ant brought the food back to the nest, supposing all ants walk at approximately the same speed. Thus, the pheromone quantity accumulated in the lower path will be two times more than in the upper path. Therefore, the probability of the next choosing for the following ants will be a random choice of approximately %66 for the lower path and %33 for the upper path since the ants can exploit the information of the other ants' pheromones deposited on the ground. More ants will visit the path where pheromone accumulation is faster. As can be seen in Figure 1, the probability of lower path increased to %71 in the next step. Once the pheromone levels of the lower path are sufficiently large, all ants will be using the shorter path.

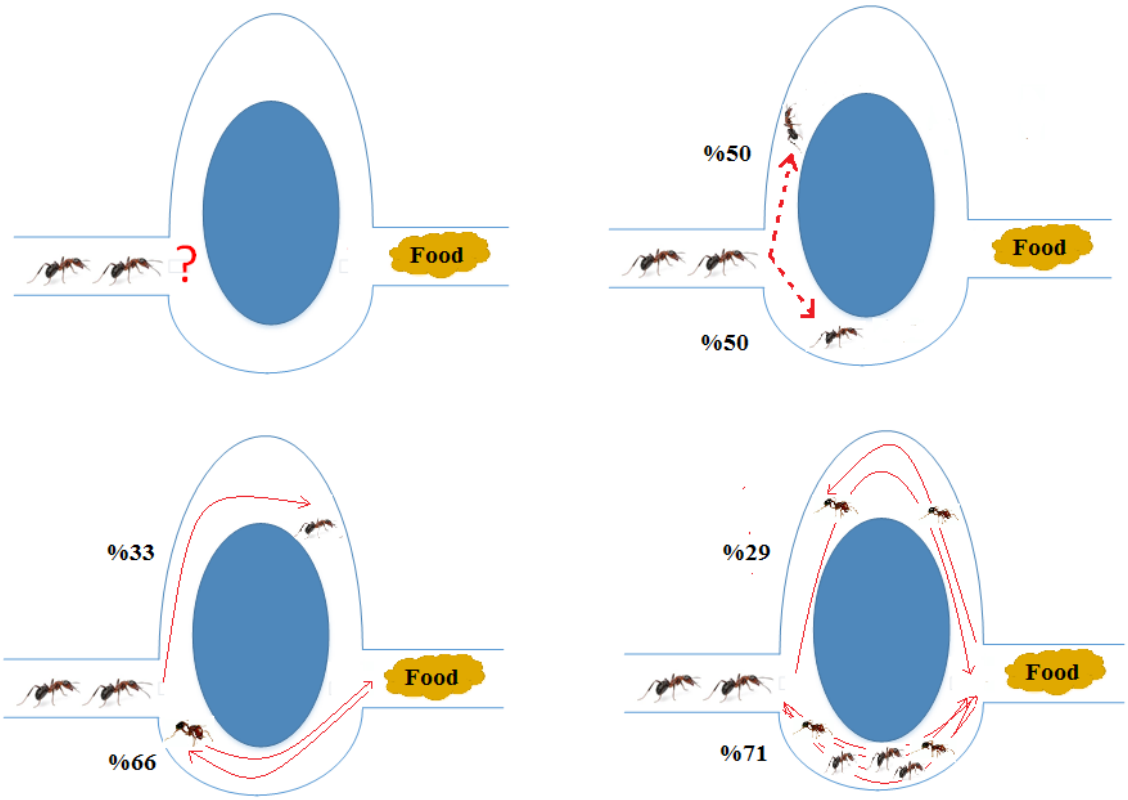

Figure 1: Ants path for finding the shorter path

The way in which artificial ants build an assembly line balancing solution is straightforward: each ant iteratively selects a task for assignment using a probabilistic selection procedure as the real ants do.

EXPERIMENTAL RESULTS AND DISCUSSION

In our experiment, the 30-tasks precedence relationship of bathrobe manufacturing with simulated processing times is used as shown in Figure 2 and Table 1, respectively.

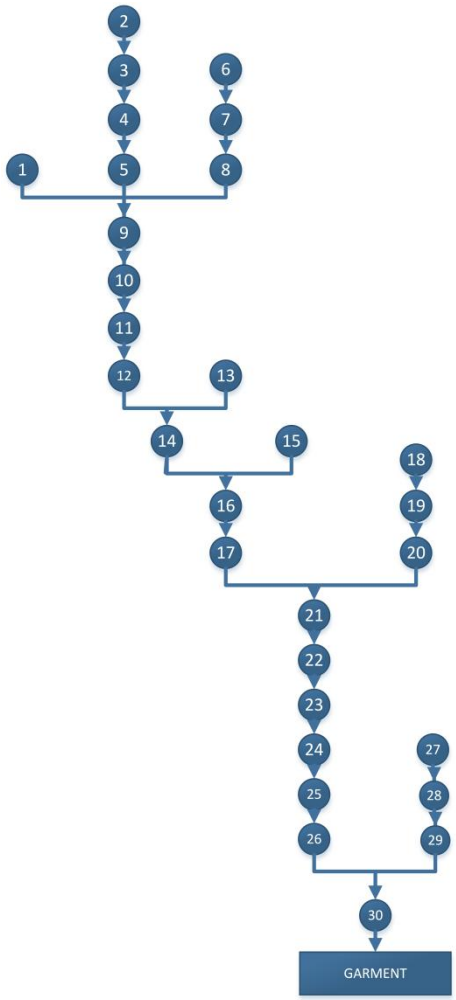

Figure 2: Precedence relationships of the bathrobe manufacturing

Table 1: The 30 tasks required in bathrobe manufacturing

Task No	Task Time in Seconds
1	30
2	18
3	30
4	40
5	15
6	10
7	6
8	6
9	80
10	60
11	40
12	72
13	20
14	30
15	20
16	40
17	50
18	30
19	10
20	80
21	120
22	60
23	45
24	45
25	50
26	60
27	10
28	55
29	10
30	5

The results of our experiment prove that that using the supervisor's experience (See Figure 3) cannot effectively reach a better solution than using the ant colony algorithm (Figure 4). In fact, the ant algorithm can reach the optimal solution within seconds.

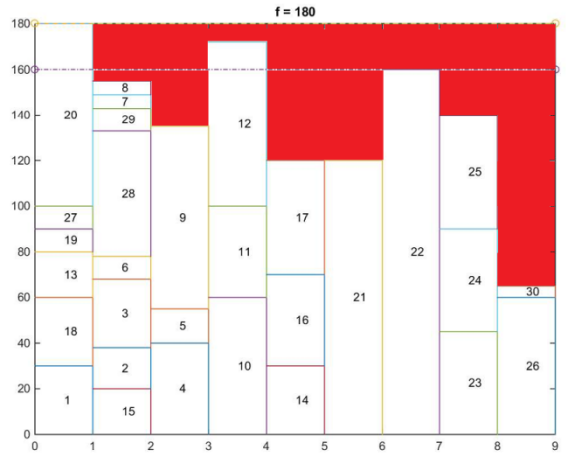

Figure 3: A line balancing solution of the manager

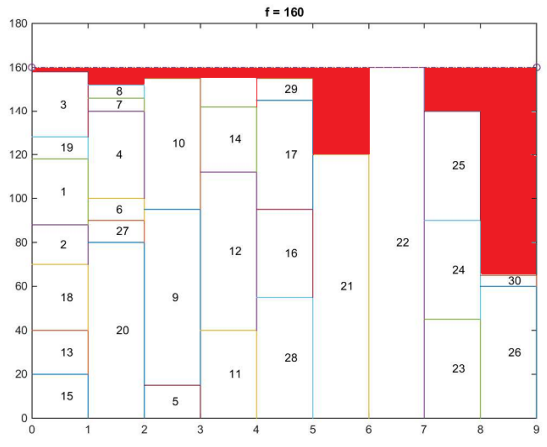

Figure 4: A line balancing solution of the ant algorithm

CONCLUSIONS

In this paper, we applied an ant algorithm to solve the assembly line balancing problem in the garment industry. By using such an algorithm, the problem can be solved in an effective manner to meet the realistic production conditions. The result of our numerical experiment showed that the performance of the algorithm in handling the problem is much better than the manager's decision. We can conclude that ant algorithms are appropriate tools to solve the assembly line balancing problem.

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GEOMETRIC MORPHOMETRICS AND THE DESIGN AND FIT OF PERSONAL PROTECTIVE EQUIPMENT

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The effectiveness of personal protective equipment, such as respirators, helmets, etc., is dependent upon their capacity to accommodate or conform to morphometric variation amongst users. A necessary step to achieving that is the adequate and accurate quantification of that variation (Bailar et al. 2007). In many cases, standard approaches for doing this involve the use of multiple, linear distance measures subjected to a Principal Components Analysis (PCA) to reduce the dimensionality of the data to a tractable number, e.g., two. The resulting scatterplot is then partitioned into blocks and sampling minima for each block established to provide what is believed to be an adequate coverage of the targeted population (Zhuang et al. 2008).

Geometric morphometrics (GM) is an approach to the analysis of shape variation that focuses mostly, though not exclusively, on two- and three-dimensional coordinates of anatomical landmarks (Slice 2005, 2007). Unlike traditional approaches, GM automatically preserves all of the geometric relationships between the landmarks identified for analysis and provides a more comprehensive and powerful analysis of shape (size-free geometry) or form (size+shape) variation. As such, GM offers considerable potential for improving the design and fitting of personal protective equipment.

The landmark coordinates generally used in GM analysis encode both size and shape variation, but also differences due to location and orientation with respect to the coordinate system used to digitize them. As such, most GM analysis proceed through a Generalized Procrustes Analysis (GPA) (Gower 1975; Rohlf and Slice 1990) that positions all landmark configurations at the same location (centered at the origin) and rotates them to minimize the sum of squared distances between individual landmarks and their iteratively computed mean locations. Additionally, coordinate variation due to size differences may be retained to reflect size variation in the subject population or factored out completely or retained in a separate "size variable" for additional analysis. An often under appreciated aspect of, especially involving large data sets, is the checking and cleaning of the data to remove obviously aberrant indicating data collection mistakes or anomalous individuals. Results determined by such data, no matter how compelling, are invalid, though care must be taken not to remove data that is simply inconvenient with respect to predetermined biases.

Figure 1 shows the result of the GPA of cleaned landmark data for facial landmarks collected for the study of the relationship between facial variation and respirator efficacy (Zhuang et al. 2009, 2010). Once the data have been so processed, analysis can proceed using familiar multi-variate methods.

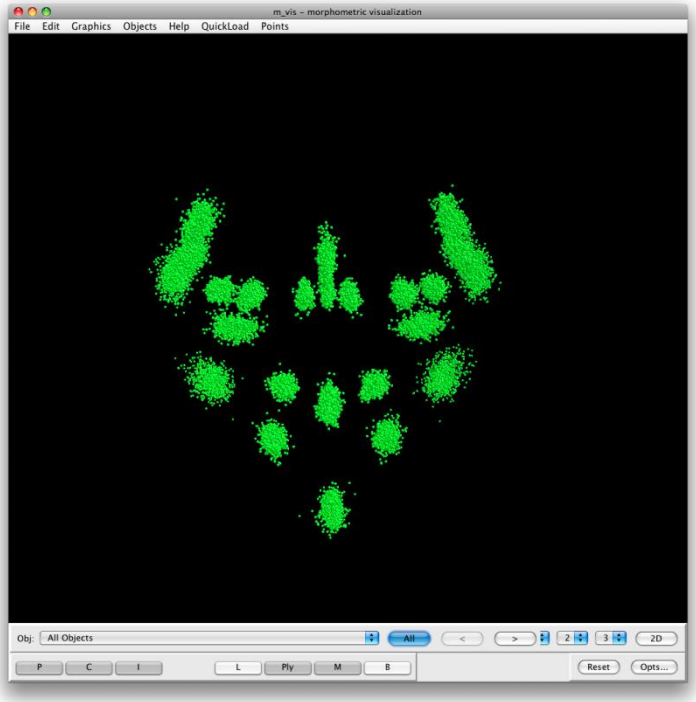

Figure 1: GPA-superimposed facial landmarks for 947 subjects.

A first step in such analyses, especially with the goal of characterizing population variation, is PCA. This provides a representation of the original quantitative data with respect to axes ordered by decreasing portions of variation in the original sample. This is based on correlations within the original data variables (GPA-superimposed landmark coordinates) and allows for the representation of maximal sample variation on a reduced set of composite variables, e.g., PC1, PC2, ... Figure 2 shows the plots of the original landmark data on the first two PC axes for GPA'd data with size retained.

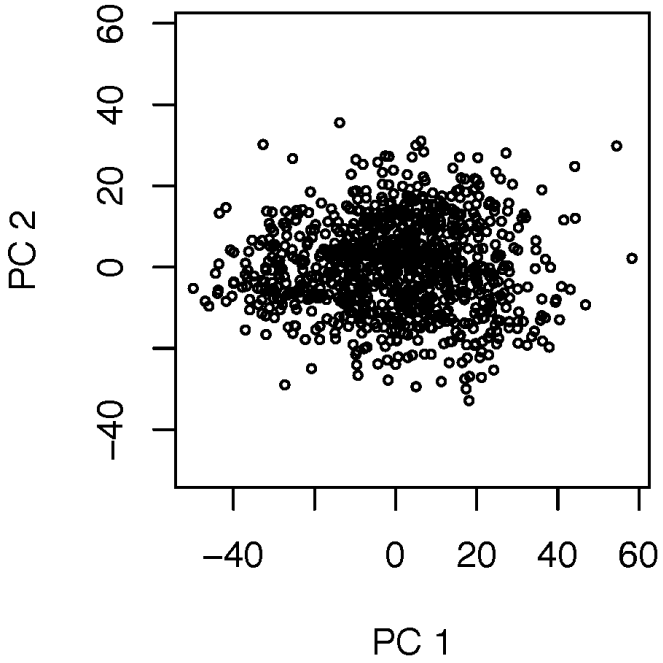

Figure 2: PC1 and PC2 scores for individuals shown in Figure 1.

Because of the GM retention of the complete geometric relationships amongst the original variables (landmark coordinates), one can use the patterns of variation expressed in the PC axes to visualize the morphometric patterns they encode. An example of this is shown in Figure 3, that shows the patterns of relative movement in landmarks encoded in displacements along PC1 and PC2. Positive versus negative directions are arbitrary in PCA, but these figures show deviations in the positive direction as (arbitrarily) determined by algorithms used in their computation. Positive displacement on PC1 is associated with the general expansion of landmarks away from the center of the face – indicative of larger faces (the negative directions is associated with the complimentary results whereby smaller faces would have negative PC1 scores). The same representation for PC2 indicates a medial movement of landmarks toward the center of the face characterizing longer, narrower faces, while the negative direction would be associated rounder faces.

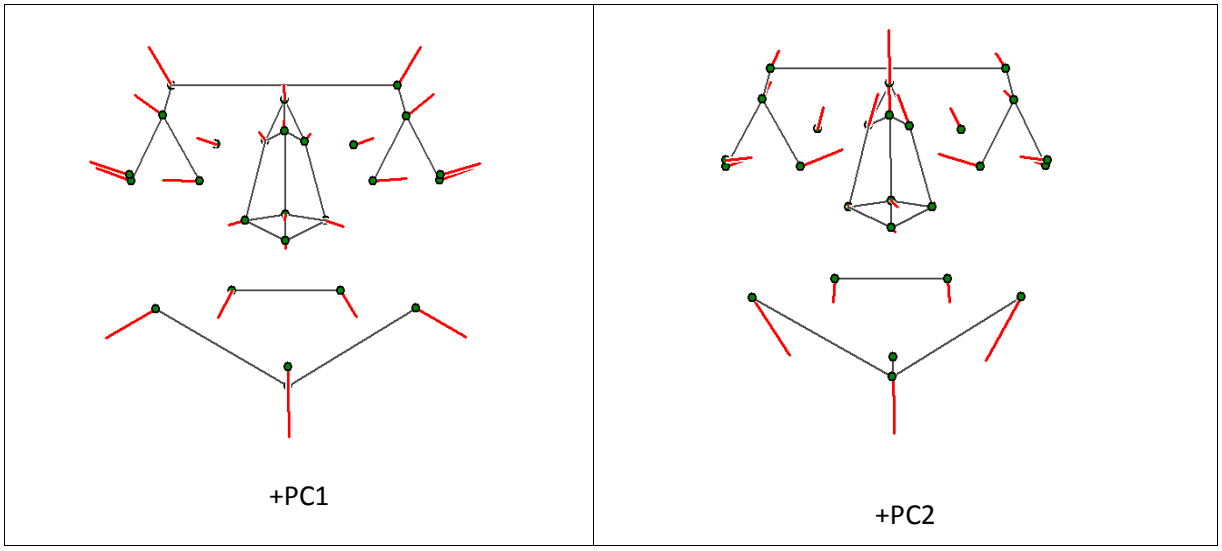

Figure 3: Visualization of facial variation with positive displacement along PC1 (left) and PC2 (right).

The GM approach can also relate morphometric variation to other results that are not directly based on morphometric variables. Figure 4 shows a modified PCA analysis, called a Gabriel biplot (Gabriel 1971), that shows both the project of individuals (circles) and the contributions of the original variables (vectors) to their scores on the PC axes. In this plot, variables were measure of the sealing capacity of various sized prespirators from different manufacturers. For these, the uppercase letter in the label of each vector represents a manufacturer – M=MSA, S=Sellstrom, V=Survivair, W=Willson, and the lowercase letter the indicated size – l=large, m=medium, s=small. Contributions of the masks to PC1 scores indicate a contrast between small (negative PC1 scores) and large (positive PC1 scores) masks. PC2, on the other hand, indicates a pattern of variation in which all masks and sizes perform better (negative PC2 scores) an its compliment where they perform more poorly (positive PC2 scores).

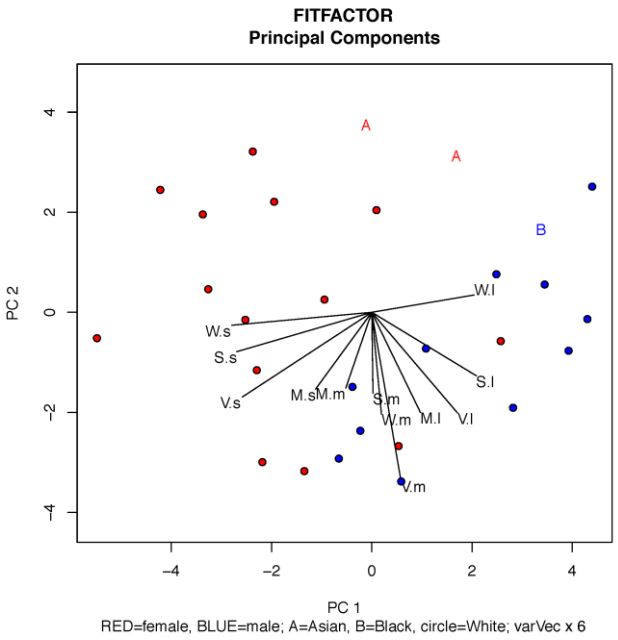

Figure 4: Biplot of individual respirator performance scores for thirty subjects.

GM allows for further analysis of these results by relating morphometric variation in the subjects to the respirator performance that is the basis for the above plot. Regression of GPA's coordinates of the subject's facial landmarks with size retained is illustrated in Figure 5. In lateral view, positive displacement on the PC1 axis is associated with general expansion of facial landmarks from their center, a result consistent with the association of positive scores with better fit for large-sized respirators. A similar representation for PC2 indicates a general front-to-back facial compression suggesting a flatter face being associated with poorer fit regardless of mask manufacturer or size. It is worth noting, then, that in Figure 4, males (blue circles) are associated with more positive PC1 scores and better overall "fittability" (negative PC2 scores). Females, on the other hand, score more on the negative PC1 (small size) axis, and more on the positive (poorer fittability) on PC2. It is suggestive, too, that the two Asians (both females) and one African-American (male), both populations characterized by flatter faces and noses, score as some of the least fittable with respect to the tested respirators – a result suggesting sex- and population-specific designs could be warranted.

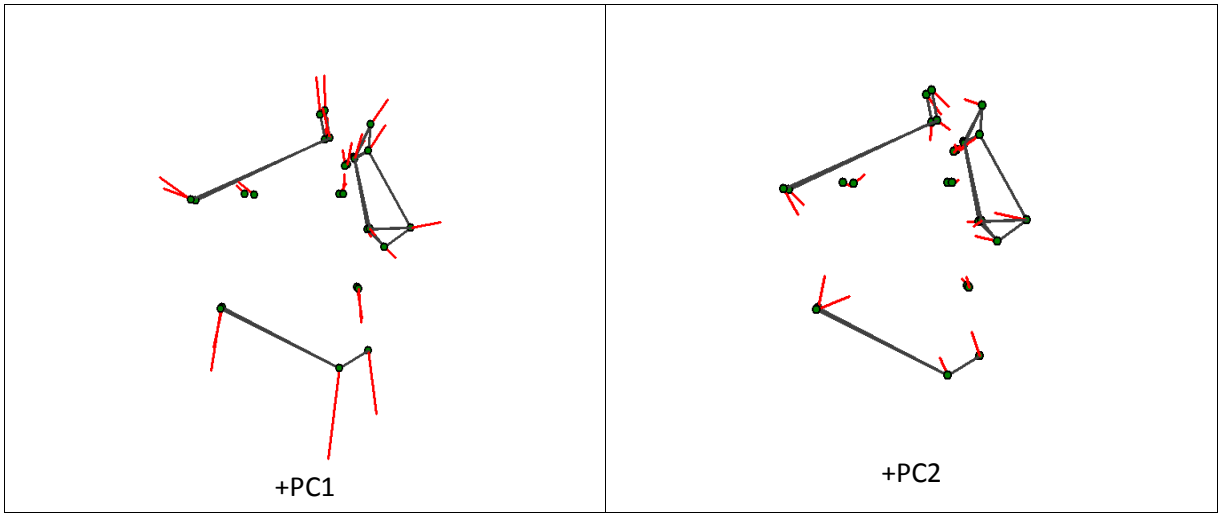

Figure 5: Visualization of regression of facial shape onto principal components 1 (left) and 2 (right) of respirator performance.

The above examples were used to illustrate the potential for GM methods to inform the design and fitting of personal protective equipment. The specific example involved half-face respirators, but the methodology has general applicability. Current research in our lab applies these same methods to assessment of variation in head shape for the purpose of improving protective headgear and assessment of morphological variation relating to footwear. In addition, we are currently working on new methods founded in the GM paradigm to address current limitations and deficiencies, such as the dependence of existing methods on manually placed, pre-determined landmarks. All of this suggests the GM approach to the analysis of design and fit of personal protective equipment promises more powerful, more comprehensive, and easier to use tools for such research.

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ENVIRONMENTAL ISSUES IN THE TEXTILE CHAIN - CERTIFICATIONS FOR RELIABLE QUALITY AND SUSTAINABILITY

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ABSTRACT:

Due to the strengthened green thinking of consumers more and more voluntary ecolabels came up over the past decades and enable producers of food or consumer products, for instance textiles, to certify their products by choosing one of the ecolabels and meet the specified requirements. Sustainability has become a keyword for the success on the textile market, although cost is still the most important point for many consumers.
There are different ways to test and certificate the quality and the sustainability profile of a textile product and the production. This paper compares some of these tools and shows the importance of the OEKO-TEX®- a third party - certificates for reliable quality and for more sustainable production in the textile and clothing sector.
In addition, the preliminary results of a current market survey dealing with the awareness of consumers and manufacturers concerning ecolabelling, will be presented. Challenging the booming ecolabel market this paper investigates whether the Hungarian attitude towards certified textiles is shaped of interest, with the main target to gather information about how to raise the degree of popularity for OEKO-TEX®label.

Key words: certification for textiles and apparels, sustainability, voluntary ecolabel, OEKO-TEX®, market survey for consumers

INTRODUCTION

Problems of the global textile supply chain

The production in the textile industry is characterised by an extremely fragmented processing structure. Companies involved in the textile processing chain starting from raw material to finished textile product are often located in a different place in the world. This is reflected in the complex supply relationships between all companies, and in many problems often due to the relocation of the production to Asia. It is a challenge to fulfil the requirements ofthe sustainable production if the environmental regulations in the individual countries involved in textile production are so different. In the past years Asian textile and clothing companies were often criticized due to their unsocial working conditions, low wages andother social issues [1], not to mention the factory collapse in Bangladesh, where 1137 workers died becauseof the ruinous condition the building showed up[2]. Until now Asia has a lack of regulations like the European REACh. This fact explains why over two thirds of Chinese lakes are already polluted due to chemicals applied by the Asian textile and clothing industry especially in the dying process [3].Above described studies of Greenpeace prove that the environmental disasters due to pollution caused by workers ignorance and absent governmental rules, endanger not just the environment but also the human beings during and after the production process as some of the chemicals stay in the textiles.

These circumstances require more information to consumers and transparency over the whole value added chain to every kind of users. Nowadays customersoften miss knowledge which environmental impacts offered products actually have [4].

Over the past ten years, the development of various ecolabelling schemes has raised the profile of environmental issues within the textile and clothing supply chain. Several national and international ecolabelling schemes are in use worldwide causing increasing confusion on the marketplace. Selected ecolabels (Figure 1) for textiles were discussed in another paper [5].

Figure 1 *Selected ecolabels for textile and clothing*

Facing to the homepage *ecolabelindex.com* there exist 459 ecolables in 197 countries out of 25 industry sectors. Some of them address the toxicity in textiles such as OEKO-TEX® Standard 100 or rate the impacts over the whole value added chain such as STeP byOEKO-TEX®(Sustainable Textile Production) [6].

The transmission in sustainable consciousness and consumption has positively changed over the past decades, although in a very slow process [7]. In case more consumers would ask for labelled products, more companies are forced to get involved with sustainable production to meet the requirements. Many non-governmental organisations like Greenpeace and the LOHAS(Lifestyles of Health and Sustainability) are fighting for a more sustainable and healthier life, even blogs orFacebook groups are callingfor healthier living. Every country has different stages of development, especially referring to sustainable growth. In the Western European countries the consciousness seems to be much more advanced than in Eastern European countries. This researchaims to investigatehow the Hungarian consumers and East European companies are aware of ecolabels, focusing on OEKO-TEX®in detail.

THE OEKO-TEX®STANDARDS AS THE MOST WELL-KNOWN ECOLABEL

OEKO-TEX® Standard 100 – new regulation

The OEKO-TEX®Standard 100 has become the most well-known environmental certification label of textile products worldwide over the past two decades. This standard stipulates comprehensive criteria and strict limit values for testing textiles for harmful substances. The standard provides a science-based unified basis for comparison for the textile and clothing industry, and covers all stages of the textile chain testing the harmful substances in the product. The label "Confidence in Textiles" can be an important tool for the end-users at decision-making when purchasing textile products. OEKO-TEX Association regularly reviews the OEKO-TEX®Standard 100 in order to improve the security of the certified products and to meet the regulations of different countries.New regulations for limit values came definitely into force on 1 April 2015, like the limit value for the sum of nonylphenol (NP), octylphenol (OP), nonylphenol ethoxylates (NP(EO)1-20) and octylphenol ethoxylates (OP(EO)1-20), that has been significantly reduced in all OEKO-TEX®product classes from 250 to 100 mg/kg. With the new regulation OEKO-TEX® Association supports the "Zero Discharge of Hazardous Chemicals (ZDHC)" initiative and the Detox campaign of international brands and retailers that have committed themselves to exclude hazardous chemicals from the production process by 2020.

STeP by OEKO-TEX®

The new certification system of OEKO-TEX®in the area of sustainable textile production, which replaces the former OEKO-TEX®Standard 1000 is the STeP. This certification is meant for brands, trading companies and producers within the textile supply chain to communicate achievements in sustainable textile production to the general public in a transparent, authentic and clear form. The certificate is accessible in any production stage starting from the spinning factory, through weaving,

knitting and finishing to end product producers and textile logistic centres. The main goal of the STeP certificate is to guarantee environment friendly production processes, optimal health and safety conditions and socially acceptable working conditions. The STeP certified companies are enable to further improve their environmental performance, social responsibility and efficiency. These help them to compete best in the market. Altough the STeP by OEKO-TEX®certification has been launched in July 2013, the overall number of inquiries has dramatically increased which illustrates the desire companies in the textile supply chain have for improving their sustainable practices specifically focused on the environmental, chemical and social fronts.

Made in Green by OEKO-TEX®

The newest addition to the OEKO-TEX®product portfolio is Made in Green - a traceable product label which allows for communication throughout the supply chain all the way to the end-user. The label ensures that made in Green textiles are not only tested for harmful substances but also sustainably produced in accordance with OEKO-TEX®guidelines. The label can be awarded to any kind of textile product anywhere in the world at any stage of the textile supply chain, so brands, manufacturers and retailers have the chance to promote their responsible practices to their customers in a clear way on point-of-sale material.

As proof that products with the Made in Green label are harmless to health, they must successfully pass a laboratory test based on the OEKO-TEX® Standard 100. Proof that the conditions in the participating production facilities are environmentally friendly and socially responsible is provided through an extensive assessment and a subsequent company audit in line with certification according to STeP by OEKO-TEX®.

For textile products that consumers buy at retail, the OEKO-TEX® guidelines for obtaining the Made in Green label are as follows:

- Any single component that equals or exceeds 5% of the total weight of the textile product must be supplied by STeP by OEKO-TEX®certified production facilities. At least 85% of the weight of a single piece of textile must be supplied by STeP by OEKO-TEX®certified production facilities.
- The general rule for the above mentioned criteria is that all the making up and wet / chemical processing facilities have to be STeP by OEKO-TEX®certified.
- The product must be OEKO-TEX®Standard 100 certified.

For intermediate products sold within the supply chain, the label issuer must be STeP by OEKO-TEX®certified and fulfil all of the above mentioned criteria.

RESEARCH ON THE CONSUMER'S AND COMPANIE`S ATTITUDE TOWARDS SUSTAINABILITY IN TEXTILES

Tools and method

For investigating the awareness of consumerand textile companies, primary data were collected on the basis of questionnaires and interviews. Two type of questionnaires were prepared for consumers and companies. For market research on ecolabels some observations were carried out in domestic supermarkets and stores.In additionally also interviews were made with selected Hungarian and Slovenian textile companies and Hungarian bloggers. The topic is worth to study as there is a general lack of research on East European countries taking into account the sustainability in textiles. The aim is to draw strategic arrangements out of the research to increase the level of awareness and familiarity of this certificates in Hungary and additionally in other Eastern European countries.
The survey for consumers was send out mainly via e-mail in Hungary to friends and colleagueswith the request to spread it out to more people. Besides the email collector the link was posted on social networks and send out to some universities to reach more young people aiming to have a good mix of answers concerning the age, gender and lifestyle for a reliable result representing the Hungarian main

unit.The spread of the survey happened randomly and some of the respondents for sure are in contact with persons that are in touch with OEKO-TEX®.Due to the online survey made in Hungary the response levels wererelative high, but there was only little control over the types of people that respond so it was difficult to achieve a representative sample, which is a non-probability convenience sample. The company survey was sent by e-mail to several customers of INNOVATEXT and other Hungarian textile and clothing companies.

Thisexplorative consumer survey contains 36 questions beginning with some questions about age, gender and location.Furthermore in the second part the knowledge of ecolabels is tested with the aid of figures and selective questions concerning the purchase behaviour. In addition the third part asks the respondents for their estimations concerning OEKO-TEX®and to prioritise given possibilities of marketing tools to let us know where to start a better advertising of the label. Moreover the questionnaire has the use to call attention to OEKO-TEX® and teach the respondents of benefits this label provides for consumers.

Due to the fact that this research project is ongoing, only preliminary results can be presented here. The extract is limited to the survey for Hungarian consumers, in the context of ecolabelling to figure out if the consumers are interested in sustainable textiles and in OEKO-TEX® Standard 100 certified products as the hypothesis implied that Hungarian consumers are not well informed and so not interested in sustainable and tested textiles.

The dissemination of the questionnaire for textile companies are not closed yet. This survey is available at the following link:
https://de.surveymonkey.com/s/L2KS3BL

RESULTS AND DISCUSSION

Consumer survey

To the analysis of the consumer's awareness 208 of the received 274 answers were investigated. The research results represent 27% male and 73% female respondents, where57 % are over 50 , 28 % are between 36- 50 and 15% are from age 26-35.

On the question „What extent do you think you are informed about bio/organic products?", the older generation, most of them graduates (82,55%) that are 50 years and older, definitely felt more informed than the youngers, where the youngest group from 18-25 felt not informed.90 % of the respondents have seen or heard of allergies caused by harmful substances in textiles.

Figure 2 shows the results for the question:„On what do you pay attention by purchasing textiles for 1. babies, 2. underwear and 3. household?"More answers were possible to this question. Quality and price are always important for all three categories, but also 100% nature fibres plays an important role by purchasing baby items and underwear.

As expected certifications on the products are more important by purchasing baby items(25,39%), but less important for underwear(18,75%) or home textiles (10,55%).

	minőség	ár	divat	tanúsított termékek	100% természetes alapanyagok	márka	nem tudom	Befragte gesamt
bébi termékek	60,55% 155	26,56% 68	4,69% 12	25,39% 65	66,80% 171	4,69% 12	13,67% 35	256
fehérnemű	65,23% 167	41,02% 105	11,33% 29	18,75% 48	58,59% 150	16,41% 42	1,17% 3	256
lakástextil	68,75% 176	59,38% 152	19,92% 51	10,55% 27	16,80% 43	4,69% 12	6,25% 16	256

Figure 2: *On what do you pay attention by purchasing textiles?*

Comparing the awareness level of the "OEKO-TEX®" label (Figure 3) and "GOTS" (Figure 4)it turned out that OEKO-TEX® is well known by 34,21%, but43,23% of the respondents have not heard of it before. The GOTS label was unknown for 61,11% and only 14,81% chose the right answer of explanation for the label.

Antwortmöglichkeiten	Beantwortungen	
nem	43,23%	115
nem tudom	9,77%	26
igen, de nem tudom, mit jelent	8,65%	23
igen, ez azt garantálja, hogy a textília káros anyagokra vizsgált	34,21%	91
igen, ez egy szervezet, ami a fenntartható termeléssel és a munkakörülményekkel foglalkozik	4,14%	11
Gesamt		266

Figure 3*: Awareness level of OEKO-TEX®*

Antwortmöglichkeiten	Beantwortungen	
nem	61,11%	165
nem tudom	10,00%	27
igen, de nem tudom, mit jelent	11,85%	32
igen, ez egy természetvédelmi szervezet	2,22%	6
igen, ez természetes és fenntartható termelést garantál	14,81%	40
Gesamt		270

Figure 4: *Awareness level of GOTS*

Figure 5 provides pictures of other ecolabels and the results show that the "C&A, we love bio cotton" label was the best known, which is not a surprise, because C&A is well known in Hungary and respondents might only decide because of the C&A sign. TÜV and "der grüne Punkt" or "BIO" are well known too because consumers see it on food packages and technical items. As expected ecolabels for textiles such as "fairwear" or "IVN" are not well known.

Figure 5: *Awareness level of further ecolabels*

Starting marketing activities is connected to many considerations such as the right media for campaigns or communication ways to consumers. Therefore according to Figure 6 we asked the respondents to prioritise several media that are from their view useful for reaching as much consumers as possible. Television, internet, in the shops and on the package of the products were the most favoured ways to communicate and inform about OEKO-TEX®.

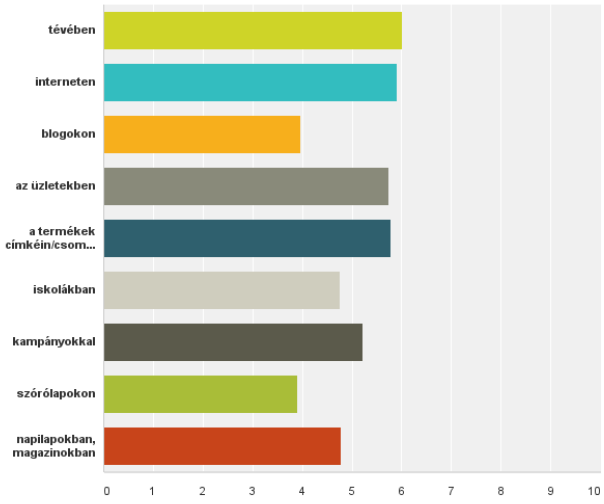

Figure 6*: Where do you think you could be more informed about the benefits OEKO-TEX® provides for you? (TV, internet, blogs, shops, packaging, schools, campaigns, leaflets, newspaper)*

The last question, if the consumers will take more care of OEKO-TEX® and certified products in future was answered with 80% "yes". Thus only 5 % declared that they will not be open minded to OEKO-TEX® in future and the remaining 15% were unsure about that.

DISCUSSION

The results described above enable to establish a relation between the age and the level of ecolabel awareness. On the one hand it is clear to see that the older graduated persons usually got more money to spend on textiles than the youngers and take care not only of the prices. On the other hand our most importanttarget group are young mothers as baby skin is very sensitive and harmful substances are dangerous especially for babies. Furthermore it turned out, that Hungarian women are more sensitive concerning the topic of sustainable textiles as more than 70% of respondents were female. Although more than 90% have seen or heard of allergies caused by harmful substances in textiles not everybody is interested to prevent from this by trusting in ecolabels.The current study provides clear evidence that price, quality and 100% natural fibres(which does not guarantee a healthier product), are still more important in Hungary than tested and certified products, even by purchasing baby items.
Nearly 35% are already aware of OEKO-TEX® which is a properaverageand a good start to become more sustainable. Additionally this result is not completely reliable, because a group of respondents were people in contact with the Hungarian OEKO-TEX®certification body. Other wellrecognized green labels are among the respondents those for recycling of packaging (63-69 %) and which are connected with brands (C&A) or well-known certifying institute (TÜV). Fair trade was known only for 23 %.

SUMMARY

Within textile production there has been a high movement towards saving natural resources, reducingwater and energy consumption, to reuse and recycling. As part of the sustainability there is a high demand for transparency within production and supply chain, and it is also important to know what can be done withthe product after it has reached the end of its useful life. There are different ways to test and certificate the quality and the sustainability profile of a textile product and the production. The OEKO-TEX® - a third party - certificates give guarantee for reliable quality and for more sustainable production in the textile and clothing sector. The STeP, connected with the Made in Green by OEKO-TEX®label is the newest certifications for brands, retailers and manufacturers who wish to be completely transparent in publicising their success in creating sustainable production conditions.

The preliminary results of the consumer survey showed up that the Hungarians are not well informed about voluntary ecolabels. For approaching this challenge more information must be provided to consumers in shape of whatever attracts their attention. Internet, and television but also information on the product or in the shop are the best places to transfer background information of this labels and winning more attention of consumers. Generating a Hungarian OEKO-TEX® facebook page or a blog could be a promising start without the input of high financial resources. Providing posters in the supermarkets or stores where certified products are sold is not a big effort as well.
According to the result more respondents will pay attention on OEKO-TEX® in future which is a good average which refutes the disinterest in sustainable textiles of Hungarian consumers.
Due to the fact that this research project is ongoing, results for companies were not presented here.

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DEVELOPMENT OF GARMENT SUPPLY CHAIN MODEL FOR PRONTO MODA COMPANY

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ABSTRACT

The EU has marked the year 2015 as the 'Year for Development'. The 'flagship initiative' is focusing on responsible management within the garment supply chain. Key stakeholders and institutional actors brainstorm these days in order to find ways to collaborate. Their initiatives are based on facts that many EU countries have developed collaborative efforts to improve the impact of the fashion industry on the environment, economy, and society. Responsible management of the garment supply chain became a hot topic and a fundamental chapter in the contemporary style management. The quality of the product depends on the efforts and the job quality of the chain actors and understanding of the life cycle of fashion garment. Solving of it as a product that will take its place in a rapidly changing market environment – and not as a taboo – helps this complex process. If the chain features in a fast changing behavior Pronto Moda company, it is moreover complicated to organize the workflow.This paper is based on a case study and performance realized in a Pronto Moda company.

Key words: Pronto Moda, Fast Fashion, garment supply chain

INTRODUCTION

We are amazed at the incredible degree of industrial and technical developments of our age.Technology and the communications revolution have resulted in the speed of news and exchange of scientific information, globalization has accelerated thetransfer of goods, and along with all these our daily routine and lifestyle has changed. We want everything quickly. Thus, theword*fast* became a prefix common used in terms such as 'fast food', 'fast train' and 'fast fashion' and simillar.

Not so long ago there were only two seasons in the fashion market: autumn/winter and spring/summer. Everybody were satisfied!However, as the world grows increasingly impatient, waitingsix months to see what we'll be wearing next, became inconceivable! To solve the problem, as first inter-seasonal collections have started to gather at the early 2000's. After the first pre-fall/pre-summer, 'resort' or 'cruise' collections were introduced, the concept of two regular seasonal collections followed by growing number of "custom made capsules" made in short production cycles became popular.The emerging hunger of the consumers to choose from the new arrivalsforced designers to launch fresh collections not just over more frequently, but as quickly as possible.

Journalist of *The Sunday Times*(London), *Shane Watson*has postedfor first about the changes within the fashion world year 2006.*" It's not designers who dictate fashion today – it's the triple-F crowd."* (Watson, 2006)*Something "went wrong"…* – she wrote, but noone could forecast, that it is just the start ofa long lasting phenomenon, which will change the fashion scene in 360 degrees and has changed our professional routine, day-to-day questioning our skill quality and credibility at all.

Fast fashion chains have grown quicker than the fashion industrywas able to stand it.The capacity of the market,today is at thelevel able to serve "traditional competitors". Consequently:*the world is still not ready for to apply this principle that worldwide causes chronicle symptoms.*

PRONTO MODA[1]: FACTS, ATTRIBUTES, AND MECHANISM

In the 20century,trendy articles became accessible to most of the people, and with the *Fast Fashion*stylish items became affordable practically to anyone. First European Fast Fashion companies were born in Italywhich strong textile industry was the first to suffer from the downturn caused by the

[1]The English equivalent of the same expression is *Fast Fashion*.

Asian manufacturers. The concept has been developedin Europe by the huge retail houses[2]. The aim was to serve markets for teenage and young adult women who desire trendy, short-cycle and relatively inexpensive clothing. (Anna Nagurney, 2012)With the spread of it as a trend,due cheapness, products similar to the popular brands become available for the lower social classes too, but theyspeed up among the upper classes as well.

Therm*Pronto Moda* is a popular Italian phrase used for the description of cheap fashionable clothing. *It isa kind of 'Mc Donalds' service within the fashion industry.* Its features are immediacy, often changing product range manufactured by the short production process, global, whimsical customer base lacking brand loyalty.Companies are forced to adapt latest catwalk trends into immediately available, inexpensive mass-produced products *"manufacturedover a night",*offering the latest catwalk trends to the mainstream customers as soon as possible.The primary objective of the model is to produce always new products quickly. The goal is not to make them long-lasting, but rather cheap, because offering a quality is in opposite with the global concept in general.
Features of Fast Fashion are:

- short production time
- fast delivery
- intense competition in the market
- great market demand

} =FAST TURNOVER

Social and environmental aspects

Conscious fashion is based on consumption of products with lasting quality, against week quality garments with the shortened life cycle.Price, as a factor closely related with the quality, and it is what may have the hugest impact on design. If the costs of the production are low, the price is expected to be acceptable. (For this reason, their quality is also much weaker.) The price of the Fast Fashion products is more popular than the regular 'seasonal competitors'.

The business model of the giant Pronto Moda brands is based on unremitting 'desire for consumption' that is instinctively activated when the garment wears awayafter the first wash. (Gwilt, 2014.)An average fashion consumer from any welfare society consumes 50 -70 kg of clothes per year. It's clear that we are *overdressed* while huge amounts of garments – fashionable just a season or a two ago– are thrown out, creating not only social, but environmental problems too. The philosophy of Fast Fashion is not compatible with the principles of sustainable development. Many clothing is synthetic and is madefrom petroleum-based fibers, which mass production generates large amounts of non-recyclable waste resulting in a resulting huge environmental pollution. Indirectly the efficiency of the product flow management within the supply chain is correlate to environmental aspects (i.e. inefficient flow management = waste of energy, environmental pollution).

Structural, cultural and marketing aspects

The world of fashion by its structureis divided into two huge classic categories: *Haute Couture* and *Prêt-à-Porter*. Haute Couture is the world iconic fashion houses that serve mainly upper-class and have prestigious social and economic value. It is an art of cloth making while the artistic viewpoint is more important than its practical approach. Prêt-à-Porter is RTW collection of the same house and recognized fashion designers). However, there are few other categories such as Semi Couture

[2]Benetton, H&M, Zara, Peacocks and Topshop where the companies, which have invented it. It particularly came to the fore during the vogue for *"boho chic"* in the mid-2000s. The first words about the new tendency were published year 2006 (Sept 17, The Times London, "The Way We Dress Now"))(Watson, 2006)

(transportation of luxurious and unique design and technology into RTW collection, limited production facilities, and high price). There are High End brands (products intended for demanding customers, which can be produced in series), world of fashion brands (streetwear, denim, sportswear, casual, outdoor, etc.) and Fast Fashion (i.e. Pronto Moda) companies.

Decession in choosing the category (referred to above) in case of Pronto Moda companies is quite instabile. The scale of getting inspiration vary from the Haute Couture stimuluses trough the latest red carpet trends towardsthe street fashion.In themelt in apot of inspirations often fabulous ideas are born, but the technologyto realise them varyes from couture craft to the most basic maniers. It is often caused by the non existing of clear lack a clear standpoint, target audience, image,and market position.

Relation of price, design, manufacturingconditions and quality

At the background of the appearance of the phenomenon is strengthening of the Asian market, with plenty of small manufacturers and large retailers, whose cheap products have invaded to the Western markets, during the early 2000s. By this important factor is the country of origin, i.e.: *where the product is manufactured?*

Most common problems are: 1.) increased production rate, stretched pace, big stress, uncertainty. 2.) Increased quantitative expectations on the design, lack of concept, frequently present "ctrlcopy paste" effect, disabled honorability. 3.) Faults of pattern, sizing and grading errors, frequently lacking etalon sample due to the enlarged sampling tempo, lack of manufacturing package, deficiency of quality control. 4.) Chronically manufacturing mistakes, quality difficulties, increased production cost, conflict, competition, quality remonstrance. 5.) Aggressive competition in the market, unethical corporate behavior. 6.) Sustainability issues.

Factor of time

Time is a critical component in the case of labor-intensive products such as clothing. Fast Fashion retailers have revolutionized the fashion market by their strategy, in which traders reply to changes in the market within just a few weeks (see Figure 2: Model B:) in opposition to the classical scheme, which covers average six months. (See Figure 1: Model A) Since the aim is to obtain fabrics, to manufacture samples, and to start shipping products with far shorter lead times than in the traditional production calendar is usual (Doeringer and Crean, 2006). Therefore, a fresh capsule collection – based on the latest trends – is created weekly. Adding more and more ‘fashion weeks’ seems to be exciting for the fashion consumers, but it has resulted in52 ‘micro seasons’ per year!

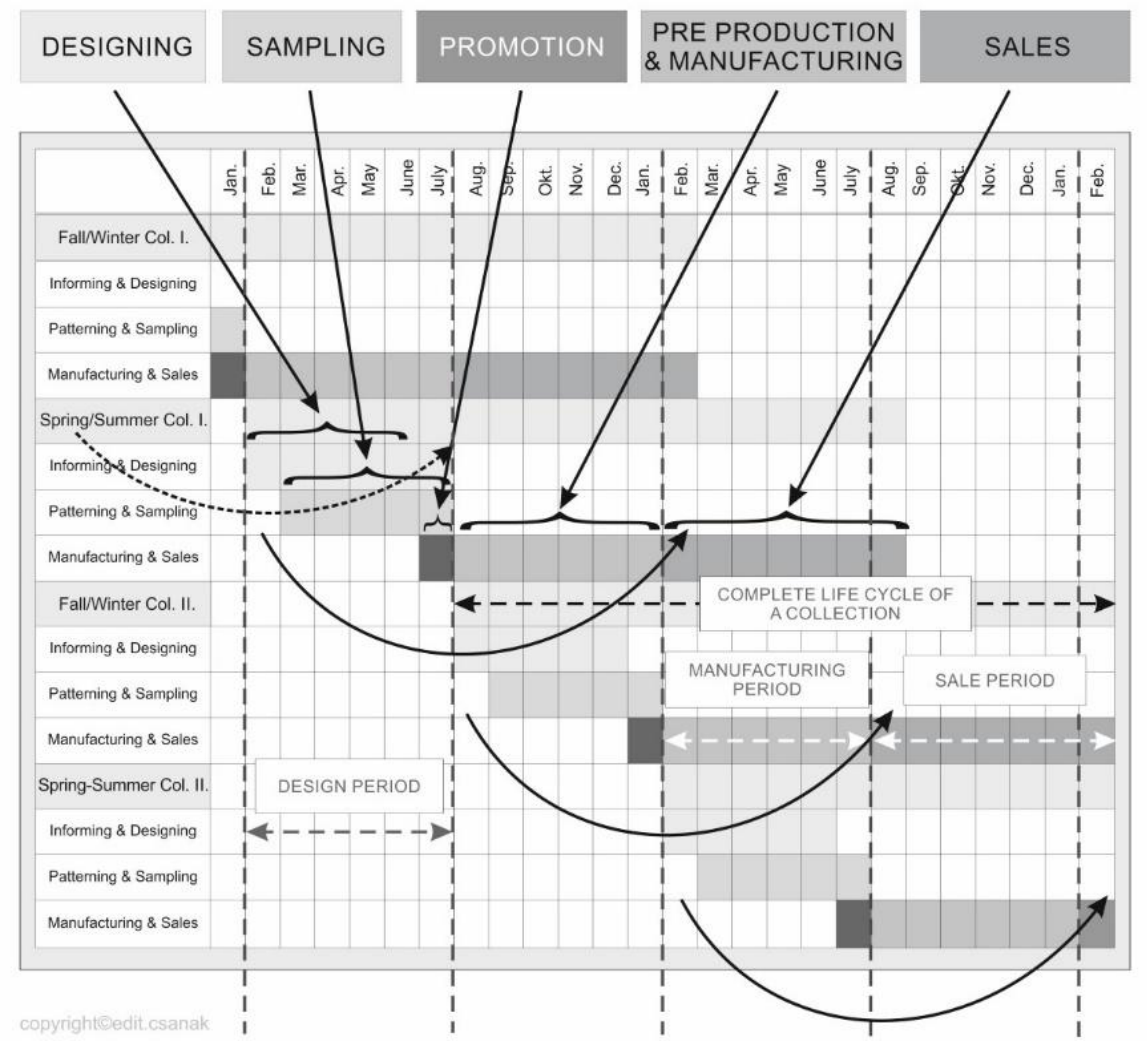


Figure 1. Model A: Schedule of 'traditional' seasonal collection development (4 seasons)

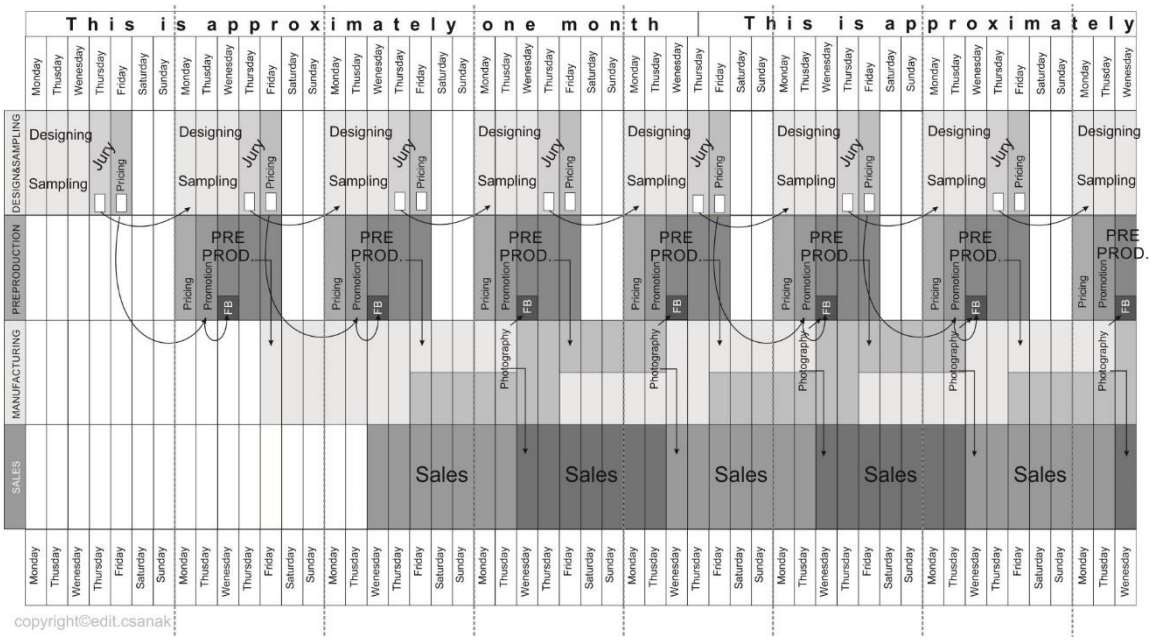


Figure 2: Model B: "Pronto Moda" – Schedule of management within Fast Fashion environment

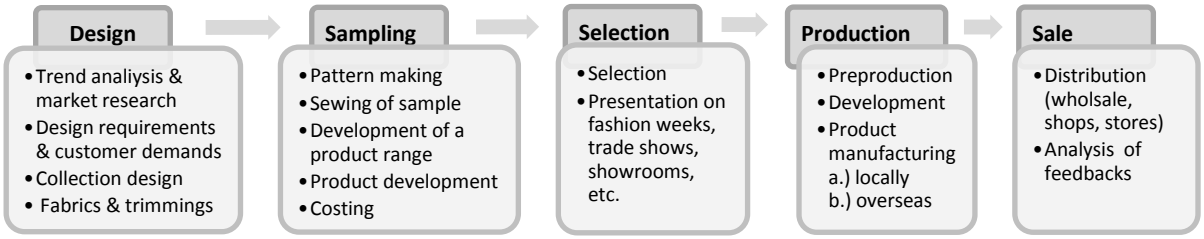
The quick tempo requires non-stop market research and strategy development, continual designing and preproduction and perpetual manufacturing. If we compare Model A with Model B, we can consider that complete cycle of garment development (from the first sketches to the last piece on sale) within a traditional seasonal collection is much more comfortable than in a Pronto Moda collection. There it isshortened to 3,5-4 weeks.
Even the product range is smaller shortened time remaining for satisfying development and manufacturing of certain product cannot be shorter than it is appropriate. Even the quantity is in most of the case a fragmental part of a regular batch.

MODEL OF THE GARMENT SUPPLY CHAIN

Garments are developed in a chain of shareholders, which work is equally important and built one onto another. The quality of the improvement made in theearly phase of the garments life cycle – its design period and production – is of key importance. Every item of each collection born in any structure of fashion industry (see details in subchapter 2.2) has to follow the model below.

Supply chain models put the greatest emphasis on the predesigning period (analysis, research, idea finding), underlining, that *agile supply chains* are more likely to be information-based. (Boutler, 2011) In an age, in which customer preferences are born overnight, and product lifecycles can be measured in weeks, the real value is to not miss the latest trend. (Donald N. Sull, 2008)

Figure 3: Key model of the garment supply chain management



METHODS

The irony of life is that one of the companies who have invented this principle, Zara – leaderof the fashion industry–, offers to held lessons for any company that faces with rapidly changing markets. (Donald N. Sull, 2008)Methods were worked out during a months lasting project; the goal was to develop and to improve themodel that allows optimal workfow inside the chain in a multiproduct fast fashion behavioured company. It was important to improve conditions of manufacturing, storage, and distribution for all the time-sensitive fashion products, and to identify methods of reaching the minimal total operational cost and best total time consumption during their production.

There are extensive references and multiply methods that offer anexpert solution for astep up the work effectiveness of the chain. Some of them highlight the importance ofdelivery time performance which must be weighed against the associated costs, and which depends on the available capacity and the operating efficiency of the system. (Anna Nagurney, 2012) Time performance within the chain is associated with planning, purchasing, manufacturing, and delivery issues that are consistently rated as important factors in supply chain management. (Bidgoli, 2010)

FINDINGS: CUSTOMIZATION

Multiply models provide different solutions for companies, to minimalize operational cost and total time consumption of producing time-sensitive fashion products. These models usually offer general standards to decision-makers.These templatesare based on an ideal case and optimal chain constitution. Even it is necessary. Usually,it does not exist. Even the chain actors – employedin a

company– are well educated professionals, errors are usually caused and born from with banal dismisses.

Holdingpresentations and to employees, their educating and studying of work task of each worker, and their place in the work management can help in maintaining the good workflow organization within the chain. It is necessary to specifyin details responsibilities each employee. Often theproblem is, that employees have a goodunderstanding of the global work process, but they do not know exactly the borders of their duties, and cannot understand some details of the workflow. If operations are explained in general, andemployees are not informed well who is responsible for finishing of certain operation and how it has to be managed it can cause errors and quality problems.It is necessary to explain each step of the work process, furthermore to give detailed description to all participants, what they have to do in certain situation. Good understanding of the product development process is a necessary. Even the development process of the garments is fast, each sample can be finished well, and all the operations have to be finished properly.If fashion supply chain management is not studied just through cost and time minimization, but from a network perspective of employees and their custom relations and responsibilities.

CONCLUSIONS

Fashion Supply Chain Management (FSCM) is a hot topic in the modern fashion theory and business too. Maintaining the clear relations between the chain actors became important, altogether with precise describing of their roles. Organizing for a design-, sampling- and (pre) production process and the complete workflow became fundamental tasks in managing of a competitive company. It is over more complex if thesehave to be made in Fast Fashion (i.e. Pronto Moda) environment.

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BODY MASS INDEX RELATED TO CHANGES IN FOOT SHAPE UNDER SPECIAL CONSIDERATION OF GEOMETRIC MORPHOMETRICS

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ABSTRACT

Overweight and obesity are becoming a global epidemic health problem, affecting children as well as adults. Extra weight and obesity influence some of the foot measurements and induces foot disorders that arise when the main foot arches collapse. Footprints are widely used as a method to classify foot types and foot pathologies in order to design foot orthotics, insoles and shoe inserts. In the study geometric morphometrics methods were used to visualize changes in foot shape affected by body mass index.

Key words: 3D foot scanner, footwear, insole, footprint shape, obesity.

INTRODUCTION

Being overweight and obesity are increasing health problems in many parts of the world. Body Mass Index (BMI) is a method used by medical professionals to determine levels of body fat. It is known as the main anthropometric index able to reveal nutritional status of an individual and was created between 1830 and 1850 by the Belgian polymath Adolphe Quetelet (Garabed, 2008, Ujević, 2010). BMI is calculated as the body weight in kilograms divided by the square of the height in metres (Pinheiro and Giugliani, 2006) or (W/H^2) after Keys et al. (1972). Besides the genetic predisposition, the environment factor plays a significant role in the increase of obesity. The World Health Organisation defines obesity as having BMI greater than 30, while an individual's BMI above 25 is considered as overweight. A person with values between 18,5 and 24,9 is normal, while BMI under 18,5 is considered as underweight (WHO, 2007, Mladovsky et al. 2009).

THEORY

Abundant studies have been made to study the plantar pressure distributions between obese and non-obese children, adults and elderly people during standing and walking confirming a strong correlation between BMI and plantar pressure (Hennig et al., 1994, Dowling et al., 2001, Hills et al., 2001, Yuk San Tsung et al., 2003, Birtane and Tuna, 2004, Filippin et al., 2007, Oladipo et al., 2009, Arnold et al., 2010, Aurichio et al., 2011, Manegoni et al., 2011). In another study, Butterworth et al. (2012) reported about the strong association between BMI and specific musculoskeletal foot disorders (hallux valgus, flat feet, tendonitis, osteoarthritis). Based on the results of those studies, it can be summarized that extra weight and obesity influence some of the foot measurements and a decrease of the foot arches, but there is still a lack of information about the influence of BMI on the form and shape of the foot. In the present study modern geometric morphometrics methods and techniques were applied to visualize the effect of body mass index on footprint form (Domjanic, 2013, Domjanic et al., 2014, Domjanic, et al., 2015).

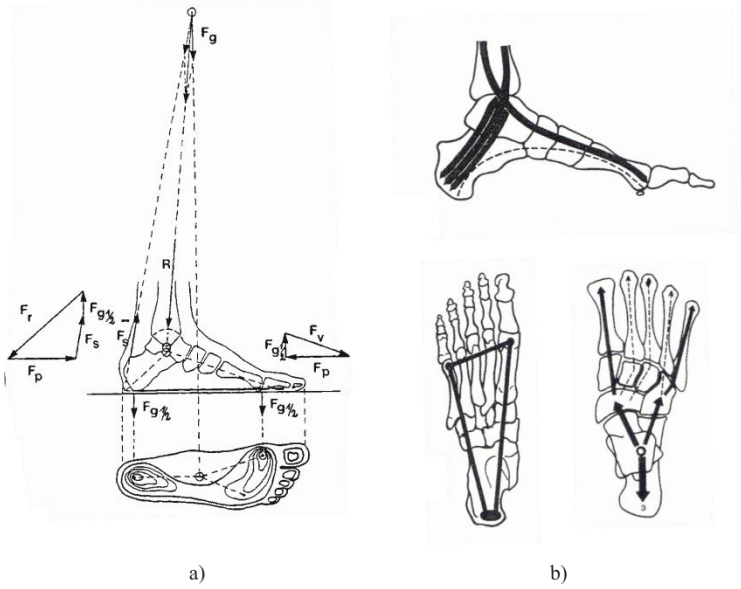

Figure 1: The correlation of Body Mass Index and foot morphology:
a) pressure transmission across entire support foot surface:
b) with stress force distribution (from Cartmill et al., 2001, Keros and Pećina, 2006).

Figure 1a shows the pressure transmission of a healthy foot. By an upright body position body weight is carried downward through the tibia alone and passes on to the talus. The talus transfers the body weight to the calcaneus that lies underneath. Most of the weight is taken from the calcaneus, which transmits it downward to the heel in the back and to the first and fifth metatarsal bones in the front forming three important points of support, Figure 1b (Cartmill et al., 2001, Cavanagh et al., 1987).

METHODS

Morphometrics, by definition, comes from the Greek: "μορφή", meaning "shape", and "μετρώ" meaning "measurement". The morphometric methodology refers to methods of the description of shapes and shape variation of geometric objects and the comparison of shape differences among samples applying statistical procedures (Loy, 2007, Domjanić, 2013).

The data for analysis, consisting of 83 female individuals were collected via the optical 3D foot scanner Pedus (Vitronic and Human Solutions GmbH, Germany), located in the Laboratory for taking anthropometric body measurements and garment construction in the Department of Clothing Technology at the Faculty of Textile Technology, University of Zagreb.

A total of four scans were made for each person, two of the left foot and two of the right foot. Additionally, body weight in kilograms and body height in metres, were recorded for each person.

In order to perform a detailed 2D footprint shape analysis the scanned foot surfaces were rendered and the footprints were extracted by cutting off the lowest (plantar-most) 2mm using the Amira software (Imersion Inc.). Due to the curvatures of the footprint shape, the foot outline was digitized by 7 anatomical landmarks and 76 semilandmarks. Semilandmarks were used to precisely define the anatomical region of the forefoot, the midfoot and the hindfoot.

The sliding landmark algorithm was used (Bookstein, 1997) to estimate the position of the semilandmarks in all individuals. In total, the analysis was composed of 332 female feet. The input data were superimposed by a Generalized Procrustes Analysis (GPA). This analysis minimizes the difference between landmark configurations by standardizing position, size, and orientation of the

configurations. The resulting Procrustes shape coordinates (Figure 2) were used for further statistical analysis ((Domjanić, 2013, Domjanic et al., 2014, Bookstein, and Domjanić, 2014,).

Figure 2: Landmark configurations of all individuals after Procrustes superimposition (Domjanić, 2013, Domjanic et al., 2014).

Principal component analysis has become the standard tool in geometric morphometrics. It is a mathematical procedure that reveals patterns of similarity or differences of the data by reducing a large set of variables into a few dimensions that contain most information of the variance (Domjanić, 2013, Domjanic et al., 2014).

FINDINGS

The landmark configurations of the sample yield 170 shape variables, thus 170 PC scores for each individual. The output from PCA (Table 1) comprise a list of the first 10 PC scores of each subject on each component, the coefficients describing the scores, the variance of each component and its percentage of the total variance.

Table 1: Eigenvalues for the first 10 principal components for the feet configuration matrix

PC	Eigenvalue	Expl. Variance	Cum. Expl. Var.
1	8.21×10^{-4}	21.28%	21.28%
2	5.24×10^{-4}	13.57%	34.85%
3	3.41×10^{-4}	8.82%	43.67%
4	3.20×10^{-4}	8.29%	51.97%
5	2.90×10^{-4}	7.51%	59.48%
6	2.47×10^{-4}	6.39%	65.87%
7	1.74×10^{-4}	4.51%	70.38%
8	1.61×10^{-4}	4.16%	74.54%
9	1.25×10^{-4}	3.24%	77.78%
10	1.18×10^{-4}	3.05%	80.83%

Principal component 1 accounts for 21.28 % of the total variance and is related to foot pathology (difference between flatfeet and high-arched feet). Principal component 2 accounts for 13.54% of the total variance in the sample and is related to shape differences between short and wide feet with short toes (low PC 2 scores) versus long and narrow feet with long toes (high PC 2 scores), Figure 3.
The visualization is based on the analysis of the 4 measurements of each individual connected with a line to show how the measurements vary for every individual. The measurements are very different,

although for the most highly repetable but not for all. Therefore, it is better to perform at least two or more scans of a person and then to average the values.

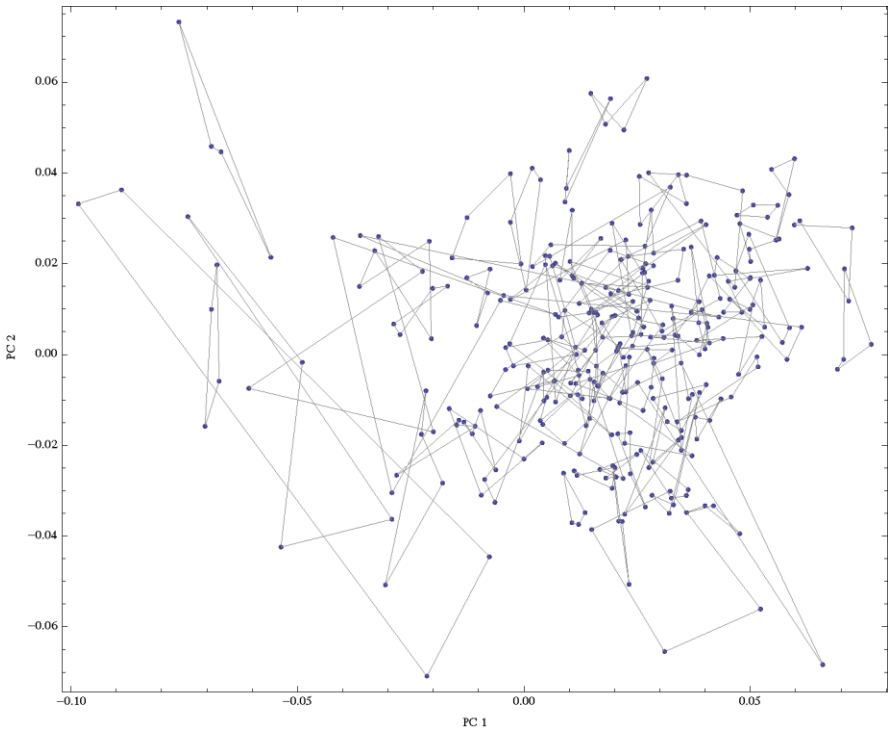

Figure 3: Scatter diagram of the PC1 and PC2 for the sample (Domjanić, 2013)

Procrustes shape coordinates of one individual have been averaged and the influence of BMI on footprint shape was investigated by regressing the shape coordinates on the respective variables, where the Procrustes coordinates have been taken as the dependent variable. Body mass index (BMI) had a significant effect on footprint shape ($p < 0{,}001$) and explained 2,8% of total shape variation.

a) b) c) d) e) e

Figure 4: Visualization of the effects of body mass index (BMI) for:
a) BMI 15, b) BMI 20, c) BMI 25, d) BMI 30, e) BMI 35 (Domjanić, 2013)

The increase of body weight influences the foot morphology particularly in the midfoot area causing foot pathologies and can cause pain and discomfort (Masaun, et al., 2009, Arnold et al., 2010).

CONCLUSION

Geometric morphometric methods had been applied to the analysis of shape changes of the human foot shape. Well-known patterns of shape variation were confirmed, such as variation in the curvature of the medial longitudinal arch and the estimated effect of BMI. The visualization in Figure 4 provide evidence that the use of GM yields interpretable results and could provide the basis for further research in the field of clothing and footwear technology.

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COLOR FASTNESS PROPERTIES OF POLY(BUTYHLENE TEREPHTHALATE) FIBERS DYED IN ULTRASONIC BATH

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ABSTRACT

Conventional textile dyeing processes need high electricity, heat and water consumption. Thus, textile researchers have been tried to use new alternative technologies. Ultrasound technology is one of these alternative technologies. In this study, PBT fiber fabrics were dyed in ultrasonic bath by using two commercially available disperse dyes (C.I. Disperse Red 167:1 and C.I. Disperse Red 65) at pH 5 and 80 ^{o}C for various dyeing times (15 minutes, 30 minutes, 45 minutes, 60 minutes and 90 minutes). The highest color strength values were obtained for 90 minutes dyeings for both dyes. All dyed PBT fibers displayed red color shades. All dyed PBT fibers exhibited good and commercially acceptable color fastness levels.

Key words: poly(butylene terephthalat) fibre, PBT, elastic polyesters, ultrasonic bath, fastness

INTRODUCTION

Conventional textile dyeing processes need high electricity, heat and water consumption (Textile, 2015; Infohouse, 2015). Textile researchers have been attempted to use new alternative technologies to reduce water and energy requirements (Parvinzadeh et al, 2010). Numerous non-traditional techniques such as microwaves and infrared radiation were investigated to decrease afromentioned consumptions (Textile, 2015). The ultrasound energy is one of the solutions for textile industry (Parvinzadeh et al, 2010). The usage of the ultrasonic energy for textile wet processing relied on 1990s (Mistik and Yukseloglu, 2005). Previous researches indicated that ultrasonic energy was potentially useful for dyeing polyesters with disperse dyes (Infohouse, 2015). These researches stated that polyester fiber fabrics dyed in laboratory with ultrasound displayed deeper color strength values than those of dyed without ultrasound (Infohouse, 2015).

Poly(butylene terephthalat) (PBT) fibers are known as elastic polyester; moreover, can be easily dyed at low temperatures with disperse dyes (Perepelkin, 2001). PBT is produced by polycondensation reaction with BDO (1,4-butanediol) and DMT or TPA (Figure 1) (Deopuno et al., 2008; Scheirs and Long, 2003) (Figure 1). In the 1950s, J.R. Whinfield and J.T. Dickons synthesized PBT and PBT polymer. Ticona and Zimmer presented PBT to the textile market as 'Cleanex' (McIntry, 2004). PBT was usually used as an injection moulding polymer and engineering resine (McIntry, 2004); furthermore, numerous PBT brands existed in the market, for instance; Vestodur (Evonik Ind.), Velox (Tepar), Toraycon (Toray), Ultradur (BASF), Eloflex (Coats) etc. (Coast, 2015; Ultradur 2015; Toray, 2015; Tepar, 2015; Vestodur, 2015). PBT fibers can be used in ready-to-wear, intimate, active and sportwear apparels, carpets, swimwear, automotive and home upholstery applications (Figure 1) (Deopuno et al., 2008; Scheirs and Long, 2003; Yıldırım et al., 2012a; Swicofil, 2015).

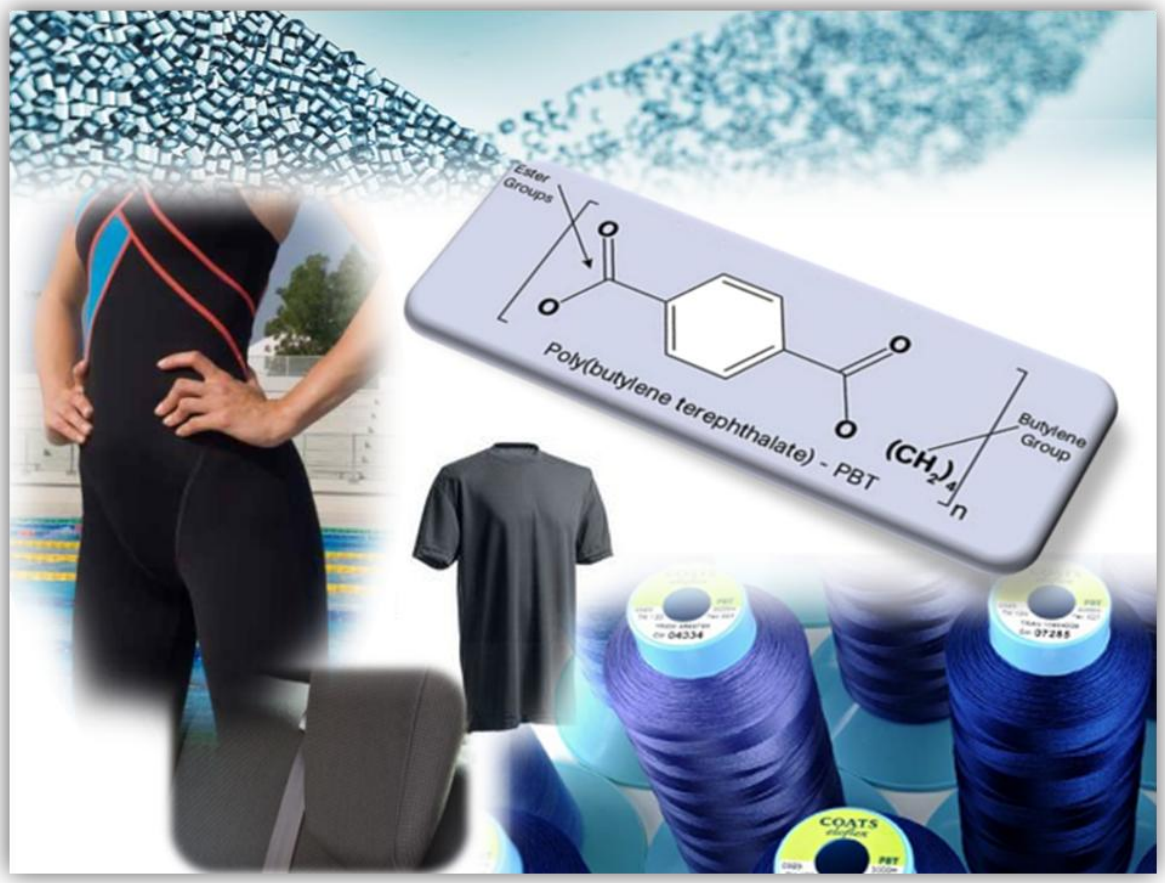


Figure 1: *Various textile applications and the chemical structure of PBT (Vestodur, 2015; Coast, 2015; Tepar, 2015; Swimsuits, 2015; Ptonline, 2015; Swicofil 2, 2015)*

In the last decades, many researchers studied about dyeing conditions for PBT fibers. PBT fibers were dyed at various temperatures and dyeing times (Yolaçan, 2006, Lee et al., 2007; Tavanaie et al., 2010; Ujhelyiova et al., 2007; Zou et al., 2006; Klancˇnik, 2007; Vajnhandl and Marechal, 2005). PBT fibers were also dyed using ultrasonic energy in some earlier studies. In one of them, PBT fibers were dyed with C.I. Disperse Blue 79 and C.I. Disperse Orange 25 in presence of ultrasound (26 kHz, 120 W) energy (Saligram et al., 1993; Internet, 2015). In other study, PBT yarns and PBT/PAN blended yarns were dyed in ultrasonic bath with disperse dyes (C.I.Disperse Red 167, C.I. Disperse Orange 30 and C.I. Disperse Blue 73) for investigating fibers' dyeability and color properties. These properties of dyed PBT yarns were compared for dyeings with or without ultrasonic energy (Yolaçan, 2006). In this study, color and fastness properties of PBT fiber knitted fabrics dyed in ultrasonic bath were investigated and discussed.

EXPERIMENTAL

Materials

100% PBT fiber single jersey knitted fabrics were used for ultrasonic bath dyeings. All fabric samples were scoured and then rinsed before ultrasonic dyeing.

Dyeing Process

In the ultrasonic dyeing processes, two commercially available disperse dyes, C.I. Number Disperse Red 65 (Low) and Disperse Red 167:1 (High) were used. Dyeing processes PBT fiber fabrics with these two disperse dyes were carried out in Ultrasonic bath (Wiseclean WUC-D10H) at 2% dye

concentration in company with 1 g/l dispersing agent at pH 5 (*adjusted via acetic acid/sodium acetate*). The liquor ratio of dyeings were 30:1. Ultrasonic dyeing temperature was set as 80°C (*maximum temperature*) and ultrasonic energy were used at maximum (40kHz, 200 W). Dyeing times were changed in order to investigate the effect of dyeing time on the color strength, exhaustion and color fastness properties of PBT fiber fabrics. The PBT fiber fabric samples were rinsed with warm water (40 °C) for 5 minutes and then further rinsed with tap water for 5 minutes. And, all dyed fabric samples were reduction-cleared with 3 g/l sodium hydroxide and 3 g/l sodium dithionite at 40°C. Afterwards, the samples were washed again (with warm water (40°C) for 5 minutes and tap water for 5 minutes) and left in the air for flat-air-drying.

Color Strength, Exhaustion and Color Fastness Measurements

The *K/S* 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:

$$K/S = (1-R^2)/2R \quad (1)$$

Exhaustion (%E) measurements were carried out in Perkin Elmer UV spectrophotometer. The bath samples retained before and after dyeing were diluted with acetone. The absorbance values of bath samples were measured and the exhaustion values of dyed samples were calculated by using following equation (Eq. 2) for each disperse dyes.

$$\%Exhaustion\ (E) = ((E_o-E_1)/E_o) \times 100 \quad (2)$$

E_o; Maximum absorbance value of bath samples before dyeing
E_1; Maximum absorbance value of bath samples after dyeing

Wash, rub, water and sublimation fastness properties of dyed fibers were investigated. The wash fastness test was performed at 50°C with sodium perborate according to ISO 105:C06 B2S test in a M228 Rotawash machine (SDL ATLAS, UK). Both dry and wet rub fastness tests were performed according to ISO 105: X12 protocol. The water fastness test was carried out in accordance with ISO 105: E01 protocol. Sublimation fastness test was carried out at 180 °C for 30 seconds according to EN ISO 105-X11 protocol. Overall fastness properties were evaluated by using ISO grey scales in the light box.

RESULTS AND DISCUSSION

Dyed PBT fiber fabrics color properties

The color properties of dyed PBT fiber fabric samples are shown on Table 1 and Figure 2a-c and Figure 3a-c.

Table 1. Color strength and exhaustion values of dyed PBT fabrics at pH 5 and 80 °C for changing dyeing minutes

Dyeing time (min)	C.I. Disperse Red 167:1 (High Heat fastness-Sublimation class)		C.I. Disperse Red 65 (Low Heat fastness-Sublimation class)	
	K/S	% BA	*K/S*	% BA
15	16,4	49,0	16,7	72,0
30	20,8	62,7	22,7	77,6
45	26,3	86,1	26,2	82,8
60	27,7	90,2	28,4	85,4
90	28,5	91,1	29,2	90,2

As seen on Table 1, the color strength and exhaustion values of PBT fibers increased by prolonged dyeing time for both disperse dyes.

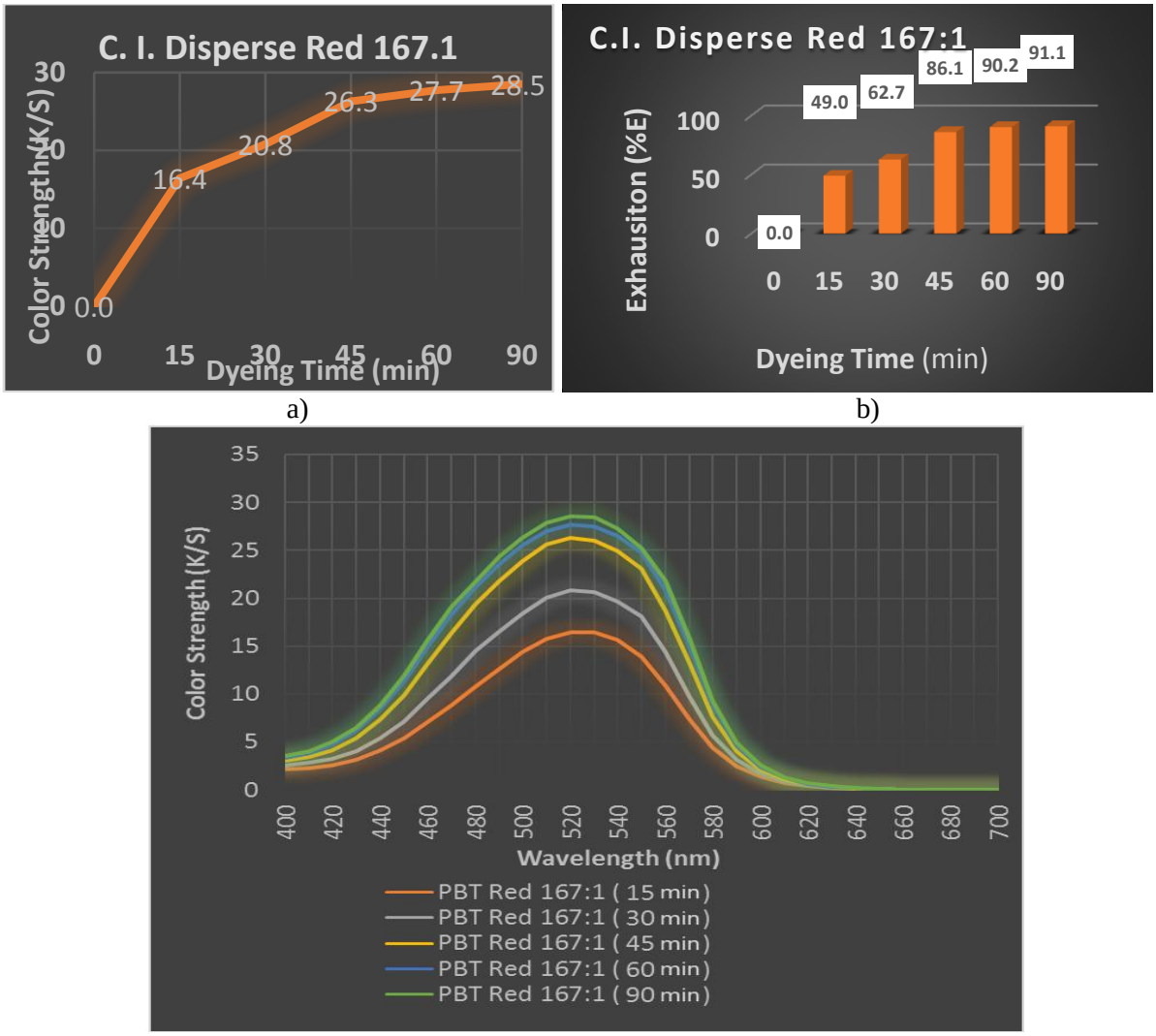
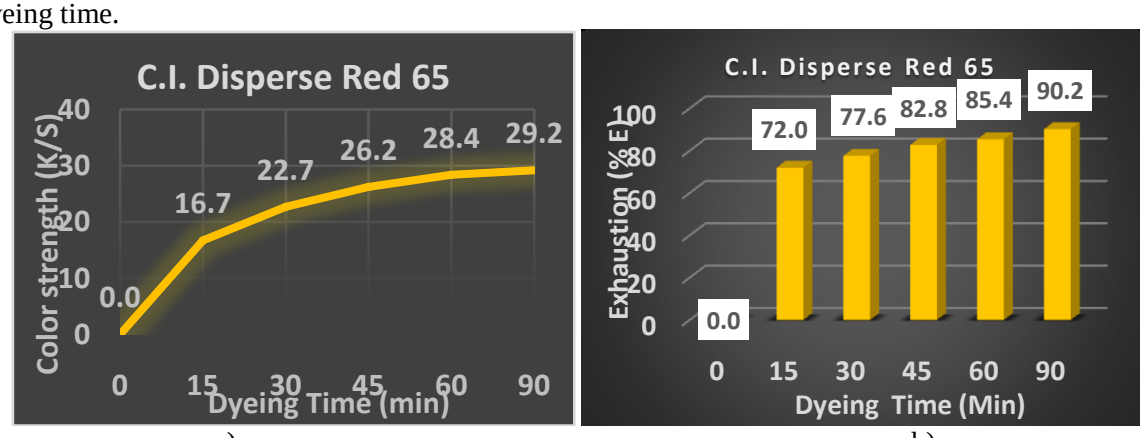
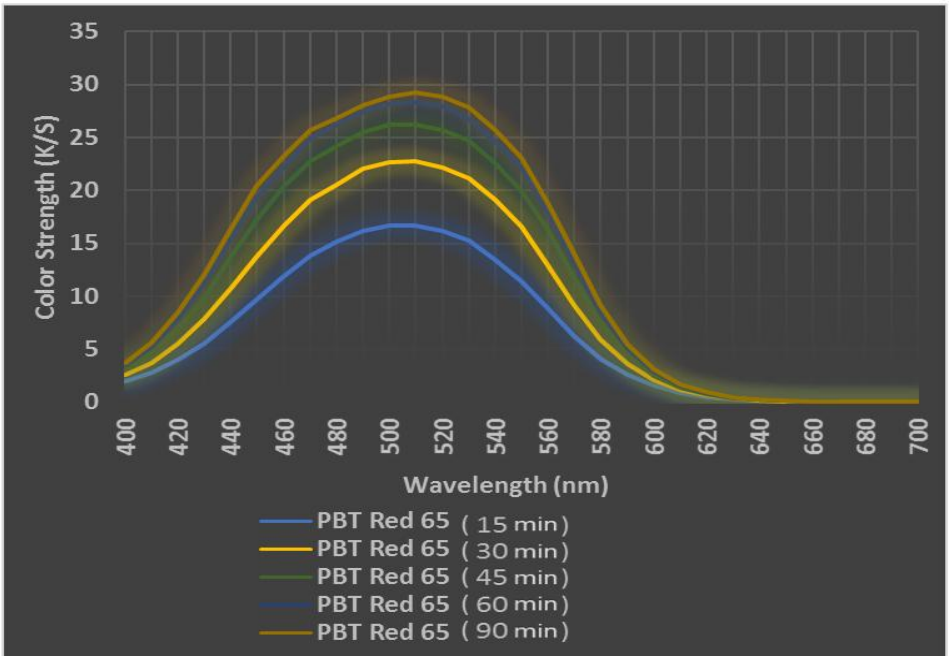


Figure 2: *Colorimetric plots for dyed PBT fibers with C.I. Disperse Red 167:1, (a) Color strength (K/S)- dyeing time graphics; (b) exhaustion (%E)-Dyeing time graphics and (c) Color strength (K/S)-Wavelength (nm) graphics for PBT fibres*

Color strength values of dyed PBT fibers changed range from 16.4 to 28.5, exhaustion values changed range from %49 to 91.1. Color strength and exhaustion values of dyed PBT fibers increased by prolonged dyeing time. The highest color strength and exhaustion values obtained for 90 minute dyeing time.





c)

Figure 3: graphics of dyed PBT fibers with C.I. Disperse Red 65, (a) Color strength (K/S)- dyeing time graphics; (b) exhaustion (%E)-Dyeing time graphics and (c) Color strength (K/S)-Wavelength (nm) graphics for PBT fibres

Color strength values of dyed PBT fibers by using C.I. Disperse Red 65 are in the range from 16.7 to 29.2. Their respective exhaustion values were in the range of 72-90.2%. Color strength and exhaustion values of dyed PBT fibers increased by prolonged dyeing time. The highest color strength and exhaustion values obtained for 90 minutes dyeings. The higher dyeing time led to higher color strength. Therefore, PBT fibers dyed for 15 minutes exhibited lighter color shades than those dyed for 90 minutes for both dyes.

Color fastness values of PBT fiber fabrics

Water, washing, perspiration and rub fastness properties were analyzed. Water, washing, acidic and basic perspiration fastness performances of all PBT fibers dyed in ultrasonic bath displayed the maximum fastness performance of 5 grey scale ratings for staining leading to excellent fastness levels. Sublimation fastness levels of dyed PBT fibers were given on Table 2.

Table 2. Comparison of PBT fabrics rub fastness values dyed at pH 5 and 80 °C for changing dyeing minutes

Rub Fastness *(Cotton staining)* (ISO 105:X12)				
Dyeing time (min)	**C.I. Disperse Red 167:1 (High Heat fastness-Sublimation class)**		**C.I. Disperse Red 65 (Low Heat fastness-Sublimation class)**	
	Wet	**Dry**	**Wet**	**Dry**
15	5	4/5	5	4/5
30	5	4/5	5	4/5
45	5	4/5	5	4/5
60	5	4/5	5	4/5
90	5	4/5	5	4/5

As seen on Table 2, PBT fiber fabrics exhibited good to excellent dry and wet rub fastness values ranged from 4/5 (4.75) to 5. Dry rub fastness values of PBT fibers were 4/5 (4.75) which are lower than those of wet rub fastness. However, all values were above 4 and commercially acceptable.

Sublimation fastness values of dyed PBT fibers are exhibited on Table 3.

Table 3. Comparison of PBT fabrics sublimation fastness values dyed at pH 5 and 80 °C for changing dyeing minutes

	Sublimation Fastness (EN ISO 105-X11)							
C.I. Disperse Red 167:1 (High Heat fastness-Sublimation	**Dyeing time (min)**	***WO***	***PC***	***PES***	***N6.6***	***CO***	***AC***	**Color change**
	15	5	5	4/5	4/5	5	5	4/5
	30	4/5	4/5	4/5	4/5	4/5	4/5	4/5
	45	4/5	4/5	4/5	4/5	4/5	4/5	4/5
	60	4/5	4/5	4/5	4/5	4/5	4/5	4/5
	90	4/5	4/5	4/5	4/5	4/5	4/5	4/5
C.I. Disperse Red 65 (Low Heat fastness-Sublimation	**Dyeing time (min)**	***WO***	***PC***	***PES***	***N6.6***	***CO***	***AC***	**Color change**
	15	4/5	4	3/4	3/4	4/5	4/5	4/5
	30	4/5	4	3/4	3/4	4/5	4/5	4/5
	45	4/5	4	3/4	3/4	4/5	4/5	4/5
	60	4/5	4	3/4	3/4	4/5	4/5	4/5
	90	4/5	4	3/4	3/4	4/5	4/5	4/5

As seen on above (Table 3), sublimation fastness values of PBT fibers dyed with C.I. Disperse Red 65 were worse than those of dyed with C.I. Disperse Red 65. This is expected, since dye molecules and molecular weight of C.I. Disperse Red 65 are smaller than those of C.I. Disperse Red 167:1. Therefore, when dyed fibers were exposed to heat, these dyes achieved higher kinetic energy and could be easily sublimated out to the atmosphere, leaving the fibre behind. Contrary to C.I. Disperse dye Red 65, sublimation is more difficult for C.I. Disperse Red 167:1 due to its bigger molecular size as well as higher molecular weight. As expected, nylon and polyester fiber parts of the adjacent multifiber fabric exhibited higher staining rates due to their known interest for disperse dyes. Overall, all fastness values of dyed PBT fibers in ultrasonic bath exhibited good to excellent color fastness leading to commercially acceptable fastness levels except for some cases in sublimation fastness.

CONCLUSION

Conventional textile dyeing processes need high electricity, heat and water consumption. Thus, textile researchers have been tried to use new alternative technologies. Ultrasound technology is one of these techniques. Poly(butylene terephthalat) (PBT) fibers are known as elastic polyesters; moreover, they can be easily dyed at low temperatures with disperse dyes. In this study, PBT fiber fabrics were dyed in an ultrasonic bath. Dyeings were carried out by using two commercially available disperse dyes (C.I. Disperse Red 167:1 and C.I. Disperse Red 65) at pH 5 and 80 °C with various dyeing times (for 15 minutes, 30 minutes, 45 minutes, 60 minutes and 90 minutes). Color strength values of dyed PBT fibers increased by prolonged dyeing time. The highest color strength values were obtained for 90 minutes dyeings for both dyes. Washing, water and perspiration (acidic and basic) fastness performances of dyed PBT fibers exhibited excellent values. Sublimation fastness values of dyed PBT fibers were in the range of ¾ -5. C.I. Disperse Red 65 dye led to lower sublimation fastness values, as expected.

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POTENTIAL FOR QUICK ADAPTATION TO THE FAST CHANGING FASHION ENVIRONMENT - A CASE STUDY FROM CHINA GARMENT INDUSTRY

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ABSTRACT

The rapid changes in the fashion industry require taking actions for quick adjustment by the garment companies. Chinese garment enterprises, as a part of the global scene, also follow the trend in garment production that exists in the western countries. This research aims to present the current state of garment enterprises in China, the problems they are facing, and the existing production trends for adaptation to the changes in garment industry. Therefore, a survey involving more stakeholders who can give a representative assessment of the situation regarding the garment industry in China was conducted. The results show that the companies are facing problems related to reduced flexibility towards changes in the garment industry and it's necessary to make changes in the management style, type of production systems and organizational culture.

Key words:China, Garment Industry, Garment Production Systems and Fast Fashion.

INTRODUCTION

In the last 6 to 10 years there is an evident trend in the garment industry for production of orders with small quantities, in short lead times, high product variability and product complexity. On the other hand, the constant endeavour of the big fashion companies to reduce production costs, leads to a trend for production relocation into low wage countries. For this reason, China as a country with great potential, has became particularly interesting for the companies from Western Europe and North America. However, there is still a challenge for Chinese companies to react quickly to changes in the fashion industry coming from the west and thus to adapt their production accordingly.The aim of this research is to investigate the potential of the Chinese garment companies for quick adaptation to changes in the fashion industry.

Much of the researches in this area are related to the trends globally. China certainly fits into the global image, but there is no sufficient number of scientific researches that can present if the global trends are fully translated into the Chinese garment industry. This research aims to fill the gap by presenting the current state of the Chinese garment companies, the problems they are facing, but also production trends for adaptation to the changes in the garment industry. Below, follows the review of the related literature, an explanation of the methodology used in this study and discussion of the results obtained. Finally, based on the results, an appropriate conclusion was presented.

LITERATURE REVIEW

Apparel assembly line is a system of people and machines arranged in a specific order to transform raw material, over semi-product, into a final product. People are arranged to work on one or more different machines, based on their skills [7,12].So far, the balancing of the assembly line in the apparel industry is still a significant problem for the area of production management. This problem is particularly evident in the sewing department, where the degree of automation is relatively low [14]. In this department the performance of the assembly line is largely dependent on the capabilities of the operators [7,14]. The fact that apparel assembly line is labour intensive includes balancing among the group of NP-hard problems[6]. Researchers have known assembly line balancing problems (ALBPs) over a several decades [1, 2]and specific ways to solve these problems are already applied in the automotive industry [3]. It goes without saying that the apparel industry by its nature differs in large

part from the automotive industry. Because of that, the successful implementation of methods to solve ALBPs in car manufacturing must be adapted to the demands and characteristics of the apparel industry. Some of the studies promote different solutions for improvement of the garment companies' performance thru simulation and testing the performance of different assembly line configuration [16]. Modular production system [4, 11], Mixed-model production system [3] or flexible unit production system [8] are some of the relatively new solutions that are used in the garment industry. However, fashion trends are constantly changing and require changing of the production practices by the manufacturers. In order to have quicker response, fashion companies have to select suppliers that can adopt better to the fast changing fashion market [5, 9, 17].There are still insufficient number of researches related to transition of garment manufacturers in China and their adaptation to the global trends [13].This research will contribute in filling the gap and investigate the potential of Chinese garment companies for quick adaptation to the fast changing fashion market.

METHODOLOGY

For the purpose of this research, an online survey[18], between the period of 15.04.14 and 28.10.14 was conducted. The survey was translated into two languages (English and Mandarin). The survey contains 34 questions grouped in 5 groups based on the area they cover. The question groups were made based on the literature review [5, 10, 17]. Every group is related to different problems with Chinese garment manufacturers and can be seen in the table2 in the appendix.The respondents were carefully selected in order to ensure collection of sufficient number of representative responses.As shown in table 1, 13 respondents were surveyed and grouped into 4 groups based on their background.Each of the participants presented in Table 1, is described with the scope of their work, the origin and the number of garment manufacturers that their responses can be related to. The name of the respondents and the companies they represent is indicated by the symbol because of their preference to remain anonymous.

Table 1. Four groups of survey respondents

No.	Respondent / group	Description	Country	Comment
1.	A /1	International fashion company	Spain	> 300 suppliers from China
2.	B /1	International fashion company	Spain	> 100 suppliers from China
3.	C /1	International fashion company	Germany	> 70 suppliers from China
4.	D /1	International fashion company	Holland	> 200 suppliers from China
5.	E /1	International fashion company	Sweden	> 300 suppliers from China
6.	F /2	Local fashion company	China	> 20 suppliers from China
7.	G /2	Local fashion company	China	> 20 suppliers from China
8.	H /3	Garment supplier for international fashion company	China	Supply > 5 international fashion brands
9.	I /3	Garment supplier for international fashion company	China	Supply > 5 international fashion brands
10.	J /3	Garment supplier for international fashion company	China	Supply > 5 international fashion brands
11.	K /3	Garment supplier for international fashion company	China	Supply > 5 international fashion brands
12.	L /4	Garment production and industrial engineering consulting company	China	Consult >20 garment manufacturers from china
13.	M /4	Garment production and industrial engineering consulting company	India	Consult >50 garment manufacturers from India, China, Pakistan, Bangladesh

It can be seen from the table 1 that four groups of respondents were selected covering different aspects of the supply chain in garment industry in China. The first group of respondents are representatives of international fashion companies existing in China. ¨Existing in China¨ means that this company has retail stores in China but also most of the production orders are made in China. These international fashion companies cooperate with 70 to more than 300 suppliers from China. The second group of respondents are representatives of a local fashion company in China. Most of them have their own production capacities, but also cooperate with other local suppliers. The third group of respondents arerepresentatives of local suppliers that cooperate with more than 5 international fashion brands. The fourth group of respondents are representatives of consulting companies in the area of garment manufacturing and industrial engineering with rich experience in Asian countries. All of the respondents share their experience thru this survey from different point of view.

RESULTS AND DISCUSSION

Based on the survey, five sets of results in each of the five sets of questions were obtained. All five sets of questions and results are presented in the table 2 in the appendix. The first group of questions is related to the upcoming trends in garment manufacturing. Results show that the majority of the respondents agree that shorter lead time for order production (69.23%), higher product quality (46.15%), smaller order quantity (53.85%), higher style variety (46.15%) and product complexity (30.77%) are new trends in apparel production, compared to 6 years ago. The second group of questions is related to the actual problems in garment manufacturing. Results show that the majority of the respondents agree that waiting (46.15%), unnecessary transport (30.77%), inappropriate processing (46.15%), unnecessary inventory (38.46%), unnecessary motion (38.46%) and defects (61.54%) are important problems that influence the performance of the production in the company. The third group of questions is related to the possible solutions of the actual problems in garment manufacturing. Results show that the majority of the respondents agree that in order to meet customer's requirements some investments needs to be done in training of the workers (30.77%), sophisticated machinery (38.46%), change of the production system (53.85%) and the management model (53.85%). The fourth group of questions is related to special production models for garment manufacturing that can be implemented in order to achieve higher productivity and flexibility. Results show that the majority of the respondents agree that multi-skilled operators (30.77%), single-piece flow production (53.85%), mix-model production (30.77%), self-controlled operators (38.46%) and team-work (38.46%) are manufacturing philosophies that can bring improvements in meeting customer's demands in the actual production environment.The fifth set of questions is related to the current situation of the garment companies in China. The results show that the majority of companies (61.54%) are able to produce 2-4 types of products, mainly ladies wear, like ladies blouses, shirts and light jackets and 53.85% of them cooperate with more than 4 clients. 30.77% of the respondents answered that the average quantity of the orders is between 2001-5000pcs and 5001-10000pcs. with average production lead time of 1.5-3months (46.15%). Usually, the garment companies from China use Progressive Bundle System (PBS) for production, with straight assembly lines where they produce single-model in a time. The most of the companies in China (92.31%) are Original Design Manufacturer (ODM), without implemented ISO 9000 standards (61.54%) and without using Lean tools for flexible manufacturing (69.23%).

The results from this study could be used as a basis for future research related to the possibilities for implementation of flexible manufacturing systems in garment enterprises in China.As the results show, Chinese companies are aware for their lagging behind the innovations in garment industry, but they are willing to invest in new production systems. For that purpose, as a continuation of this research, another study has been done already [15]. This study presents the preconditions that have to be met by a company in order to be able to transform the current production system into a mixed-model production system as a type of flexible production system. The next step would be to design and implement a mixed-model production system in a garment company in China.

CONCLUSION

Based on the survey conducted, it can be concluded that majority of the respondents agree with the existence of the garment production trends mentioned in the survey. The most of the problems related to garment production, mentioned in the survey, are approved by the survey respondents. The respondents mainly agree that improvement solutions and production philosophies presented in the survey will be beneficial for the company, but most of the companies are still using the traditional way of production and are progressing slow in implementation of new, innovative solutions for garment production.

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Appendix

Table 2. Survey questions and results.

Survey time: 15.04.2014 – 28.10.2014, Number of respondents: 13, Number of questions: 34 (5 groups), Languages: 2 (English and Mandarin), Responses explanation: A-strongly disagree, B- partly disagree, C-neutral opinion, D- partly agree, E- strongly agree						
Questions related to the upcoming trends in garment manufacturing						
No.	Question	A	B	C	D	E
1.	Customer has requirements for shorter lead time for order production (compared to six years ago)	0 (0%)	1 (7.96%)	0 (0%)	3 (23.08%)	9 (69.23%)
2.	Customer has requirements for higher quality level of the goods (compared to six years ago)	1 (7.96%)	1 (7.96%)	0 (0%)	5 (38.46%)	6 (46.15%)
3.	Customer has requirements for smaller order quantity (compared to six years ago)	1 (7.96%)	2 (15.38%)	2 (15.38%)	7 (53.85%)	1 (7.96%)
4.	Customer has requirements for higher variety of product styles (compared to six years ago)	1 (7.96%)	1 (7.96%)	1 (7.96%)	4 (30.77%)	6 (46.15%)
5.	Customer has requirements for higher product style complexity (compared to six years ago)	0 (0%)	2 (15.38%)	4 (30.77%)	3 (23.08%)	4 (30.77%)
Questions related to the actual problems in garment manufacturing						
No.	Question	A	B	C	D	E
6.	"Overproduction" is the highest rated waste type, which influences the performance of your production company	2 (15.38%)	4 (30.77%)	4 (30.77%)	1 (7.96%)	2 (15.38%)
7.	"Waiting" is the highest rated waste type, which influences the performance of your production company	0 (0%)	0 (0%)	2 (15.38%)	5 (38.46%)	6 (46.15%)
8.	"Unnecessary transport" is the highest rated waste type, which influences the performance of your production company	0 (0%)	4 (30.77%)	2 (15.38%)	3 (23.08%)	4 (30.77%)
9.	"Inappropriate processing" is the highest rated waste type, which influences the performance of your production company	0 (0%)	2 (15.38%)	0 (0%)	6 (46.15%)	5 (38.46%)
10.	"Unnecessary inventory" is the highest rated waste type, which influences the performance of your production company	0 (0%)	1 (7.96%)	4 (30.77%)	5 (38.46%)	3 (23.08%)
11.	"Unnecessary motion" is the highest rated waste type, which influences the performance of your production company	0 (0%)	3 (23.08%)	3 (23.08%)	2 (15.38%)	5 (38.46%)
12.	"Defects" are the highest rated waste type, which influences the performance of your production company	0 (0%)	1 (7.96%)	1 (7.96%)	3 (23.08%)	8 (61.54%)
Questions related to the possible solutions of the actual problems in garment manufacturing						
No.	Question	A	B	C	D	E
13.	In order to meet customer's requirements, the highest priority of garment manufacturers is to invest in training of the workers	0 (0%)	4 (30.77%)	3 (23.08%)	2 (15.38%)	4 (30.77%)

14.	In order to meet customer's requirements, the highest priority of garment manufacturers is to invest in sophisticated machinery.	0 (0%)	5 (38.46%)	3 (23.08%)	5 (38.46%)	0 (0%)
15.	In order to meet customer's requirements, the highest priority of garment manufacturers is to change the actual production system	0 (0%)	3 (23.08%)	1 (7.69%)	7 (53.85%)	2 (15.38%)
16.	In order to meet customer's requirements, the highest priority of garment manufacturers is to change the management model	1 (7.69%)	0 (0%)	0 (0%)	7 (53.85%)	5 (38.46%)
Questions related to special production models for garment manufacturing						
No.	Question	A	B	C	D	E
17.	Implementing "multi-skilled operator (one operator to work on several operations)" manufacturing philosophy will bring improvement in meeting customer demands in the actual production environment	1 (7.69%)	3 (23.08%)	4 (30.77%)	4 (30.77%)	1 (7.69%)
18.	Implementing "single-piece flow" manufacturing philosophy will bring improvement in meeting customer demands in the actual production environment	1 (7.69%)	2 (15.38%)	2 (15.38%)	7 (53.85%)	1 (7.69%)
19.	Implementing "mixed-model (more styles in one line)" manufacturing philosophy will bring improvement in meeting customer demands in the actual production environment	1 (7.69%)	3 (23.08%)	4 (30.77%)	4 (30.77%)	1 (7.69%)
20.	Implementing "self- controlled operator" manufacturing philosophy will bring improvement in meeting customer demands in the actual production environment	0 (0%)	1 (7.69%)	4 (30.77%)	5 (38.46%)	3 (23.08%)
21.	Implementing "team-work" manufacturing philosophy will bring improvement in meeting customer demands in the actual production environment	0 (0%)	0 (0%)	4 (30.77%)	5 (38.46%)	4 (30.77%)

Questions related to the actual state of the garment manufacturers			
No.	Question	Yes	No
22.	Your company has implemented ISO 9000 standard	5 (38.46%)	8 (61.54%
23.	Your company use Lean tools for flexible manufacturing	4 (30.77%)	9 (69.23%)
24.	Your company is an Original Equipment Manufacturer (OEM)	8 (61.54%)	5 (38.46%)
)25.	Your company is an Original Design Manufacturer (ODM)	1 (7.69%)	12 (92.31%)
26.	Your manufacturing plant is capable for production of:	1 type of product	2 (15.38%)
		2-4 types of products	8 (61.54%)
		More than 4 types of products	3 (23.08%)
27.	Your manufacturing plant is capable for production of the following types of products (more than one answer in possible	Shirt	8 (61.54%)
		Ladies blouse	6 (46.15%)
		Jacket	6 (46.15%)
		Trousers	5 (38.46%)
		Dress	5 (38.46%)
		Suit	2 (15.38%)

		Heavy coat	3 (23.08%)
		Jersey	4 (30.77%)
		Knitwear	3 (23.08%)
		Underwear	2 (15.38%)
		Protective clothing	1 (7.69%)
		Others	3 (23.08%)
28.	Your company cooperates with:	Only 1 client	0 (0%)
		2-4 clients	6 (46.15%)
		More than 4 clients	7 (53.85%)
29.	Select the main product that represents your company, from the list below	Shirt	2 (15.38%)
		Ladies blouse	5 (38.6%)
		Jacket	1 (7.69%)
		Trousers	0 (0%)
		Dress	0 (0%)
		Suit	1 (7.69%)
		Heavy coat	1 (7.69%)
		Jersey	2 (15.38%)
		Knitwear	1 (7.69%)
		Underwear	0 (0%)
		Protective clothing	0(0%)
		Others	0 (0%)
30.	Average quantity of the orders produced in your manufacturing plant is:	500-2000 pieces per order	3 (23.08%)
		2001-5000 pieces per order	4 (30.77%)
		5001-10000 pieces per order	4 (30.77%)
		More than 10000 pieces per order	2 (15.38%)
31.	Required average lead time (from receiving P.O. to delivery date) for order production is:	1 month	2 (15.38%)
		1.5 -3 months	6 (46.15%)
		More than 3 months	5 (38.46%)
32.	Your company use one of the following production systems for material handling:	Progressive Bundle System (PBS)	11 (84.62%)
		Unit Production System (UPS)	0 (0%)
		Other	2 (15.38%)
33.	The shape of the assembly line in your company is:	Straight	8 (61.54%)
		Parallel	3 (23.08%)
		U-shape	2 (15.38%)
		Modular- cell	0 (0%)
		Other	0 (0%)
34.	Your company use one of the following assembly lines:	(Single-modelAssemblyLine)	10 (76.92%)
		(Multi-modelAssemblyLine)	3 (23.08%)
		(Mixed-modelAssemblyLine)	0 (0%)

A MODEL FOR REVIVAL OF SERBIAN APPAREL (TEXTILE) INDUSTRY

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ABSTRACT:

This paper deals with real operating conditions that impose clothing manufacturers to choose their own strategy that will give them success on the market only in places where the competition has left them a place. The paper points out that they have essentially innovative products and in order to the development of these products, the existence of strong links between retail sales, research institutions and industry is mandatory. It is emphasized that staff with industrial experience can only establish this relationship. In order for them to be created in Serbia today it is necessary to take a far more serious approach to their training by higher educational institutions, the country and business entities.
The proposed model implies responsible relationship of higher education institutions, the country and businesses towards staff training in real operating conditions of the Serbian apparel industry. In this way, we would create trained people who, instead to look for jobs, they would create jobs for themselves in an existing business environment.

Key words: Serbian textile industry, staff with industrial experience, the model of the revival of Serbian textile industry, the promotion of the fashion sector.

INTRODUCTION

The textile industry is particularly sensitive to the recession. Overflow of cheap textiles and the expansion of production in Asian countries have led to a crisis in the textile industry, especially in countries in transition. Serbia's met transition without resources, development strategy and entered the privatization process at the same time expecting new investments and increasing efficiency of existing social companies. However, when choosing the model of privatization the country opted for a model that provides increase of the budget, financing an expensive state apparatus and to a large extent the lack of new Greenfield investments. In such circumstances, the textile industry was first destroyed.

It is true that the problem of staff now in the textile sector but the basic problem is difficult to make a sound fact that this problem only emerged in the public educational system of medium to higher education. With the closure of large social textile companies have emerged all of today's private companies from the textile sector. The fact is that these private enterprises at its foundation mainly employed professional workers with industrial traditions that have lost their jobs in social enterprises. Thus, the problem of personnel in the textile sector is the fact that professional workers with industrial experience, in which social companies invested vast amount of training and substantial resources are retiring today in a growing number.

The reluctance of private companies to invest in the training of highly qualified personnel for specific jobs that are require only by these companies and the expectance of these companies for the country to do it for them, is the main problem and that in turn results in lower competitiveness of the sector today. Therefore, this paper proposes the solution of human problems in the real conditions in which the sector operates in Serbia. The basic idea is that through promotional activities in this sector include as many young people and the implementation of their activities enable young people not to be seeking work but to create it themselves in the current textile companies [1-2].

SUCCESS OF COMPANIES IN THE FIELD OF FASHION SECTOR

Today, the success of business entities is reflected in how they direct their development towards innovation, new knowledge, education as well as creating a unique added value.

In assessing the performance of textile companies 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 explain the difficult situation in which the textile industry is, it is necessary to look back to the past development of this industry.

However, this situation is changing in the early 80s, primarily influenced by the political changes in many countries in Africa, Asia and South America. Many companies from developed countries with the use of political changes in these countries start making cheap products with small investments that are primarily intended for the markets of these countries. This way a markets product life is prolonged, as it does not require an expensive development strategy that is necessary for new products in the market.

This has led to the emergence of an entirely new concept in the global economy that can be expressed with the question: Why pay workers in Europe and America 10 times higher than in Asia and Africa? As well as a request: Let them create this "stupid" thing cheaper. Under this concept a profit company is the only difference. It is interesting that in this conception there is no place 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 major dislocation of jobs to countries with cheap labor. The development of technology makes it unnecessary because it seemed unnecessary to improve the operation of the manual labor for a dollar a day.

This concept puts the quality of a product in the background. What is emphasized is a very new scientific discipline - marketing is used to convince people that this product is designed just for them. With aggressive marketing of the product it is imposed upon customers as something that expresses a personal opinion, property, etc. Aggressive marketing does not emphasize quality and comfort of clothing but is replaced by the story that if we buy eg. the same brand of shirts worn by Novak Djokovic, we will be playing tennis like him, we will be fashion conscious if we wear clothes from Versace and the like.

This concept of a global economy, which has replaced the technology as the science with marketing has proved to be unsustainable, because in countries without production remained only: well-paid jobs related to a small number of civil servants, jobs in highsubventional branches of economy as well as a large number of users for social welfare.

The new story of aggressive marketing had to be placed in the new concept of product sales. This creates commercial centers in suburban areas, where the buyer usually goes by their own transport and where they are provided facilities for day care. At these places the customer has at their disposal a very large range of products. These centers are designed for the customer to lose a sense of reality, and create a sense of personal satisfaction by buying products that are not good quality but should create a sense of identification. The whole concept strives to convince the customer that only one product does not provide full identification, but it takes a number of different products.

This concept of selling is quite different from selling in small retail stores. These actions are in the real environment, located in the city center, and these vendors directly and realistically communicate with buyers and customers that are aware that they are spending hard-earned money. So these actions with customers do not communicate through the media but through its window next to which thousands of people pass daily. In such an environment innovative clothing can only be sold that have a real purpose and clear reasons why buying.

To attract the attention of customers, who are primarily in passing, to the products in store windows, these products must be attractive and suggestively exposed. This need has caused a significant development of design, which has, in a very short time, established itself as the most important scientific discipline of technology. Design was actually created as a synthesis of the entire textile science with psychology and sociology with the aim of creating and developing new products that have to be functional, beautiful and socially acceptable.

Design opens a new story that designer clothes, which today are expensive, of high quality and are innovative, offers the customer expression of personality. With design, the customer receives a huge selection to express individuality in appearance. This is a totally different story than the one offered by aggressive marketing of identification with someone or something.

It is obvious that the design concept uses the media to communicate with customers. It is obvious that the media is no longer used in an aggressive and suggestive way but as an informative tool to inform people about what they are offered and how to express their personality.

The concept of design has, in a large manner returned customers in shops located in city centers and thus significantly positioned sale of innovative products that are the result of the interaction of science and technology as well as production.

It cannot be expected that the concept of design, ie. innovative products to suppress completely the concept of "make me a stupid thing cheaper" but its merit is certainly positioning in the global market of the two concepts. It is realistic to expect that the global economy grows and thus the standard of the citizens, which will increase the market share for innovative products.

TODAYS PRODUCTION CONCEPT

The fact is that today manufacturers use three concepts, namely: to create cheap products of dubious origin and quality and sell them cheaply; create cheap products and to sell them expensive and assure customers that the brand is most important that the buyer possessing products identifies with something or someone; create an expensive, high-quality and inventive product that will, with its properties rather than aggressive marketing, convince customers to acceptability, and expensively sell them.

Figure 1. Clothing manufacturing division

Today realistic business conditions impose manufacturers the choice of their own strategies to claim their success in the market only in places left by the competition. It can be freely said for the textile production that they make inventive and expensive products that the competition has left room for. Of course the development of these products requires a highly educated workforce and a series of related activities such as market research in order to determine what products the market demands; the development of research centers in which the product is made as a result of research and development of new materials; development of technological development centers where the development of the production process is and would adapt existing technology of the manufacturers.

These are very large requirements that must be met to make the system viable. In fact, there must be a strong link with retail, research institutions and industry. This means that the retailer, which is in constant contact with customers, requires such a product of the scientific institutions that they should develop and the industry itself needs to produce.

PERSONNEL - KEY ISSUE IN SERBIAN TEXTILE INDUSTRY

As it has already been said that the production system is sustainable, there must be a strong link with retail, research institutions and industry. This connection can be achieved only by a highly creative staff that will offer solutions and development of new technologies and products capable to cope with the strong competition on the world market.
Creating quality staff is a long and demanding job in which primarily companies, country and higher education institutions must participate. It is evident that in this business there are very big omissions. It is difficult to cover all the failures but we can mention some of the more important.

Company atitude toeards training of the staff (personnel)

There are few companies in Serbia, which today can say that they have competitive products on the market and an engineering team in the technical preparation of production. Such an attitude towards human resources stems from the condition of the establishment and a short history of existence of a large number of companies. The closure of large social textile companies created most of today's private companies in the textile sector. The fact is that these private enterprises at its foundation mainly employed professional workers with industrial traditions that have lost their jobs in social enterprises. Thus, the problem of personnel in the textile sector in the Serbian industry is that professional workers with industrial traditions today retire in a growing number. The reluctance of private companies to invest in the training of highly qualified personnel for specific jobs required only by those companies and their expectance that the country does it for them, is the main problem and that in turn results in lower competitiveness of the sector today [2-10].

How does an organized system look, we recently saw during a visit to Germany's Pirin Tex in their manufacturing facilities which are located in the Bulgarian town of Gotse Delchev. The company employs 3,500 workers, and the majority of its personnel is trained in its own education center. For the training of its staff, the company spends about 150,000 euros, with which the Bulgarian sountry paid the license for the job. What is obvious is that this company had a natural evolution of its brand Rollman. Specifically, they have been developing over the past 20 years, its product and the training of its own staff. The results are visible: their cheapest clothes cost 1,200 euros. What is even more noticeable, unlike our companies, is that with them you cannot hear anything bad about the competition or the country. One gets the impression that they only care of the development of their own products and within that the primarily development of the technical preparation of their production engineering team. This impression is acquired in contacts with other successful companies.

Figure 2. Signing the Contract of technical cooperation with the German company Pirin Tex

Unlike these companies, the behavior of domestic companies mostly boils down to always the same story about the difficult business conditions, which are mainly to blame the country and the competition. No one can say that problems do not exist but it is difficult to understand that a company with over 100 employees complains of unfair competition of Entrepreneurs who has a total of two unregistered sewing personnel. It seems that there is a real problem and is related to the lack of personnel with both groups. Therefore, the appearance and quality of the products of both companies is similar but are really in the market competition.

So, the key issue is to tied to the development of the company, which was not based on the development of competitive products, but on the conditions prevailing in the market during the sanctions and transition. This market was not a healthy viewfinder for the engineering team for product development. So many of our companies today are losing their positions in the market competition with companies whose priority was to invest in personnel and development of its own products.

Countries atitude towards training of the staff (personel)

It cannot be said that the educational system of training staff has the country to blame. Most of the problems for the training of personnel blames the institution itself. There are individual problems, such as: this years attempt to extinguish the textile department in Arilje - one of the largest regions in which the textile companies are concentrated.

The countries inadequate attitude towards human resources can be found in the existing conditions of their employment. Specifically, Mr. Željko Sretić - Minister of Economy, said that the general impression is that the Serbian economy further stifles problems of forest of unadjusted regulations and achieving standards in production.

If we try to answer the question why graduates here have very little desire to start their own work is likely to get a response to this problem that we named – a forest of unadjusted regulations. We should ask ourselves whether our graduate student can open a production of unique clothing and if the products can be sold in their store. The answer would be yes with a very small investment. However, if you wonder if he himself can do the job and at the same time follow and comply with all legal requirements, it is difficult to find the answer. In fact, after a meeting of businessmen from the market and the tax inspection it was hard to say that someone in one place certainly knows what it takes companies to meet in this sector. It seems that the worst of all this is that hardly anyone can quickly get to the information in the state institutions on which all legislations must meet if they want to start

their own business in this sector.

This in itself is not a big problem for big companies that have a large administration. However, unemployment can hardly be solved without creating conditions for the development of entrepreneurship and start-up work. Telling students that it is good to start their own business alone is very difficult because, as the Minister said, in the forest of unadjusted regulations, very easily there can be made a criminal offense. In this regard, constantly pounding the information through the mass media, drastic penalties for economic offenses further declines students of launching own businesses.

It's hard to talk about solutions that would motivate students to, by themselves or employing several workers, start their own business.

It seems as a very acceptable solution, in this case, according to the type of business, size of company and location (city, disadvantaged areas) to determine the financial obligations that could be easily paid by to the state for example. only on one account. Also, the Chamber of Commerce would be able to follow these entrepreneurs in terms of information on regulations and the like. This would free up entrepreneurs of administrative tasks and could only work the best of what they know how to work. It seems to me that this would really increase the motivation of students to start their own business. In the present circumstances it seems that the fear of entering into legal violations in the complicated forest regulations is an important reason why many graduates flee from launching own businesses.

Atitude of higher educational institutions towards personel training

Certainly there are some problems in higher education staff for the textile sector. From the recent student protests we should perhaps pay attention to the part of their demands relating to the quality of teaching. Specifically, students propose to start work on finding long-term solutions to the problem of teaching quality and lack of clearly defined programs of study. They point out that in many programs of study they do not clearly know what competence and knowledge a student gains from attending these study programs. Also, students propose that it must determined exactly why the student is attending a study program and to determine how much of time it is exactly necessary for them to attend.

Figure 3. Students of Technical faculty attend class

It is sure that these problems arise by irresponsible teachers who have had access to other teaching duties in their long practice. Not only these teachers, also teachers who are from these first teachers that have acquired the same habit. Today the problems of personnel training are clear and are for one

simple reason and that is that previous social companies significantly invested in the further training of staff that came from the university. Basically investments were in the acquisition of specific knowledge required for specific jobs in these companies. Today, however, private companies, accustomed to easily getting personnel from the laid off labor market that gave them the low-cost highly skilled personnel with industry experience, and who have lost their jobs in social companies that were destroyed, are not able to understand that they need to invest in people. In such an environment, higher education institutions must, themselves, find ways of training of highly qualified personnel with industrial experience.

AN EXAMPLE OF PERSONNEL TRAINING TO REVIVE THE SERBIAN TEXTILE INDUSTRY

Considering the above problems and constantly following the changes in the textile sector Technical Faculty "Mihajlo Pupin" - University of Novi Sad, has adapted their study programs to the needs of the economy. The emphasis is on the technical preparation of making clothing products. In this sector there first appeared a need for a large number of personnel. Faculty Management has invested its own funds to equip laboratories and purchase of equipment.

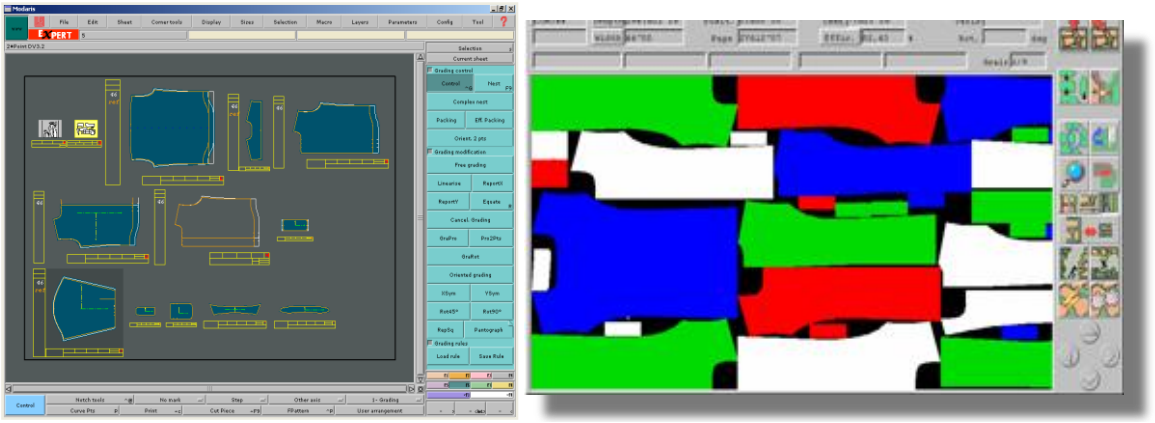

Figure 4. Industrial software in possession of the Technical faculty [11]

The Faculty has signed an educational center with the French company Lectra from which we obtained industrial software and equipment worth several hundred thousand euros. This training enables students to learn modern software for design, modeling and grading of clothing as well as for fitting of tailoring images. Also, students have at their disposal and industrial software for the design and development of technical documentation. All these softwares are installed on the 15 workstations so that students in them can work individually. An industrial plotter for plotting and cutting patterns and a board for digitalization is part of the equipment that accompanies the software. In addition to this equipment, students can use the plotter for printing on textile materials.

Students also have the access to the world's leading service for analyzing fashion trends WGSN.

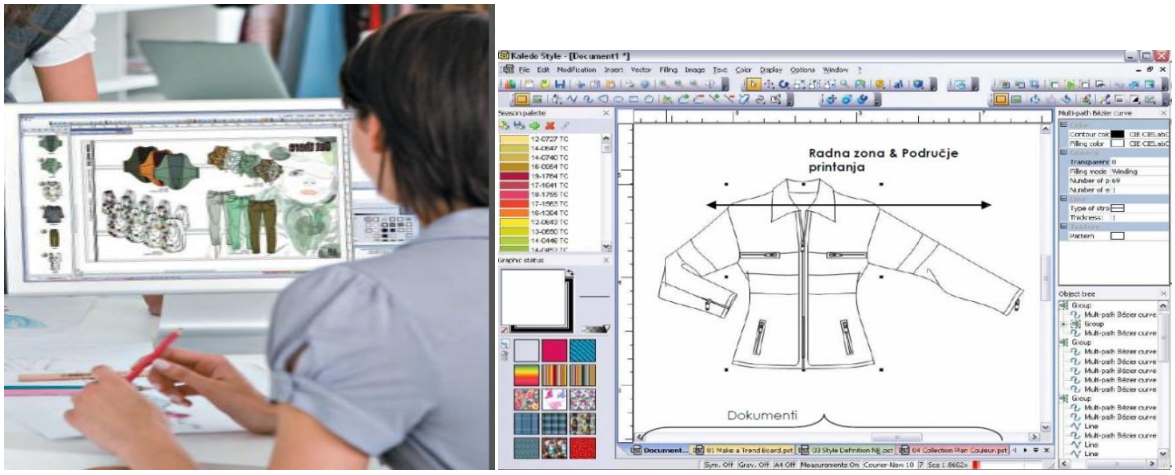

Figure 5. Industrial software in possession of the Technical faculty [11]

A major contract for the students is a contract on cooperation with the Donghua University in Shanghai, St. Petersburg State University of Technology and Design, University of Maribor, as well as contracts on business and technical cooperation with the German company Pirin Tex.

It is sure that with this work we have achieved a lot on the training of students. Our graduates successfully find jobs in local companies. We are want to mention the successful practice of our two students in the German company Pirin Tex and also two of our students who will, this year, go to summer school of design organized by the Donghua University in Shanghai.

The plan is to continue to connect with the industry through the establishment of centers of technical support to the economy. Through these centers, students would work to develop new products for enterprise as well as the technical preparation of production.

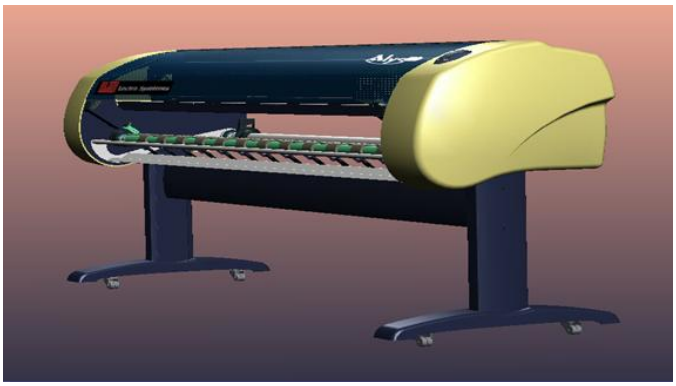

Figure 6. Industrial plotter in possession of the Technical faculty [11]

This approach is new in this region and represents a step forward in the realization of the project of our faculty - to work for a job. The Faculty already implemented a summer work internship in cooperation with Zrenjanin businessmen. The aim of this practice is for students stay to work in those enterprises. The goal of involving students in the model of reviving the textile and clothing industry is the same and that is to get students actively involved in solving real industrial problems. Acquiring these skills will definitely make it easier to get a job after graduation.

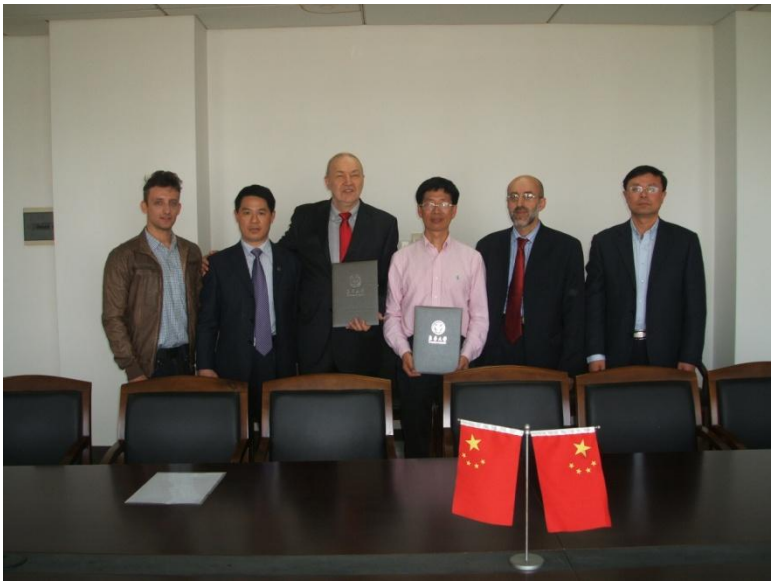

Figure 7. Signing the Contract of technical cooperation with Donghua University

An exit from this situation must be found only by those who in the sector. The solution is in finding good ideas. One such good idea is gathering educational institutions and companies around towards a common idea of development of new fashion products and to be able to cope with the strong competition in the market. Specifically, based on the judgment of the facts rises a real possibility for a solution to revive the textile industry Serbian regional assembly of enterprises and educational institutions in the center of production engineering. The success of the realization of these ideas can be guaranteed only when the large number of young people implement in these activities. The idea of establishing regional human centers of production engineering is primarily based on the inclusion of a large number of students and high school students in these activities.

CONCLUSION

There is not much need to prove the fact that for the success of any sectors, including individual enterprises crucial are managerial, technological and technical knowledge and experience of professional staff in the enterprise. This means intensifying integration of the textile sector. However, with the inadequate transition of the textile sector in Serbia we have experienced the closure of many companies and the release of a large number of workers, which resulted in a negative attitude towards this sector.

Therefore, this paper proposes a model to revival of the textile industry. The basic idea is that through promotional activities in this sector we include as many young people and for the implementation of their activities enable young people not to seek work but to create it themselves in the current textile enterprises. The model predicts intensive involvement of students primarily in the technical work of preparing and developing new fashion products.

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THE INVESTIGATION OF COMPRESSION HOSIERY

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ABSTRACT

Numerous studies around the world emphasize the unconditional impact of compression therapy as prevention of varicose veins, of trophic ulcers healing and other problems. Therefore, the development of new knitted materials for prevention and rehabilitation of anatomical forms and functions of the human body is an important issue as for medicians as for textile researchers.
The purpose of this research work is to study the structure parameters and the properties of compression hosiery for compliance with the standard requirements and for providing the necessary therapeutic effect. The compression stockings for women have been produced on circular knitting machine «Lonati» (Italy) with a special supply for elastomeric yarn. The single backed weft knitting have been chosen for stocking manufacturing. Researches of structures parameters and deformation characteristics of stretch fabric, as well as an influence of wet-heat treatments on the properties of compression hosiery have been carried out. The investigation of structure parameters and physical and mechanical properties of compression hosiery is establishing their conformity to the standard.

Key words: elastomeric yarn, compression hosiery, structure parameters, deformation characteristics, weft knitting, single backed interlooping

INTRODUCTION

Medical textile is a wide segment of the textile market due to the widespread need in them, not only in hospitals but also in everyday life, as the product for hygiene, disease prevention and the postoperative recovery period. Assortment of medical textile products is very miscellaneous.

Particular attention is drawn to medical elastic products for fixing and for compression due to their high demand. These products are divided by design into five groups: elastic bandages, elastic supporting bandages, bandages for joints fixation, compression garments, highly compression hosiery [GOST R 51219–98]. However, despite a variety of medical textile, compression hosiery for therapeutic and prophylactic using has become incredibly popular today because of its accessibility and ease using. That is why; compression hosiery is the most interesting now as for patients and for medical personal as well as for textile researchers.

The compression therapy is a basis of any treatment of varicose veins. It is now recognized that the prevention and treatment of disease through the using of compression underwear, is the only reasonable, safe method. The aim of the use of compression bandage is the reduction of venous hypertension, which results from valvular insufficiency. The application of external compression by means of a bandage serves to increase the velocity of blood flow within the veins by providing support to the muscles.

Due to the fact that medical textiles influence directly on human health, it is necessary to ensure the requirements for such products during the manufacture process. Therefore, the authors focus on the research of parameters and properties of compression hosiery and the establishing their conformity to the standards.

THEORY

End-using of compression textile products requires strict adherence to hygienic, physical and mechanical requirements. This creates the limitations in the choosing of the raw materials and of the interlooping, in design methods of structure parameters and physic-mechanical properties of knitted fabrics. Following most important requirements should be taken in account during developing the

elastic textile materials for medical purpose. First of all, manufacturing technology should provide the necessary performance and high quality of product. Secondly, knitted fabric must withstand the repeated washing without changing functional properties and ensure even distribution of pressure. Moreover, knitted fabric for compression products must be well stretched without compromising normal plasticity level of movement and should not change the size during the using. Such properties are provided by combination of a yarn and the special filaments as well as by type of an interlooping.
The creation of high-quality compression products needs the elastic fabric that provide the desired effect of preserving the product shape during the using and the ease movements. The elastomeric yarn has high stretch properties (up to 400%) and are capable to restore their original size after removing the load. Consequently the development of new types of textile fabrics with hight stretchability, elasticity and compressive capacity is possible by the using an elastomeric yarn [Ayzenshten E, 2000]. In this case, it is very important to investigate the properties of knitted fabric considering the impact of elastomeric yarn on the structure.

It is well known [Tsitovich IG at all, 2004], that weft knitting are characterized the big variety of interlooping. Nevertheless, the requirements to the compression products restrict this choice greatly. The fabric for such products should be stretchable and elastic. Specifically it should be able to restore the original size after removal of the load and to withstand the repeated load. Compression clothes should fit the human body or its part, has good hygienic properties and the smooth surface to avoid any uneven compression of skin at the points of contact. The peculiarity of knitted fabrics with elastomeric yarns is possibility to vary the compression effect as well as the hygienic properties depending on the yarn positioning in the structure.

The method of the elastomeric yarns fixing in the knitted structure affects the fabric properties and the elastomeric yarns positioning (inside or on the surface) as well. Classification of methods of elastomeric yarns fixing was carried out by prof. Kochetkova O. [Kochetkova OV, 1983] that facilitates the analysis of the properties of knitted fabric. She divided all existing methods into the few parts: the using elastomeric yarn as filling yarn, the laying it as backing yarn and the knitting it into loop. The best option for the compression fabric is the method that provides a secure fixing of elastomeric yarns in knitted structure, an equability of loops structure, an elasticity and shape stability of elastic fabric.

The analysis of geometric models of knit structure with different types of elastomeric yarn fixing has showed [Kochetkova OV, 1983] that knitted structure with weft filling elastomeric yarn has the largest elastic part of strain and the minimum content of elastomeric yarns. This fabric is high stretched in coursewise direction. The knitted structure with loops that formed from elastomeric yarns has the smallest elastic part of strain and maximum content of elastomeric yarn, but this knitted fabrics high stretched in both coursewise and walewise directions. The necessary flexibility and strain of the knitted fabric [Shalov II at all, 1984] are provided by the pre-stretching of elastomeric yarn before knitting and by its tendency to restore the original dimensions after removal of the tensile force [Tsitovich IG at all, 2004].

The single weft knitted fabric is thinner than double one that is why it is recommended for the manufacturing of compression hosiery, namely - half stockings. Elastomeric yarn is lying as backing yarn in proposed structure thus its high stretch properties are fully appeared. The backing yarn laying on the same needle in each courses would lead to an increasing of fabric thickness and to the formation of vertical relief, which is quite undesirable for therapeutic and prophylactic purposes. That is why the backing yarn laying is shifting at one needle in each courses, thereby mesh knitted structure with smooth surface is formed.

The purpose of this research work is to study the structure parameters and the properties of compression hosiery for compliance with the standard requirements and for providing the necessary therapeutic effect.

EXPEREMENTAL SAMPLES

To achieve the main goal of research the compression stockings for women have been produced on circular knitting machine «Lonati» (Italy) with a special supply for elastomeric yarn. The stockings have been made in size 4 with three I - III classes of compression. The compression women stockings were made from following yarn: textured polyamide yarn (PA6 78/18/2 dtex) and Lycra covered by polyamide of two linear density. The elastomeric yarn in the knitted structure is laying as backing (Ly310 dtex + 2 (PA22 / 7 dtex)) and is knitting in the loop (Ly22 dtex + 2 (PA 44 / 34 dtex)) as well.

METHODS

To study the properties of compression hosiery the standard research methods have been used. The structure parameters and physic-mechanical properties were determined for the each of the two recommended points [GOST R 51219–98]: the ankle is the most narrow and dense area of the stocking and the lower leg is the area of the stocking that is covering the widest part of the lower leg. Experimental studies of breaking characteristics have been conducted on tensile test machine with clamping length 50 ± 1 mm and a constant speed of clamp 150 mm / min. The experimental studies of stretching of elastic fabric have been conducted on tensile test machine too by the fixing an elongation at the point when the load was 50 N. The investigation of residual stretching have been carried out at the same time. The test was stopped and sample was under 50 N load for 30 min. After load removal the sample was left for 60 min for relaxation and elongation was measured again. The residual stretch have been calculated on the results.

RESULTS AND DISCUSSION

The details of measured structure parameters of compression stocking are given in Table 1.

Table 1: The structure parameters of compression stocking

Class of compre-ssion	Hosiery part	Length, mm		Stitch density per 100 mm		Thick-ness, M mm	Basic weight g/m^2		Changing after WHT, %
		loop l_1	float l_2	Nc	Nw		m_s	regulation	
1	ankle	1,60	0,47	240	210	0,60	250	$120 \leq m_s \leq 200$	2.1
	lower leg	1,70	0,78	240	120	0,60	217		0.8
2	ankle	1,61	0,45	240	210	0,61	252	$200 \leq m_s \leq 300$	1.2
	lower leg	1,69	0,76	240	140	0,66	228		1.1
3	ankle	1,60	0,42	240	210	0,59	251	$300 \leq m_s \leq 400$	1.4
	lower leg	1,69	0,73	240	150	0,70	230		0.2

The loop length is the main process characteristic that determines the structure parameters and physic-mechanical properties of knitted fabrics. The experimental results have showed that the loop lengths on both part of stocking as the ankle as at the lower leg are the same for all compression levels because at this case they depend on the hosiery size. The portion length of elastomeric backing yarn at one loop decreases with increasing compression. It is well known that a higher level of compression provided by increasing the stretch degree of elastomeric yarn before knitting. The length of backing yarn on the lower leg is longer by 65÷75 percentage than on the ankle that is largely dependent on the difference in leg size at these areas.

The following trends have been set as research result of the stitch density. Number of wales per 100 mm on ankle part is almost the same at all three compression levels. This is due to the fact that area is formed as a result of relaxation of elastomeric yarn up to the most tight structure formation when the loop step equals four diameters of thread. [Shalov II at all, 1984]. At the same time, the number of wales per 100 mm on lower leg increases with increasing compression. The elastomeric yarn relaxes

after the load removing according to the stretch degree before knitting, that leads to the difference of stitch density coursewise (in the direction of the elastomeric yarn laying). As for the knitting density walewise, it was found that it is 240 loops per 100 mm and does not depend on as the stocking area as the compression level .Thus, number of courses per 100 mm is depend on the knitting conditions (the gauge of knitting machine and the linear density of the thread).

The investigation is showed that knit thickness on ankle of compression stockings is 0.60 $\pm$ 0.01 mm for all compression levels. Thus confirms the above conclusion that the relaxation of elastomeric yarns in the knitted structure on this area is not full. It is limited by the loop size that is smallest on the ankle area of hosiery. The thickness on the lower leg of compression stocking increases with increasing of the compression level. The loop length on this area is by 5÷6 percentage longer the loop length on the ankle area. Such increasing of the loop length leads to largely relaxation of backing elastomeric yarn in the knitted structure. Consequently, the transverse dimension of elastomeric yarn increases. Moreover, the loop skeletons are turned in the knitted structure from the frontal plane to the perpendicular plane.

The basic weight of the same stocking area is the identical for all compression level, the difference of the value is within 5%. This confirms the known fact that the basic weight depends on the loop length, the stitch density and thickness of knitted structure, which is also not depend on the compression level. The basic weight on the lower leg is by 8-13% lower than on the area of ankle. It is associated with an increasing of loop length and thus with a decreasing of stitch density coursewise. At the same time, the basic weight increases with increasing of compression level because of an increasing of the fabric thickness and the stitch density coursewise.

Comparison of experimental data with the standard indicates compliance for compression stocking of class II. The basic weight of compression stocking of class I is higher than standard value by 9% on the lower leg and by 25% on the ankle area. The basic weight of compression stocking of class III is below the standard by 23% and 17%, respectively. It is recommended to review the knitting parameters to reduce the basic weight of knitted compression stocking of class I and thus decrease the material consumption.
The changing of linear dimensions of knitted fabrics after wet-heat treatment is one of the main characteristics of the product quality. The investigation of influence of wet-heat treatment on the compression stockings is showed that the changes in linear dimensions of the products do not occur. The value does not exceed 5% that recommended by standard.

The main physical and mechanical properties of compression products are the breaking characteristics, the full and the residual stretch. The results of the studying of stretch characteristics of compression stocking are given at the Table 2

Table 2: Physic-mechanical properties of compression stocking

Class of compre-ssion	Hosiery part	The load at 400 % elongation, N		Full stretch, %			Residual stretch %	
		before WHT	after WHT	before WHT	after WHT	regula tion	before WHT	after WHT
1	ankle	88,2	68,6	211	181	≥ 120	10	1
	lower leg	19,6	19,6	363	308	≥ 120	10	2
2	ankle	98,0	88,2	199	150	≥ 120	5	0
	lower leg	24,5	19,6	357	280	≥ 120	7	2
3	ankle	63,7	98,0	183	120	≥ 120	0	1
	lower leg	34,3	24,5	329	267	≥ 120	2	0

It was determined during the tensile test that any specimen of knitted fabric was not broken even at 400% of elongation. The value of the maximum load recorded at 400% elongation is less than the

recommended 15 N by standard for all three compression levels for both parts of women's stocking of size 4 (table 2). The same trend is kept for specimens of knitted fabric after wet-heat treatment.

The experimental values of elasticity (table 2) of compression stocking on the ankle and on the lower leg show that elongation is decreasing with increasing of compression level. The obtained values of full stretch correspond the standard both before and after wet-heat treatment of knitted product.

The intensity and degree of sizes recovery of elastic fabric after the tensile force removal depend on the elasticity, on the deformation degree and on the thickness of knitted fabric as well as on the method of elastomeric yarn fixing in knitted structure and on the yarn elasticity. Herewith the strain relaxation of elastomeric yarn is a crucial factor in the determining the degree of the recovering process. The residual stretch cousewise is in the 10% range; moreover, the best value is shown by stocking of compression level III (table 2). it can be explained by the fact that knitted fabric of compression level I is more stretched than knitted fabric of compression level III at the same load. Therefore, the process of recovering the structure is longer. It should be noted that the value of parameter is significantly reduced after wet-heat treatment.

Altogether, the physical and mechanical properties of compression hosiery correspond the standard, and wet-heat treatment does not affect the therapeutic effect.

CONCLUSION

The carried out investigation of structure parameters and physical and mechanical properties of compression hosiery is establishing their conformity to the standard for the following parameters: changing of linear dimensions products after wet-heat treatments is within 5% and does not affect the physiotherapeutic properties of compression hosiery; residual part of full stretch of products does not exceed 10% that is regulated; values of tensile strength and elasticity of the products correspond to the standardized value.
It was found that exposure of wet-heat treatments on the properties of compression hosiery is not significant. The experimental results show that differences in knitted fabrics properties before and after WHT are within the allowable error. This means that the wet-heat treatment of compression hosiery does not affect the therapeutic effect.

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THE USAGE OF ULTRASONIC BATH FOR ELASTIC POLYESTER DYEING

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ABSTRACT

Poly(trimethylene terephthalate) (PTT) is an elastic, easy dyeable and important aromatic polyester fiber. In this study, PTT fiber knitted fabrics was dyed with disperse dyes using ultrasonic bath for 15-90 minutes dyeing period range. PTT knitted fabrics were dyed at 80°C with two disperse dyes (C.I. Disperse Red 167:1 and C.I. Disperse Red 65) with different sublimation classes at pH 5. The colorimetric properties (*CIE-Lab, K/S, L^*, C^*, a^*, b^*, h^o*) of dyed PTT substrates were compared for each dyeing times. The results indicate that the color yield values of dyed PTT samples were increased in company with increasing dyeing time.

Key words: Poly(trimethylene terephthalate) fibre, PTT, elastic polyesters, ultrasonic bath

INTRODUCTION

Poly(trimethylene terephthalate) (PTT) fibers are elastic and easy dyeable polyesters (Perepelkin, 2001). PTT can be produced by polycondensation reaction with PDO (1,3-Propanediol) and TPA (terephthalic acid) or DMT (dimethyl terephthalate). Researchers notified that unit cell of PTT has a zigzag structure (Deopuno et al., 2008; McIntyre et al., 2004; Scheirs and Long, 2003). This structure can be behaved like a coil spring under elongation (McIntyre et al., 2004). PTT fibres can be easily dyed at low temperatures with disperse dyes and used in various textile application such as ready-to-wear, intimate, active and sportswear apparels, carpets, swimwear, automotive and home upholstery applications (Figure 1) (Deopuno et al., 2008; Scheirs and Long, 2003; Yıldırım et al., 2012a).

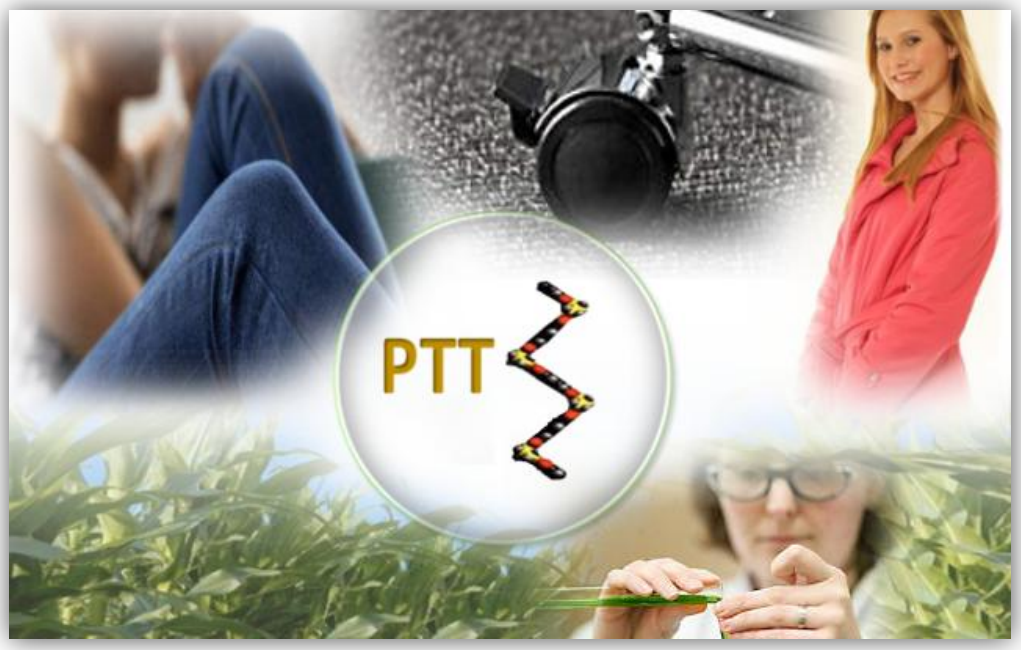

Figure 1: various textile applications of PTT (Dupont 1, 2015; Dupont 2, 2015)

In recent years, several studies were contributed to studying the dyeability properties of PTT fibres. Many researchers were investigated the dyeing processes, dyeing conditions and dyeing kinetics of PTT (Ovejero et al., 2007; Yang et al., 2002; Hawkyard, 2004; Kim et al., 2005; Wang et al., 2010; Vo et al., 2008; Zou et al., 2010; Zou et al., 2009 ; Wang and Hu, 2009; Bolhová et al., 2007;

Klancˇnik, 2006; Zheng et al., 2008). In a recent work, ultrasonic assisted dyeing of PTT fabric was studied. In that study, dyeability of PTT fabric by ultrasonic energy and the dyeing parameters such as dyeing time, dyeing temperature, ultrasonic power and swelling agents were investigated (Wang et al., 2010). The effect of ultrasonic energy on dyeing process of cotton, silk, wool, acrylic, polyesters was also investigated before. The results indicated that the polyesters dyeing with disperse dyes in the presence of ultrasonic waves led to breakage on the dye aggregates and acceleration on the dye uptake and dye diffusion rate into the fiber (Wang et al., 2010; Textile, 2015). Ultrasonic vibrations create refraction and compression in water and produce bubbles. The creation and disintegration of bubbles phenomenon is known as cavitation. (Textile, 2015).

As stated above, there are few limited ultrasonic assisted PTT dyeing studies in the literature. In this study, PTT fiber knitted fabrics was dyed with disperse dyes using ultrasonic bath for 15-90 minutes dyeing period range. PTT knitted fabrics were dyed at 80^{o}C with two disperse dyes (C.I. Disperse Red 167:1 and C.I. Disperse Red 65) with different sublimation classes at pH 5. The colorimetric properties (*CIE-Lab, K/S, L*, C*, a*, b*, h^{o}*) of dyed PTT substrates were compared for each dyeing times.

EXPERIMENTAL

Materials

100% PTT fiber single jersey knitted fabrics were used for ultrasonic bath dyeing. All fabric samples were scoured and rinsed before ultrasonic bath dyeing to remove any possible impurities.

Ultrasonic Dyeing Process

The ultrasonic dyeing processes were carried out on ultrasonic bath (*Wiseclean WUC-D10H (40 kHz 200 W HF- power)*) using two commercially available disperse dyes (*C.I. Number Disperse Red 65 (Low) and Disperse Red 167:1(High)*) via maximum (%100) ultrasonic energy (40 kHz). PTT fiber fabrics dyeing processes were carried out with a liquor ratio of 30:1 at 2% dye concentration in company with 1 g/l dispersing agent. The dyeing temperature was adjusted at 80 ^{o}C and various dyeing times (15 minutes, 30 minutes, 45 minutes, 60 minutes and 90 minutes) were selected in order to study the effect of dyeing time on the colorimetric properties of PTT fiber fabrics. For each different dyeing times, dyeing pH is adjusted to pH 5 via acetic acid/sodium acetate. After dyeing processes, PTT fiber fabric samples were rinsed with warm water (40 ^{o}C) and then tap water for 5 minutes. Afterwards, all dyed samples reduction cleared in Atac Lab-Dye HT machine with 3 g/l sodium hydroxide and 3 g/l sodium dithionite at 50 ^{o}C for 15 minutes to remove unfixed surface dyes. Then, fabrics were washed with warm water (40^{o}C) and then tap water for 5 minutes and left in the air for flat-air-drying. These air-dried samples were used for colorimetric measurements.

Colorometric Measurements

The colorimetric properties (CIE Lab; *L*, a*, b*, C**, and *h^{o}* values) were measured via DataColor SpectraFlash 600 (Datacolor International, Lawrenceville, NJ, USA), spectrophotometer using 10^{o} Standard observer under illuminant D65 for each dyed samples. The colour strength value of dyed samples (*K/S*) is calculated by means of the Kubelka-Munk equation (*Eq. (1)*) given at below:

$$K/S = (1-R^2)/2R \quad (1)$$

RESULTS AND DISCUSSION

Colorimetric Properties of PTT fiber fabrics dyed using ultrasonic bath

Colorimetric values of dyed PTT fiber fabric samples are shown on Table 1.

Table 1. Colorimetric properties of PTT fabrics dyed using ultrasonic energy at pH 5 and 80 °C for various dyeing times

Disperse dye (C.I. Number)	Dyeing Times (min)	K/S	L*	a*	b*	C*	h°
C.I. Disperse Red	**15**	6,2	48,07	49,01	0,82	49,02	0,96
167:1	**30**	8,4	45,21	51,2	1,76	51,23	1,97
(High- Heat	**45**	10,2	43,08	51,66	2,75	51,73	3,04
fastness-	**60**	11,7	41,66	52,04	2,92	52,12	3,21
Sublimation class)	**90**	20,9	36,24	53,42	6,63	53,83	7,07
C.I. Disperse Red	**15**	9,5	43,41	46,31	14	48,38	16,8
65	**30**	12,1	40,94	47,33	15,1	49,7	17,7
(Low- Heat	**45**	14,2	39,16	47,05	15,9	49,66	18,7
fastness-	**60**	18,8	35,54	46,52	15,7	49,11	18,7
Sublimation class)	**90**	23,4	33,49	47,72	16,6	50,52	19,2

It can be seen that the *K/S* values of PTT fibers increased with prolonged dyeing time for both dyes (low and high weight) (Table 1). PTT fibres dyeing with C.I. Diperse Red 65 dye for 90 minutes exhibited the highest K/S value. C.I. Disperse Red 65 dye has lower molecular weight than C.I. Disperse Red 167:1. Increasing dyeing times resulted in increasing color yield (K/S) for both dyes (Table 1 and Figure 2-9).

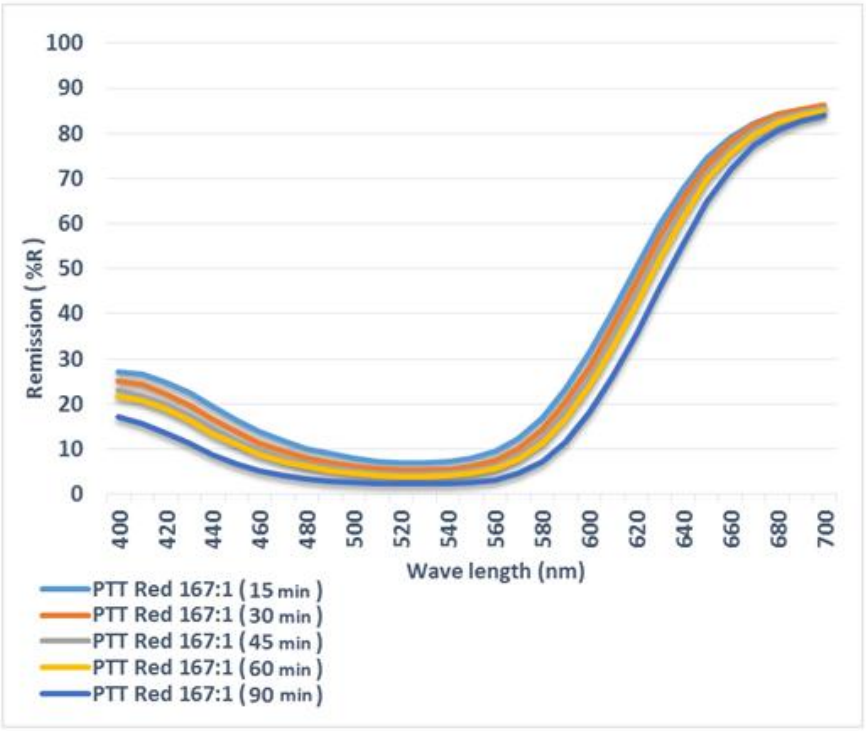

Figure 2. Remission (%R)-Wavelength (nm) plots of PTT fibres dyed with C.I. Disperse Red 167:1

The remission curves of PTT fibres dyed with C.I. Disperse Red 167:1 for various dyeing times were quite similar. Remission curves for all dyed PTT fibers are the exhibition of red shades. The remission curve of dyed PTT fibers for 15 minutes (the top one in the graph) led to brighter color shades than the dyed PTT fibers for 90 minutes (the bottom one).

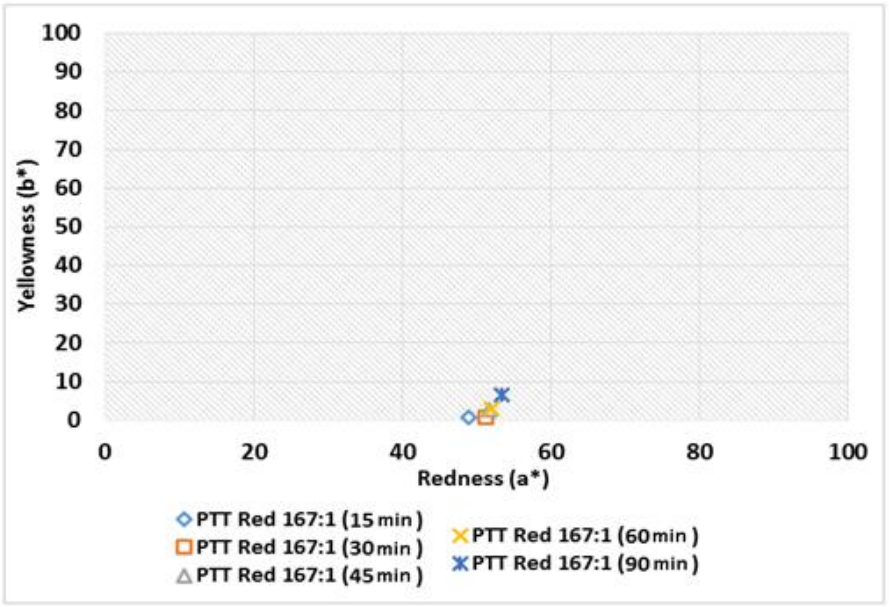

Figure 3. Redness (a)- Yellowness (b*) plots of dyed samples (with C.I. Disperse Red 167:1)*

Red color shades are also clearly visible from redness (*a**) and yellowness (*b**) values as well as hue angle values (h^o) (yellow-red axis zone) for all PTT fibers dyed in ultrasonic bath for different dyeing times. The redness (*a**) and yellowness (*b**) values of all dyed PTT samples were close to each other. The highest *a**- *b** values were reached at 90 minutes ultrasonic bath dyeings. Hue angle values of the dyed PTT fibers increased via prolonged dyeing time and the value reached to 7.07 (h^o) for 90 minutes ultrasonic bath dyeing.

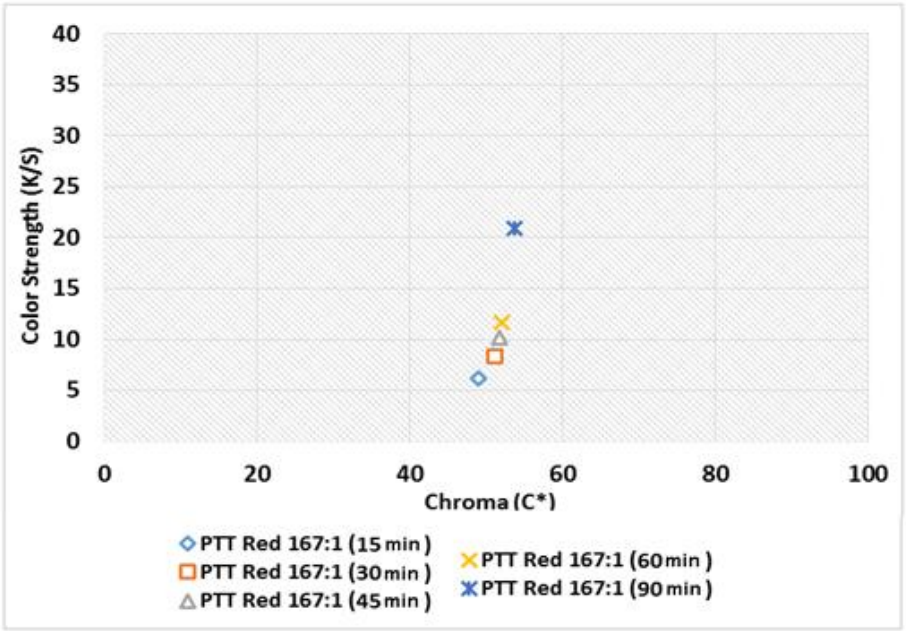

Figure 4. Color strength (K/S) - Chroma (C) plots of dyed samples (with C.I. Disperse Red 167:1)*

As seen on Figure 4, the color strength (*K/S*) and chroma (*C**) values enhanced with prolonged dyeing time. The highest color strength value was observed for 90 minutes ultrasonic bath dyeing.

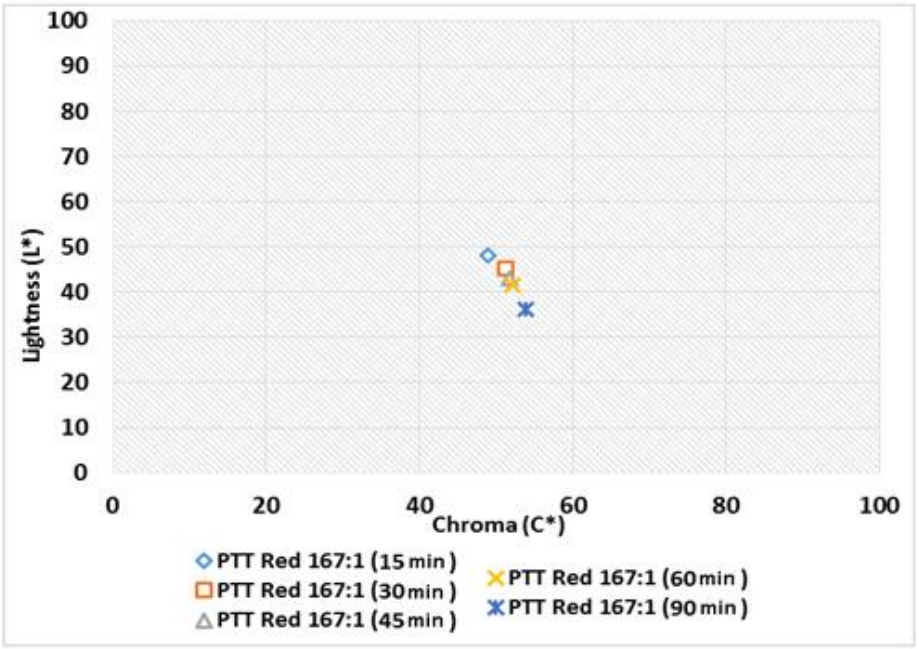

Figure 5. Lightness (L) - Chroma (C*) plots of dyed samples (with C.I. Disperse Red 167:1)*

The lightness (*L**) values of dyed PTT fibers decreased with increasing dyeing time. Color shades of dyed PTT fibers gets darker with prolonged dyeing time with lower lightness value (*L**).

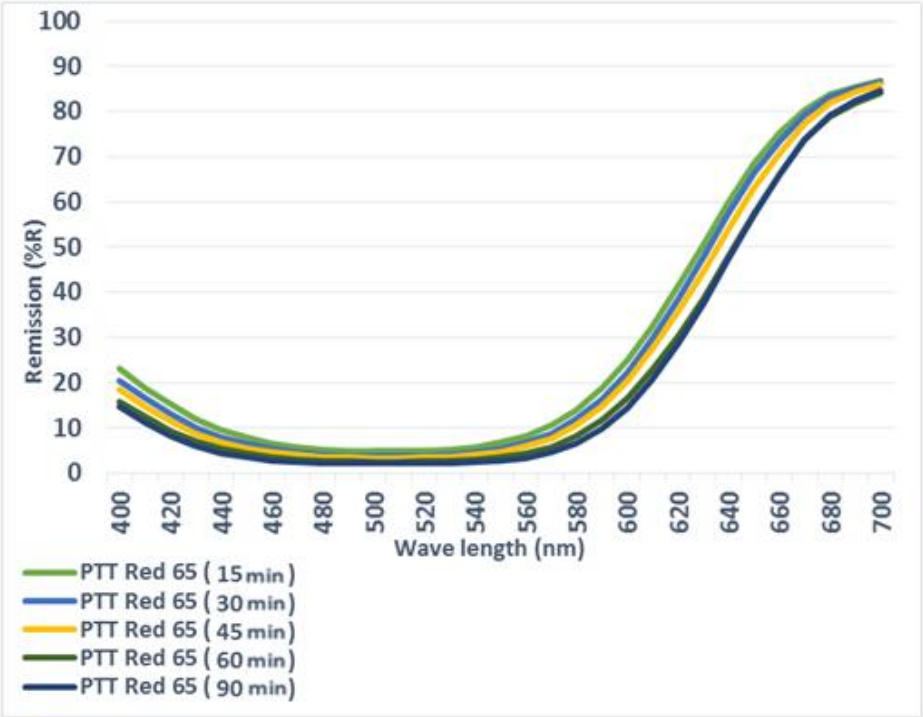

Figure 6. %R-nm plots of PTT fibers dyed with C.I. Disperse Red 65

The remission curves of PTT fibres dyed with C.I. Disperse Red 65 in ultrasonic bath for various dyeing times were quite similar with the other dye studied. Both dyes exhibited similar reflection trend. Remission curves for all dyed PTT fibers by C.I. Disperse Red 65 exhibited red color shades as expected.

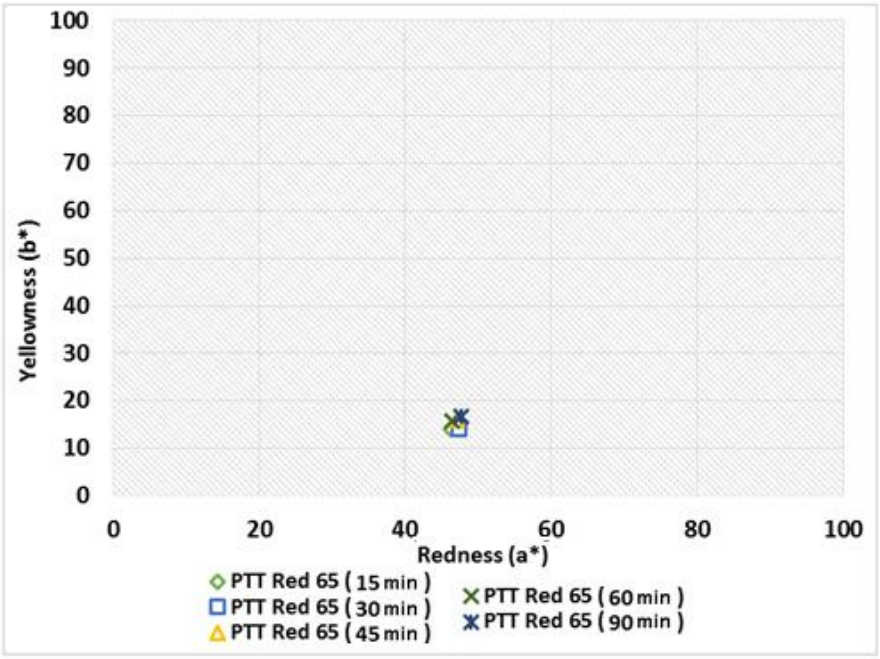

Figure 7. a- b* plots of dyed samples (with C.I. Disperse Red 65)*

The dyed fabrics were in red shades. This observation is also validated by redness (*a**), yellowness (*b**) values and hue angle levels (h^o) for all PTT fibers dyed using ultrasonic energy for different dyeing times. All dyed PTT fibres with different dyeing times exhibited quite similar *a*- b** values.

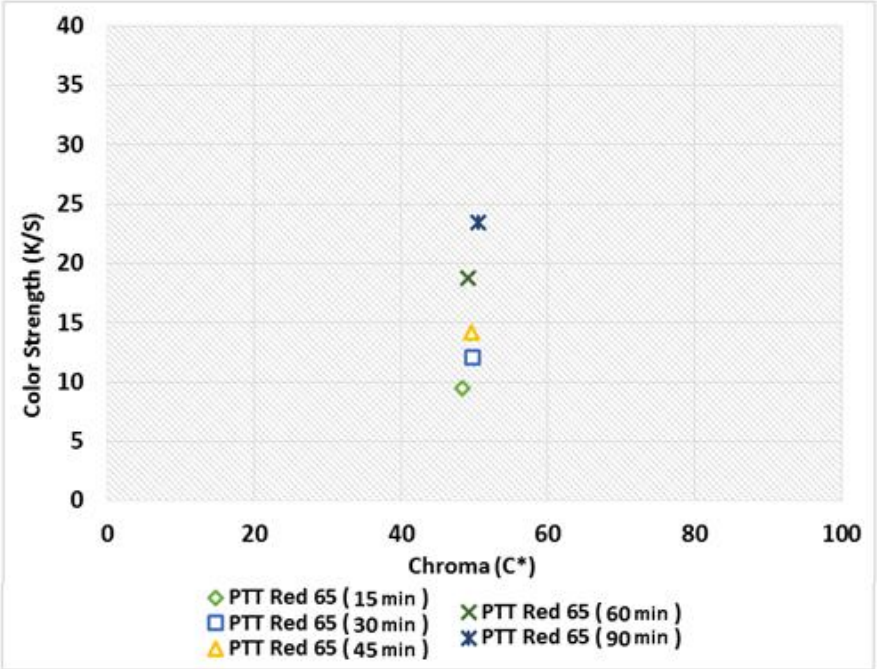

Figure 8. K/S - C plots of dyed samples (with C.I. Disperse Red 65)*

The color strength (*K/S*) and chroma (*C**) values increased. Longer dyeing times led to slightly higher chroma and distinctly higher color yield. Similarly, as seen on figure 9, the lightness (*L**) values of dyed PTT fibers declined with increasing dyeing time leading to darker appearance.

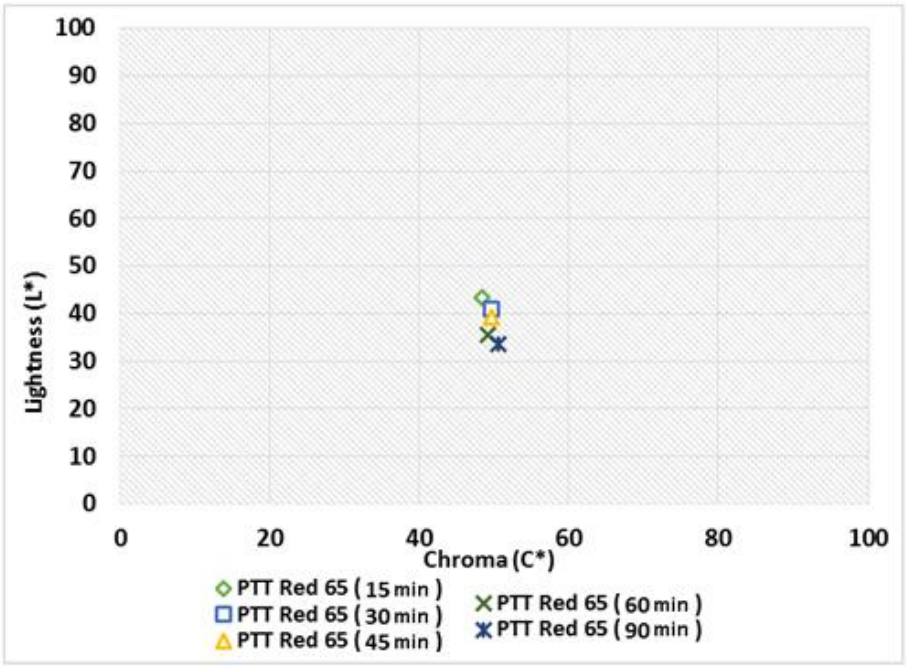

Figure 9. L - C* plots of dyed samples (with C.I. Disperse Red 65)*

As seen on all figures, the *CIE-LAB* values of the dyed PTT fibers for various dyeing times with two disperse dyes were different. The highest color strength for dyed PTT fibers was obtained for 90 minutes ultrasound bath dyeing. The color strength and the colorimetric properties of dyed PTT fibers were affected from ultrasonic energy and dyeing time. This is actually in line with the earlier study (Wang et al., 2010).

CONCLUSION

Elastic and easy dyeable PTT fiber can be dyed at low temperatures without using carrier. In this study, PTT fiber fabrics were dyed in ultrasonic bath for 15 minutes, 30 minutes, 45 minutes, 60 minutes and 90 minutes at pH 5. The dyeing temperature was set to 80^{o}C and two disperse dyes (C.I. Disperse Red 167:1 and C.I. Disperse Red 65) were selected for dyeing. The colorimetric properties (*CIE-Lab, K/S, L**, C**, a**, b**, h*^{o}) of dyed PTT samples were compared for each dyeing times. The results indicate that the color yield values of dyed PTT samples enhanced with prolonged ultrasonic bath dyeing for both disperse dyes. Moreover, all studied dyeing times (15 minutes, 30 minutes, 45 minutes, 60 minutes and 90 minutes) resulted in similar colorimetric value trends and similar color yield value trends for both dyes, C.I. Disperse Red 167:1 and C.I.Disperse Red 65 dyes.

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SOFTWARE FOR MONITORIZATION OF THE WASTEWATERS DISCHARGED BY THE TEXTILE COMPANIES

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ABSTRACT

Water is subject to direct and anthropogenic pollution, being widely spread in industry, agriculture, everyday life. Development of urbanization and industrialization and changes in consumption manners, determined a quantitative and qualitative evolution of wastewater, transforming them into complex products. Wastewater is resulted from water used in homes, public institutions, laundries, hospitals, schools, hotels, companies etc. It is rich in microorganisms and in toxic / harmful substances (detergents, dyes, pesticides, metals etc). Chemicals in municipal wastewater are largely found as decantable suspension.
Environmental protection against pollution is a priority for the European Union countries (including Romania and Serbia), as well as for countries around the world. Community policy on the environment is based on integration of environmental policy into sectoral policies of the European Union, with special attention to measures for pollution prevention. One of the most used methods is the prevention and strict control of the factors that contribute to environmental pollution. For effective monitoring of wastewater quality indicators, INCDTP Bucharest has realized a database for storing and managing the data collected from discharged wastewater generated by the textile industry. In the present paper is presented this software that helps specialists to obtain a proper management of the quality indicators of wastewater generated by the textile industry.

Key words: wastewater management, wastewater monitoring, database, pollutants

INTRODUCTION

Being a basic activity in integrated water management, quality monitoring has become an indispensable tool to space and temporal assessments regarding the evolution tendencies of concentrations and loads of pollutants, those related to compliance with the quality criteria and objectives, depreciation of accidental pollution at local and regional level.

A viable strategy in developing monitoring programs in national and / or transnational region (including Romania and Serbia) should be based on the production of necessary information, with a cost-benefit balance. The fundamental elements of a monitoring strategy derive from the quality cycle (see Figure 1), (Petropol Serb G.D., 2012).

The main wastewater monitoring objectives are: assessment of quality and trends; compliance with quality standards and objectives; calculation of massive flows of pollutants; alarming in case of accidental pollution.
Beside these objectives other monitoring aims, both for Danube as well for its effluents can be defined (Mihaescu R., 2014):

- assessment of current water quality, in correlation with quality standards and objectives;
- control of efficiency of policy instruments, agreements, permits, approvals for water quality improvement;

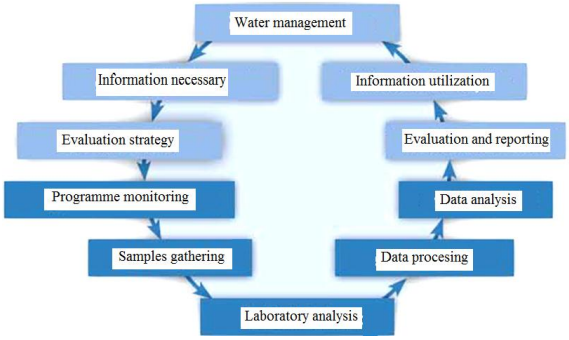


Figure 1: Water management cycle

- assessing long-term changes in aquatic system and its surroundings;
- determining the quality of border waters;
- development of knowledge on water and environment quality conditions as a result of natural and anthropic causes;
- identification of priority areas that need improvement in terms of environmental protection;
- providing information on the effects of aquatic environment activities;
- identifying and monitoring sources of pollutants and assessing the associated specific load;
- characterization and understanding of water quality issues, based on further investigation.

MONITORING INDICATORS

In the context of an environmental report, indicators are representative, concise and easy to read parameters which are used to present the main features of the environment, the factors that influence it and the impact of environment on society. Environmental indicators are often used when political processes cannot be fully evaluated based on generally accepted rules. Such indicators are actually models that describe one or more aspects of the environment and are scientifically recognized and based on simple data (in terms of availability and ease of measurement). This type of environmental information is usually presented at a higher level of aggregation. Monitoring indicators are classified into the following categories:

- indicators of achieving the management objectives;
- indicators for assessing the current situation and trends;
- multi-criteria indicators describing the environmental conditions;
- data comparability indicators.

Environmental indicators are measurable properties that, alone or in combination, provide scientific and management evidences on ecosystem quality or reliable evidence on quality trends. Environmental indicators should be measured by the available technology and scientifically validated for assessing the quality of ecosystems and providing useful information for managerial decision makers. Thus, a wide variety of physical, chemical and biological measurements on the conditions and processes on various scales shall be performed. Measurements of environmental indicators shall lead to valid quantitative and qualitative data that can be temporally and spatially compared. Interpretation of measurements should be accurate so natural variability and effects induced by anthropic activities shall be described. The methodology used for these measurements must be reproducible and provide the same level of sensitivity to the entire geographical area. Indicators to characterize the current state and trends can be grouped into the following categories:

- indicators of biological response and exposure;
- indicators of chemical exposure and response;
- indicators of physical habitat;
- indicators of stressing agents.

Indicators are created so that the following can be achieved based on their analysis:

- quantification of current wastewater quality;
- identification and quantification of the main causes of water pollution;

- quantitative evaluation of measures and investments;
- setting targets for intermediate and final goals.

COMPONENTS OF A MONITORING SYSTEM APPLICABLE IN TEXTILE INDUSTRY COMPANIES

The monitoring system is the component part of the information system making the data collection, transmission, storage and processing. It is a very complex system, which integrates into a well-defined organizational framework with specialized personnel.

Elements of a monitoring system can be grouped into the following components (Pricop F., 2013):

- technical part or hardware;
- system of programs or software;
- database;
- human resources and organizational framework.

Technical part or hardware is the totality of data collection, transmission and processing, in which the electronic computer plays a central role (see figure 2).

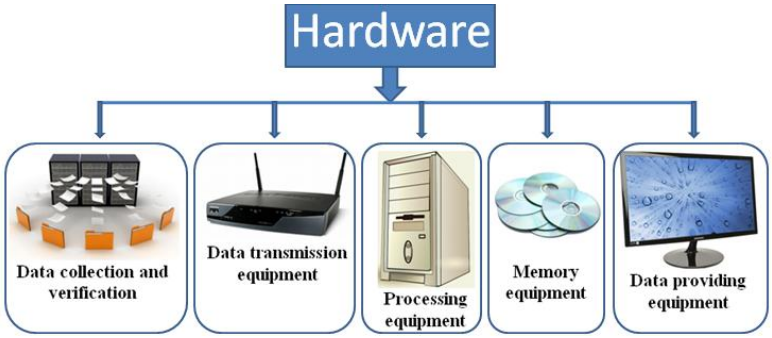


Figure 2: Hardware components of a monitoring system

The programme or software system comprises the total of programmes used that are implemented. They are the operational basis of the PC. It is divided on two categories:

- basic software;
- application software.

The basic software represents the programme operation system, the company programmes packets etc. The application software represents the total programmes written for concrete needs of monitoring and management of the respective process. The information basis comprises the data subjected to processing. All the other components are simple passive elements, they have a value only to the extent that the information basis exists and it has a high quality. The human resources in the organizational structure comprise specialist personnel such as analysts, programmers, operators and other categories of personnel. They work in a well defined organizational structure: the IT office and IT centre with information and functional links.

QUALITY MONITORING SOFTWARE FOR TEXTILE INDUSTRY WASTEWATES

For an effective monitoring of quality indicators was realized a database for storing and managing data collected from wastewater generated by the textile industry. The data base for storage and management of the data collected from the wastewater from the textile industry is software product accomplished with Visual Fox language programme version 6. The product has a friendly interface, easy to use even by an regular user. The actual database itself consists of 6 work files (5 nomenclatures and 1 basic file containing the data collected), whose functionalities will be presented further (Pricop F., 2013):

1. NOMFIRM.dbf - nomenclature of companies with the company name.

2. NOMINDFC.dbf - nomenclature of the standardized physical and chemical indicators that characterize the samples collected from the treatment plants analyzed.
This nomenclature contains the following fields:

- indicator code;
- indicator name;
- indicator measuring unit;
- number of the norm used for evaluation;
- additional information for completing the norm.

3. NOMLOCPRELEV.dbf - contains data about the sampling place, having the following fields:

- code of the company where the sampling took place;
- code associated to the sampling place;
- name of the sampling place.

4. NOMLAB.dbf - nomenclature of the analysis laboratories, with the fields:

- code associated to the laboratory performing the analysis;
- name of the analysis laboratory.

5. NOMRAPINC.dbf - nomenclature of the testing reports, whose content is made of:

- code of the company where the sampling took place;
- sample code, which consists of linking the numbers of test reports out of which the laboratory values are extracted from;
- number of testing report;
- date of testing report;
- code of sampling place;
- code for admitted value;
- code of the laboratory performing the analysis.

6. VALINDFC.dbf - work file containing the value of physical and chemical characteristics of the data collected, with the fields:

- company code;
- sample code;
- values obtained from the wastewater sample analysis;
- a set of indicators associated to the type of values, -1 for the sign ”<” from the report.

Its objective is to make the calculations that synthesize the monitoring (highlighting the physical and chemical indicators that exceed the admitted value, their statistics in time, the extreme values that are not within the limits set by norms etc.) of the process. (Pricop F., 2012).
The software (database) was developed by INCDTP and used to monitor the textile companies from Giurgiu North Technological and Industrial Park. Some of the results obtained are (Pricop F., 2012):
a. Water pollutants - the software allows the management of information referring to water pollutants. The window makes a selection in the followed pollutants database.
b. Quality conditions related to water pollutants - the software allows the management of information referring to the quality conditions of the water pollutants. Practically, this comes to highlighting the values of the pollutants analyzed that are within normal limits and of those which exceed these limits.
c. Tests (measurements) of water pollutants - the software allows to collect and to update the information referring to the measurements or tests of the water quality. The window that is activated after choosing this option was presented in the previous chapter (VALINDFC.dbf work file).
d. Water pollution - average values - the software allows to calculate average values of the samples tested for a set of measurements (depending on the company, sampling location etc.) of wastewater and pollutant.
e. Tests - exceeded values - the software allows the access to a data collection, in view of the analysis and evaluation, by means of data sets that were gathered in the companies, sampling locations and pollutants. Values that exceed the alert threshold are highlighted and compared to the maximum admissible concentration and to the exceptionally admitted. From the data collection only the exceeded values are extracted. The value of the risk is calculated as an average of the exceeded values. The highlighting of the exceeded values and the calculation of the risk factors are effected on both the whole period for which data exists and for a period specified by the user between the start and the end time (see figure 3).

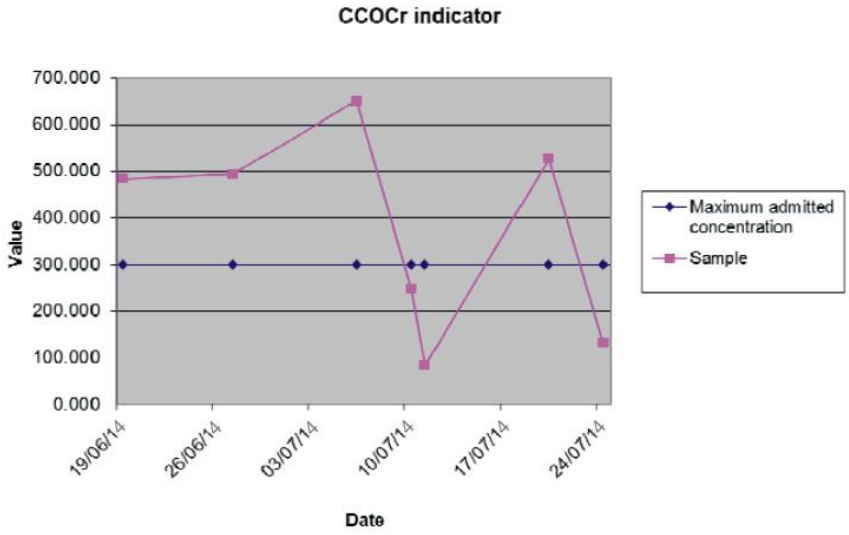


Figure 3: Graphic illustration of exceeding values (CCOCR indicator)

f. Diagrams - the software allows the access to the data collection for analysis and evaluation by means of the sets defined and of the pollutants (see figures 4 and 5).

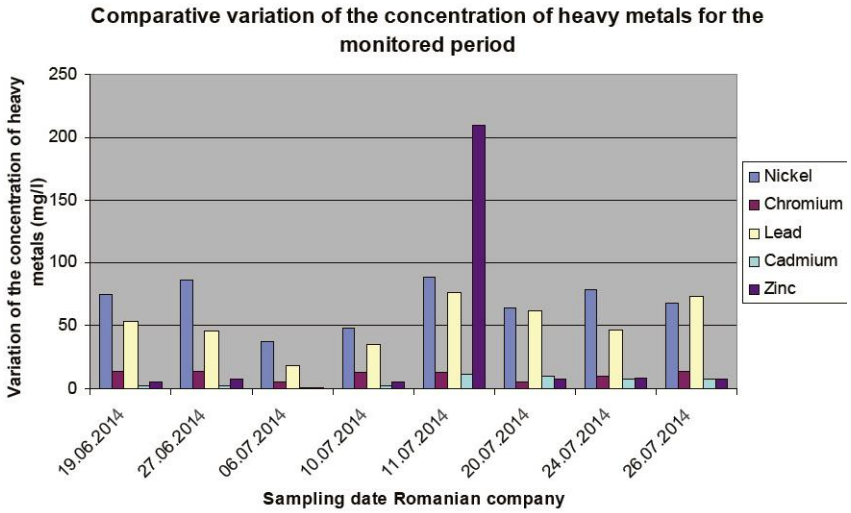
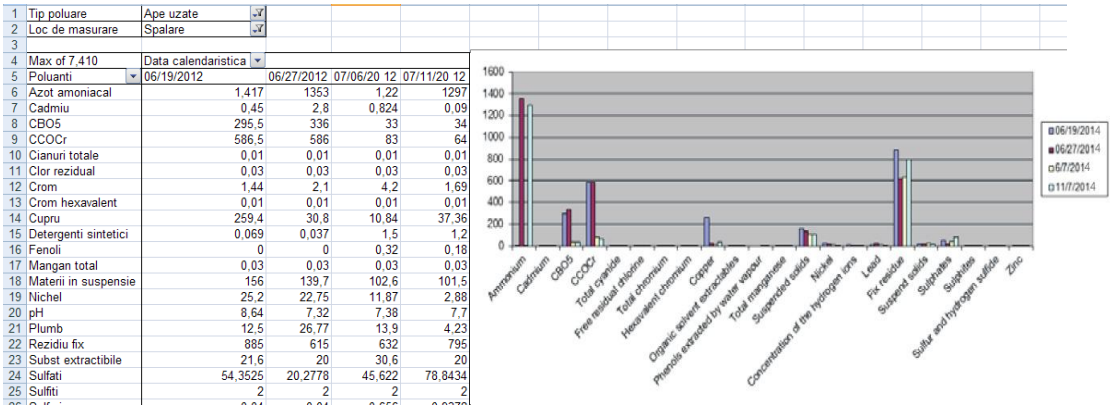


Figure 4: Comparative variation of heavy metals content concentration for the monitorized period (from the companies within the Giurgiu North Technological and Industrial Park)



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2	Loc de masurare	Spalare			
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4	Max of 7.410	Data calendaristica			
5	Poluanti	06/19/2012	06/27/2012	07/06/20 12	07/11/20 12
6	Azot amoniacal	1,417	1353	1,22	1297
7	Cadmiu	0,45	2,8	0,824	0,09
8	CBO5	295,5	336	33	34
9	CCOCr	586,5	586	83	64
10	Cianuri totale	0,01	0,01	0,01	0,01
11	Clor rezidual	0,03	0,03	0,03	0,03
12	Crom	1,44	2,1	4,2	1,69
13	Crom hexavalent	0,01	0,01	0,01	0,01
14	Cupru	259,4	30,8	10,84	37,36
15	Detergenti sintetici	0,069	0,037	1,5	1,2
16	Fenoli	0	0	0,32	0,18
17	Mangan total	0,03	0,03	0,03	0,03
18	Materii in suspensie	156	139,7	102,6	101,5
19	Nichel	25,2	22,75	11,87	2,88
20	pH	8,64	7,32	7,38	7,7
21	Plumb	12,5	26,77	13,9	4,23
22	Rezidiu fix	885	615	632	795
23	Subst extractibile	21,6	20	30,6	20
24	Sulfati	54,3525	20,2778	45,622	78,8434
25	Sulfiti	2	2	2	2

Figure 5: Comparative variation of heavy metals content concentration for the monitored period (from the companies within the Giurgiu North Technological and Industrial Park)

g. Statistics - the software allows a synthesis referring to the data collection for the set, pollutant type and pollutant chosen. The values that exceed each of the three thresholds (alert threshold, maximum admissible concentration and exceptionally admissible concentration) will be highlighted. The following will be calculated:

- total number of tests (measurements) existing in the data collection associated with the set;
- number of tests (measurements) with values exceeding the three thresholds;
- probability to exceed the value for each of the thresholds;
- value of risk as an average of values exceeded;
- the highest value measured.

CONCLUSIONS

Sustainable development has become a requirement of environmental and technological efforts are directed towards permanent modernization. Through the activities of monitoring and control of wastewater quality parameters throughout the hole technological process of wastewater treatment plants and by creating a database, was contributed to the reduction of negative impact on the natural ecosystems and the implementation of strategies to prevent environmental pollution.
INCDTP developed a software program for proper management of waste water quality indicators and tested it.

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TEXTILE FIBERS USED IN PRODUCTS FLOATING ON THE WATER

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ABSTRACT

The production of floating textile materials has an important role in textile industry; however there are limited fiber options for such materials. Only few fibers exhibit properties which are suitable for floating product manufacturing, although there are more than hundredtextile fibers are available and used in textile industry. The most important parameter for floating purposes is obviously the density of the fiber. As expected, specific gravityshould be less than 1g/cm^3 so the fiber can float on the water. Only few fibers such as polypropylene, polyethylene, high performance polyethylene, kapok and milkweed fibers have convenient specialties for floating materials' production. These materials are used as buoyant marine products in addition to their usage as oil-spill cleanup. In this review, floating fibers were determined and their information as well as their buoyant end-use applications was highlighted.

Key words: polypropylene fiber, polyethylene fiber, high performance polyethylene fiber, kapokfiber, milkweed fiber

INTRODUCTION

Today, more than hundred fibers are used in textile industry but there are limited numbers of textile fibers which can be used in floating material textile production. A textile fiber is required to satisfy specific properties such as specific gravity (density) less than water and surface energy less than water in order to be used in the production of floating textile materials[1]. In other words, it has to float or buoy on the water. Natural kapok fibers, natural milkweed fibers and also synthetic polyolefin fibers such as polypropylene, polyethylene and high performance polyethylene (HPPE) fibers can be used as floating raw textile materials for buoyant textile material production. Kapok is the lightest natural fiber and also it has hollow fiber structure[2]. Fiber structure of milkweed fiberis so similar to that of kapok fiber, it has also hollow fiber structure[3]. Milkweed has specific gravity less than 1 g/cm^3. Both kapok and milkweed fibers are buoyant but milkweed fiber is hydrophilic whereas kapok fiber exhibit hydrophobic character[2,3].

All polyolefin fibers like polypropylene, polyethylene and high performance polyethylene (HPPE) have specific gravity less than 1 g/cm^3. All these synthetic olefin fibers can float on the water. However polyethylene fiber sinks on some conditions but polypropylene fiber will float [4]. All thesesynthetic and natural fibers have specific gravity less than 1g/cm^3 and they can be used in floating marine textile products such as ropes, life jackets, mooring lines, fishing lines, and nets in addition to their special usage as oil-spill cleanup.

BUOYANT TEXTILE FIBERS AND THEIR END-USE APPLICATIONS FOR FLOATING MATERIALS

Polypropylene Fiber

Polypropylene fiber, belongs to polyolefin family, is one of the buoyant synthetic fiber (*Figure **1***). These fibers can float on the water and they are totally hydrophobic leading to water repellent property for single fiber. Their buoyancy is related to their density, surface tension and the amount of air between fibers in the yarn or fabric structure[5]. Specific gravity of the polypropylene fiber is 0.90 g/cm^3 and water's specific gravity is 1 g/cm^3. This means that polypropylene can float on the water since it is lighter than water. Surface tension is another parameter that effects buoyant property[1,6]. Difference between surface energies of water (72 dynes/cm^2) and polypropylene fiber (29 dynes/cm^2) lead to not only buoyancy property but also water repellent behavior[1]. Furthermore, amount of air

that is trapped between the fibers are also very important for this buoyant character of the polypropylene fiber[6].

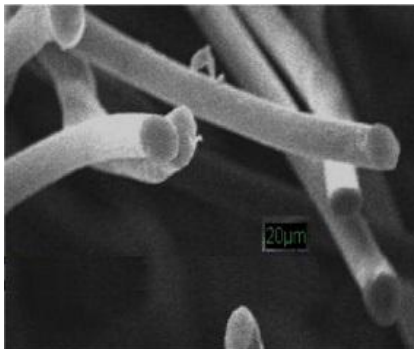

Figure 1: SEM image of polypropylene fiber [7]

Although polypropylene fiber is ahydrophobic fiber, it can absorb oil. Even though it is saturated withoil, it will keep floating on the water. Polypropylene fiber never sink to the bottom-ground but it can float lower level than the water line (the interface or boundary line between the atmosphere and the water) inside the solution which contains some chemical substances such as soap, detergent, alcohol or chemical dispersant which may affect its floating capability[4].Thesekinds of substances can cause changes on the surface energy of the fiber and the water surrounding the fiber leading to the ingress of water between the fibers via penetration. Nevertheless, it is not enough to sink the polypropylene fiber to the bottom-ground [1,4].

Polypropylene fiber is commonly used in floating products, on the water, such as lifejackets[5], mooring and tow lines[5], ropes[5] (Figure 2), inhibitive barriers water pollution[8,9], fishing lines, fishing nets. Polypropylene can also be used as a material for marine oil-spill recovery due to its low density, hydrophobic character and excellent physical and chemical properties[7-11]. When oil and some oil-based materials are spilled into sea water, they can be seriously dangerous for environment[7]. Buoyant fibers can be used in order to cleaning such oil-spills from water or seawater.

Figure2: Polypropyleneropes[12]

Polyethylene Fiber

Polyethylene fiber also belongs to the polyolefin family like polypropylene fibers[5]. Its specific gravity is slightly lessthan 1g/cm^{3}which is similar to other polyolefin fibers and it can also float on the water[5]. However, polyethylene fiber sinks on some conditions on contrary to polypropylene fiber which will float on many conditions[4].Life jackets, ropes, lines and fishing nets are some of the examples of polyethylene fiber for their floating textile material usage. They have good resistance to

moisture, to UV light and to most of the chemicals. Polyethylene fibers and their nonwoven structures can also be used for oil-absorbing materials as in polypropylene fiber[11].

High Performance Polyethylene Fiber (HPPE)

High performance polyethylene (HPPE) fiber, that is produced from ultra-high molecular weight polyethylene (UHMWPE) polymer, can be used in the production offloating textile materials[13,14]. All Dyneema, Spectra and Tekmilon commercial HPPE fibers' densities are slightly less than 1g/cm^3[14]. This fibers' superior properties such as high strength, high modulus and low density makes them a good candidate for marine product utilization such as ropes, lifejackets, fishing lines, mooring lines, fishing nets, composite structures whichcan be used in boat production[13].These superior properties lead to the creation of durable marine floating textile materials (Table 1). Besides, their usageis suitable for humid conditions and sunny places such as oceans and seas[14] due to their good resistance to chemicals, sea water and sunlight [13].

Table 1: Properties of High Performance Polyethylene Fibers[14-16]

Density (g/cm^3)	0.97-0.98
Young Modulus (GPa)	80-130
Moisture Regain (%)	~0
Elongation (%)	2.5-3.6
Tensile Strength (GPa)	3.5

Kapok Fiber

Kapok fiber,that is the lightest natural fiber in weight, has flotation capacity 14 times better than that of cork[2] (Figure 3). This fiber is extracted from the seedpods of the Kapok tree, also called ceibatree, whichgrows in the tropical forests[17-19]. Specific gravity of the kapok fiber depends on the region that grows. For instance, density of Indian kapok fiber is about 0.0554 g/cm^3 while Japanese kapok's density is about 0.0388 g/cm^3[2].

Figure 3: Respectively; Kapok tree [18], semi-opened kapok fruits[20], opened kapok fruit [21], kapok fruit with the inner fiber [22]

Kapok fiber,in the range of 2–4 cm long (Figure 4), is fragile and can break easily. Therefore, their solely usage for spinning and weaving is very difficult. It is generally blended with other fiber in small quantities[17,23].Kapok fiber has a hollow structure with large lumen [23,24]and contains approx. 80% air. It is extremely buoyant and can support up to 30 times of its own weight in water[2]. Kapok fiber iscompletely eco-friendly due to their pesticide-insecticide-free production.It is also non-allergic because the fibers are coated with a thin layer of wax leading to hydrophobic (water-repellent) properties[2,24]. This wax coating stops the ingress of insects and tiny organisms into the fiber. It is also a good material for stuffing beds, pillows and cushions for fiberfill purposes[17].

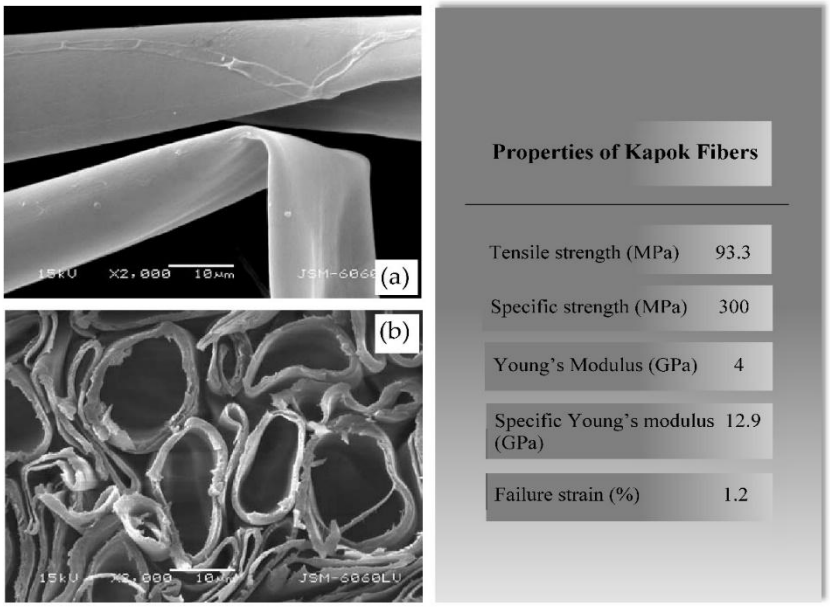

Figure 4: SEM images of kapok fibers[25] and properties of kapok fiber [2]

Kapok fiber, 8 times lighter than cotton, is also very soft as well as silk. Because of its good insulation features, it is used for acoustic and thermal insulation[26]. Kapok fiber is used for floating products such as lifejackets[27,28], fishing lines [29,30], fishing nets [2,29] and ropes [29], since kapok is extremely buoyant and does not absorb water.It has hydrophobic identity and highly oleophilic character [24,31]. Furthermore, kapok fiber can be used for oil spill cleanuppurposes since it has excellent oil absorbency and retention capacity[3,7,24,31,32] (Figure 5). Additionally, kapok fiber is found to be useful as electrodes for microbial fuel cells in recent researches [18].

Figure 5: Flating products made from kapok fiber [33]

Milkweed Fiber

Milkweed fiber,belongs toAsclepiadaceae family and also known as stubborn weed, is another textile fiber that can float above the water[34] (Figure 6). Density of milkweed fiber is0.9 g/cm^3. Milkweed fiber will only absorb oil thanks to its hollow structure[35]. It is able to absorb oil quickly up to 40 times of its weight[3].While milkweed fiber absorbs oil, it repels water[3].Its oil absorbing capacity is 4 times greater than that of polypropylene materialsused for spills[3].This fiber, that grows in Canada, USA and Mexico, have hollow structure and does not need fertilizer. It is also non-allergenic[35].

Figure 6: a) milkweed seed pod[36]; (b) opened milkweed follicle[37]; (c) fibers attached to seed [38], (d) fibers attached to seed (dry state)[39], e) SEM image of Milkweed fibers[7]

CONCLUSION

This review highlights the special fibers whichare used in floating textile materials production. There are limited fiber options for buoyant fibers. Fiber properties such as density, surface energy and amount of trapped air between the fibers have important roles in production of buoyant products. Today, it is known that fibers such as polypropylene, polyethylene, high performance polyethylene, kapok and milkweed fibers have convenient specialties to these buoyant textile products.

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INFLUENCE OF SEWING SPEED ON PRESSER FOOT DISPLACEMENT

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ABSTRACT

The dynamic of stitch formation was investigated for industrial lockstitch sewing machine, stitch type 301. The presser foot displacement at various sewing speed was analyzed using specially developed program. Woven fabrics of same fibre composition and different weave were tested in warp and weft direction.
It was shown that increasing of the sewing speed and fabric structure affects the height of presser foot displacement in feeding phase. The increasing of the sewing speed affects presser foot trajectory and behavior in a needle penetration phase.

Key words:stich formaton monitoring, sewing speed, presser foot displacement

INTRODUCTION

The end of the 20th century has brought important new trends in fashion design, marketing tools and consumer attitudes that have reshaped the demands on the textile and apparel industry. The main consequences to apparel manufacturing have been a constant increase of individual production orders, product and materials variety and much smaller order quantities.

This fact posed new requirements on the production systems and equipment: both have to be flexible and reliable. In the case of equipment, this means that quicker set-up times are required whenever materials changes and the quality assurance has to be much more efficient.
Managing this situation with the traditional empirical machine set-up and process planning methods is difficult. Better control and predictability of the processes are required.

To achieve the objective of a more complete, and, in particular, more objective control, the first step is a better understanding of the stitch forming process and fabric-machine settings interaction. This is one of the motivations for several researchers and manufacturers to perform studies using sewing machines devised with sensors to measure several process variables in real-time (Matthews B. N., et al., 1988, Chmielowiek R., et al., 1995).

For the feeding system, two variables were evaluated: the presser foot bar compression force and displacement, using, respectively, a piezoelectric force transducer and a Linear Variable Differential Transformer (LVDT), attached to the presser foot bar. This led to the development of an electromagnetically actuated presser foot to replace the standard spring actuated presser foot system, proving to be reliable, effective, and able to control the movement of the fabric plies, according to material characteristics and sewing speed.

The approach towards the development of a presser foot controller to accomplish the main objectives mentioned previously has already been published (Silva, L. F., et al., 2003). For the sake of completeness, it must be referred that this study began with the development of a software module to ease the setting of force according to the properties of the fabric being sewn. Two control strategies were implemented:
1 - An open-loop control, according to the control curves determined for each tested fabric, as a function of the imposed seam quality, and knowing that the force applied by the electromagnetic actuator should be proportional to the measured sewing speed, and
2 - A closed-loop control, using a PID PC-based module and computing the presser foot bar maximum displacement peak, above the throat plate level, as the feedback variable, to be compared

with a reference defined within the admissible displacement values found to assure good feeding performance and seam quality.

A dedicated signal acquisition and analysis equipment was also developed for measuring, respectively, the presser foot bar compression force, the needle penetration and withdrawal forces and the needle and loppers threads consumption and tension. With this system, the performance of the sewing machine feeding system (made up by a standard presser foot, with a helical compression spring on the presser foot bar, a throat plate and a differential feed dog) was studied. LVDT was also attached to the sewing machine to measure the presser foot bar displacement and, along with the kinematic analysis, enabled a better understanding of the feeding system dynamics. To study the behavior of the presser foot mechanism an advanced "sewability" tester was used, where the performance of needles, presser feet, feed dogs, fabrics and sewing threads can be assessed during high speed sewing (Rocha A.M, at al., 1992, Rocha A.M, at al., 1996, Rocha A.M, at al., 1996, Carvalho M., Ferreira F.N., 1996, Carvalho H., at al., 1997, Carvalho H., at al., 1998). They have instrumented overlock sewing machine, with miniature piezoelectric force transducers on the presser foot and needle bars, encoders and semiconductors.

The current paper presents the development of stitch formation monitoring methods relying on the measurement of presser foot displacement with variation of the fabric structure and different sewing speed (1000spm, 3000spm and 4000spm) on foot displacement.

EXPERIMENTAL

The materials investigated are woven fabrics of same fibre composition, warp and weft yarn count. The fabric designated A is in plain weave, while fabric B is in twill weave. The geometrical roughness of the fabric was measured on KEFS-B system for fabric evaluation under low load. The fabric A in plain weave have greater geometrical roughness compared to fabric B.
The particulars of fabric structure parameters are shown in Table 1.

Table 1: Investigated fabric particulars

Fabric	Weave	Warp density, cm^{-1}	Weft density, cm^{-1}	Fabric thickness, mm	Fabric weight, g/m^2	Geometrical roughness μm
A	Plain	29	20	0.39	200	10.8555
B	Twill 2/2	35.4	24.4	0.45	250	3.8910

The seams type 1.01.01, applying stitch type 301 were produced using PFAFF industrial lockstitch sewing machine. The samples were produced in warp and weft direction. Samples were sewn using needle size of 100Nm, Tt=25tex sewing thread.

Data collection devices were implemented on a sewing machine, namely strain gauges and piezoelectric sensors, encoder, and hardware for signal conditioning and processing. The devices are connected to a data acquisition board installed in a PC, with software that allows sensors calibration, on-line graphical display and signal processing functions. The program includes also basic statistical facilities, in order to shorten the evaluation of the results. A LVDT (Linear Variable Differential Transformer) was used to measure the presser-foot vertical displacement. Piezoelectric sensors were used to measure forces on the needle bar and on the presser-foot bar, generated during the stitch forming.

In a stitch cycle, the feed dog is at the throat plate level, during its rising movement, at approximately 80 degrees, being its maximum position at around 160 degrees. It will be at the throat plate level again at approximately 260 degrees on its descending movement. During almost half period of the stitch

cycle fabric feeding occurs and during the other half the stitch is formed. Therefore, a stitch cycle corresponds to a rotation of 360 degrees of the sewing machine main shaft. The beginning of the cycle (0 degrees) is marked when the needle is on its lower position, after fabric penetration (Table 2).

Table 2: Needle and feed dog position / motion in a stitch cycle

Main shaft Position (degrees)	Position / motion of the needle	Position / motion of the feed dog
0	Needle at its lowest position, after fabric penetration – beginning of the cycle	Feed dog below the throat plate on its descending movement - beginning of the cycle
20-70	Needle withdrawal from the fabric – rising movement	Feed dog at its lowest position and returning under the throat plate
80	Rising movement	Feed dog at the throat plate level
100	Needle tip withdrawal	Feed dog above the throat plate
160	Rising movement	Feed dog at full rise
170	Needle at the top position	Feed dog above the throat plate
170-260	Descending movement	Feed dog moving to advance the fabric
260	Needle tip penetration	Feed dog at the throat plate level
360	Initial position of the cycle	Initial position of the cycle

RESULTS AND DISCUSSION

Trajectory of presser-foot displacement monitoring is represented in the figures (1 and 2). Presser-foot displacement can also be divided in phases:

- Phase 1 is the feeding phase, in which the feed-dog emerges from the throat plate and pushes the fabric. The presser-foot should in this phase ideally accompany the vertical component of the feed-dog's movement;
- Phase 2 is the needle penetration phase, in which the presser-foot should hold the fabric firmly against the throat plate.

In feeding phase (fig. 1 and 2) the presser-foot describes different trajectories depending on sewing speed. When the speed is 1000spm the peak of trajectory is more rounded. Increasing the sewing machine speed to 3000 and 4000spm, results in sharper trajectory peaks. The height of the presser foot movement also varies with sewing speed. There is noticeable increasing in presser foot height changing when increasing sewing speed from 1000 to 3000spm. When increasing from 3000 to 4000spm, also there is increasing of presser foot height but no as noticeable as in the previous case.

Regarding phase 2, (needle penetration phase), we also notice differences in presser foot trajectory at different speed. At 1000spm the trajectories of the presser foot is smooth in second phase as it was in the first phase. When speed is increased over 1000spm, and the feed-dog disappears under the throat plate, there is a deviation from the ideal situation and we see the occurrence of needle bouncing in the second phase and loosing of the contact with the fabric.

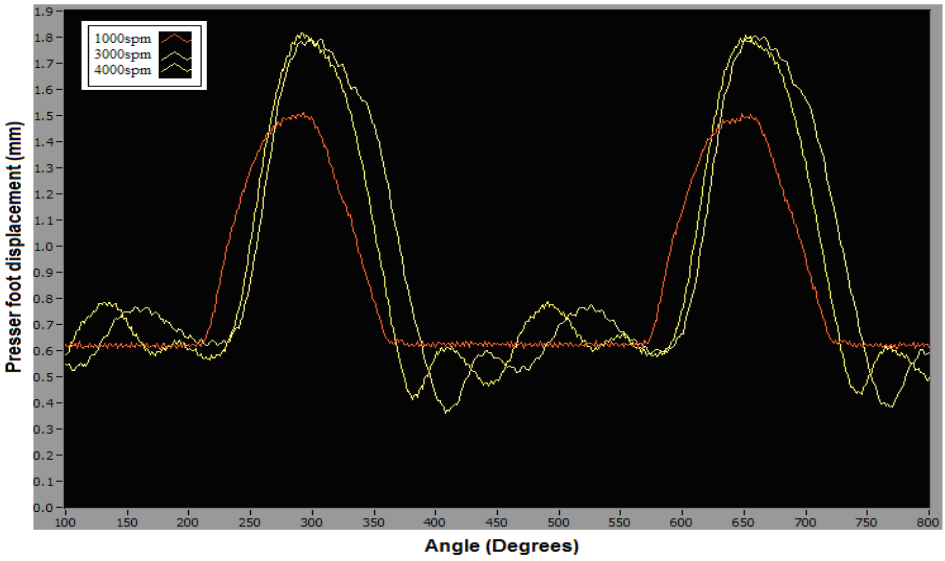


Figure 1: Displacement of the presser foot at speed 1000, 3000 and 4000 spm on fabric A, for seams in warp direction

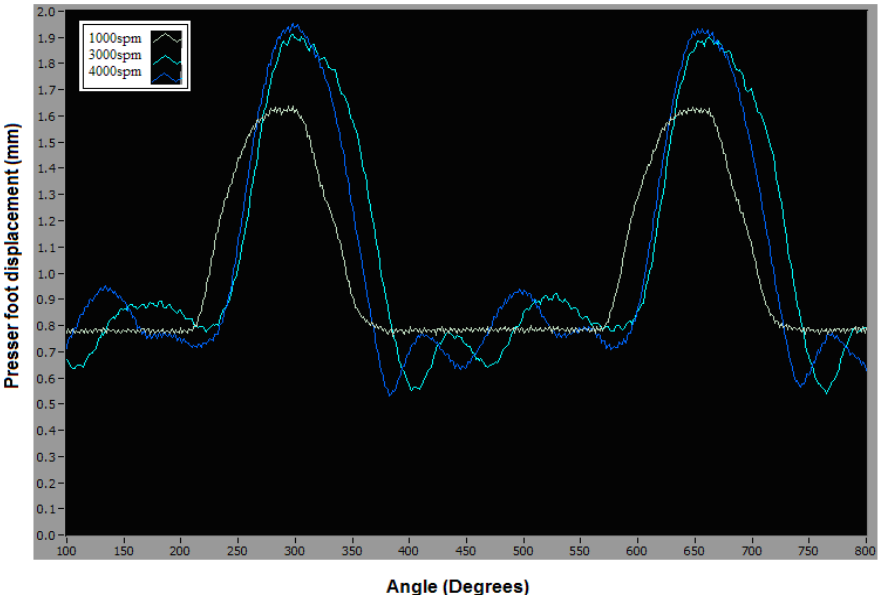


Figure 2: Displacement of the presser foot at speed 1000, 3000 and 4000 spm on fabric B, for seams in warp direction

The fig. 1 and 2 shows a graph of presser foot displacement for the sample A plain weave and B twill weave for various sewing speed. The two samples show similar trajectories for all tested speeds. The difference between two samples is in height of the presser foot displacement in both phases. The sample B having higher fabric thickness, in both sewing directions gets greater amount of presser foot displacement compared to fabric A (plain weave). In this case, the height of displacement of presser foot can give relevant information about the thickness of the seam at the point of stitch formation.

From diagrams fig. 3 and 4, when the seam is formed in weft direction, we can see the same behaviour as in the case of warp seams at all testing speed.

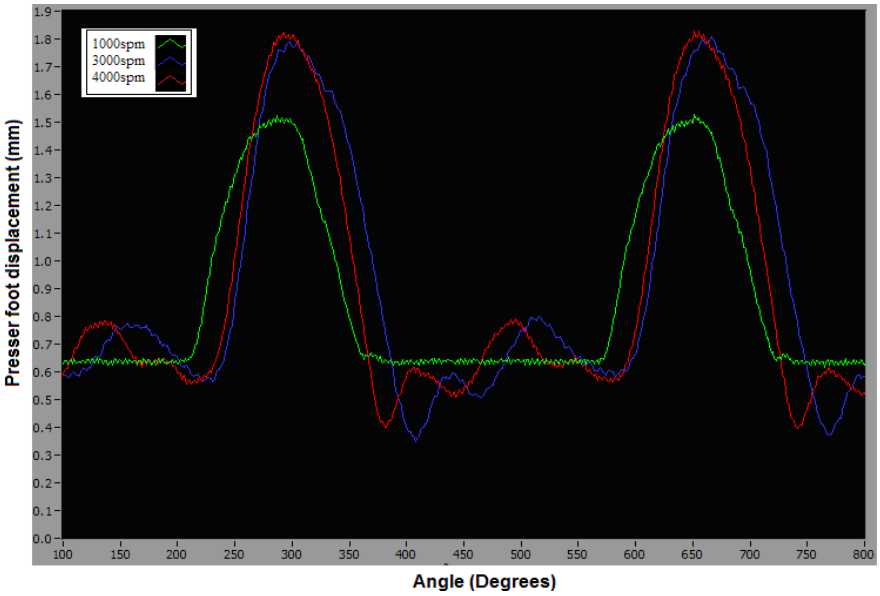


Figure 3: Displacement of the presser foot at speed 1000, 3000 and 4000 spm on fabric A, for seams in weft direction

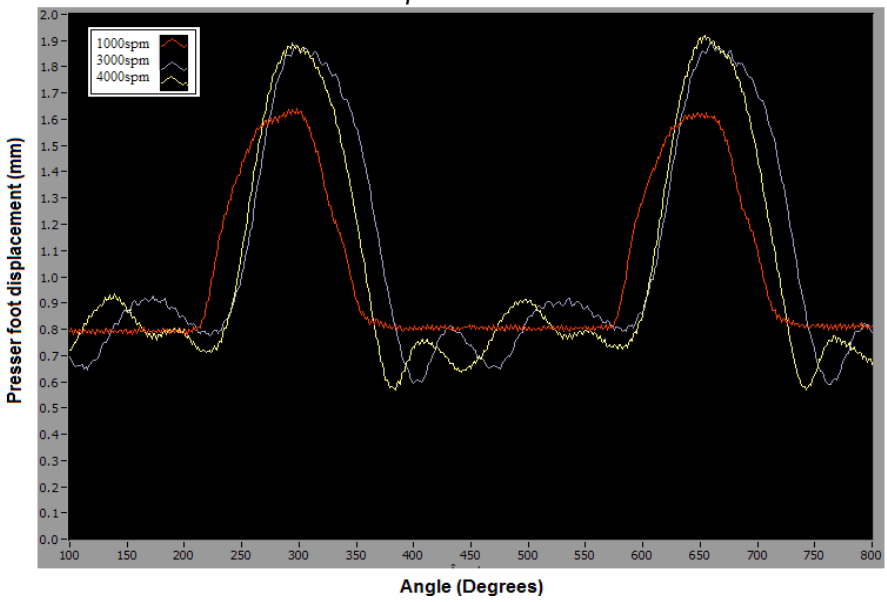


Figure 4: Displacement of the presser foot at speed 1000, 3000 and 4000 spm on fabric B, for seams in weft direction

Table 3 shows the maximum heights of presser foot displacement at the stage of fabric transportation for seams in warp and weft direction.

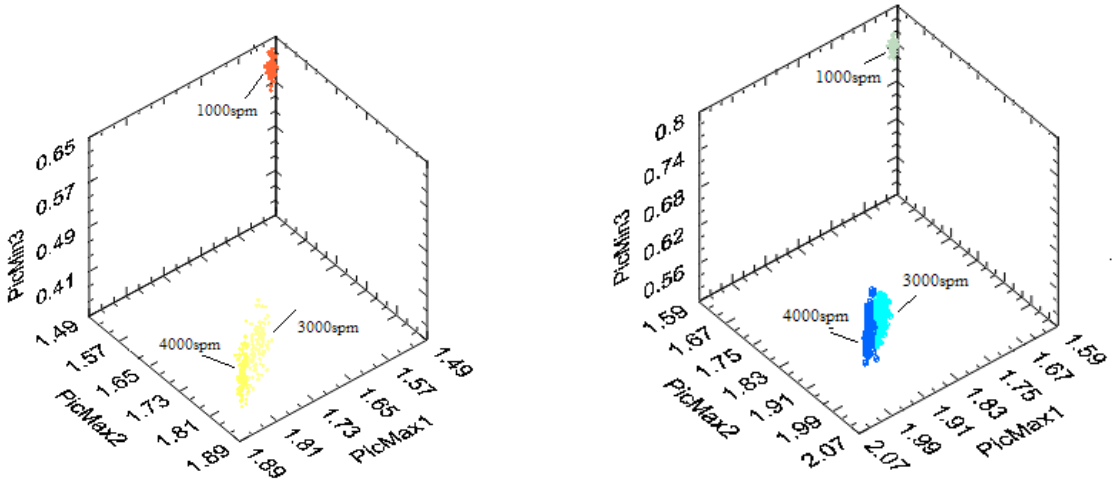
Table 3: Max. presser foot displacement in warp and weft direction at speed 1000, 3000 and 4000spm

Fabric	Max. presser foot displacement (mm)					
	Warp samples			Weft samples		
	Sewing speed					
	1000spm	3000spm	4000spm	1000spm	3000spm	4000spm
A	1.515	1.779	1.856	1.512	1.775	1.827
B	1.631	1.921	1.962	1.629	1.886	1.949

It can be seen that there is increasing of the amount of presser foot displacement with increasing sewing speed for fabrics A and B. For sample A, the maximum height of displacement at 3000spm and 4000spm is 1.779mm and 1.856mm respectively. For sample B, the maximum height of displacement at 3000spm and 4000spm is 1.921mm and 1.962mm. The difference in presser foot height between 3000 and 4000spm is smaller compared to difference in height from 1000spm to 3000spm. So, increasing of the speed after 1000spm affects great increasing in presser foot highest position.

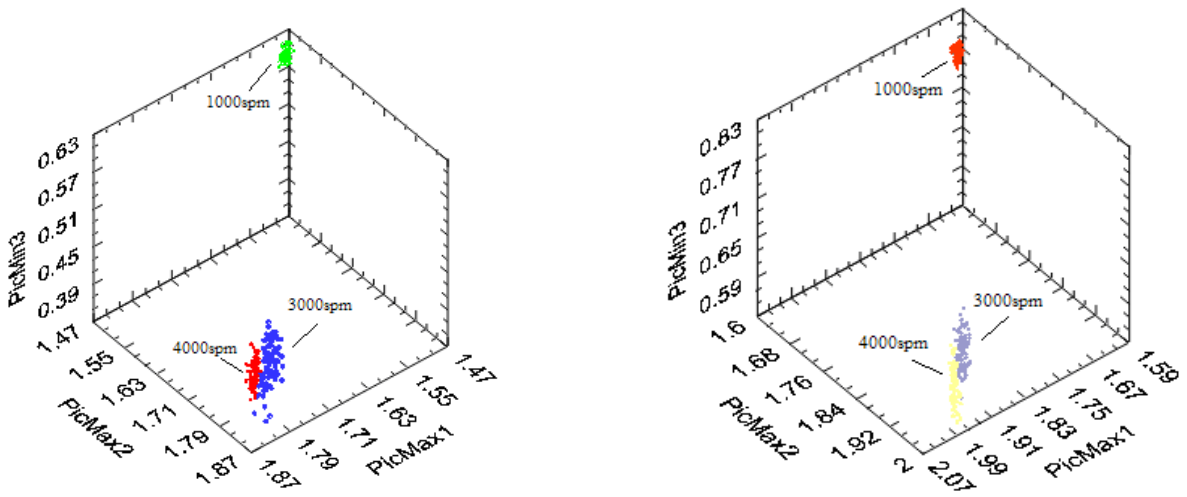
For weft seams, there is general slightly lower presser foot displacement, for both samples for all tested speed. The sample A shows an increase from 1.512mm to 1.775mm and 1.827mm with increasing sewing speed. For sample B shows the same pattern and increases the height from 1.629mm, 1.886mm and 1.949mm with increasing of the sewing speed.

Figure 5 (fabric A and B for warp direction) and figure 6 (fabric A and B for weft direction) presents a screenshot of these sewing efficiency test modules showing some parameters relevant to evaluate presser-foot trajectory, namely peak displacement values, signal spectrum and harmonic distortion. For the displacement signal, 2 peaks and a valley of the signal are detected within certain phases of the stitch cycle. One possible representation are that of fig. 5 and 6, in which each dot represents a stitch with its coordinates being the peaks and valleys computed for it. A 3-dimensional graph, in which a point is plotted for each stitch, being its coordinates the 3 feature values extracted from stitch.



a) b)

Figure 5: Screenshot of the software, in the example showing data about the performance of the feeding system (presser foot displacement) at: a) fabric A and b) fabric B, warp direction for all sewing speed (1000, 3000 and 4000spm)



a) *b)*

Figure 6: Screenshot of the software, in the example showing data about the performance of the feeding system (presser foot displacement) at: a) fabric A and b) fabric B, weft direction for all sewing speed (1000, 3000 and 4000spm)

CONCLUSION

The introduction of advanced technologies in the sewing machines monitoring is a reality that matters all machine manufacturers. Their main objective is to reduce machine setting times and obtaining good quality seams.

The results obtained showed that the sewing speed and fabric structure variations have influence on sewing machine stitch forming parameters. These results are an important tool for evaluation and prediction of materials behavior in sewing, namely the development of a redesigned fabric feeding system with controlled actuation and improving fabric control to achieve better sewing quality.

With increasing sewing speed, the amount of presser foot displacement increases for both fabrics. For fabric A, the maximum height of displacement at 3000spm and 4000spm is 1.779mm and 1.856mm respectively and for fabric B is 1.921mm and 1.962mm. The difference in presser foot height between 3000 and 4000spm is smaller compared to difference in height from 1000spm to 3000spm.

For weft seams, there is general slightly lower presser foot displacement, for both fabrics for all tested speed. The fabric A shows an increase from 1.512mm to 1.775mm and 1.827mm with increasing sewing speed. The fabric B shows the same pattern and increases the height from 1.629mm, 1.886mm and 1.949mm with increasing of the sewing speed.

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EFFICIENCY OF markers for checked fabric

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ABSTRACT

Efficiency of markers for plain and checked fabric of various pattern repeat is investigated. The markers are created using methods of blocking and linking, i.e. special positioning of pattern pieces relative to each other depending on the pattern repeat. All markers are created for size 40 and the fabric width of 148cm. The results obtained show different utilization of cutting patterns depending on the style, marker construction and pattern repeat.

Key words: marker efficiency, pattern repeat, blocking, linking

INTRODUCTION

CAD/CAM systems for nesting/marking and CNC automated cutting equipment have proven effective in increasing the efficiency of the individual cutting operation. But the greatest opportunity for savings in overall time and material costs remains more effective optimization of the overall cutting process – from order through cutting (Beazley A., et al., 2003). The cut order planning process, spreading and cutting process in the cutting department, determine the utilization of textile materials. Great importance in increasing the efficient use of materials is the planning the conversions work orders in cutting plans. The purpose of this research was to investigate the influence of the level of applied technology on the percentage of generated textile waste in clothing manufacturing companies.

Cut order planning is an important linkage in the workflow control system. Cut order planning is the activity of planning the order for cutting, as input into the marker making stage so that the cutting room receives complete spreading and cutting instructions (Wallace T. F. et al. 2003). The cut order planning process is a dynamic function that must respond to the ever - changing status of many critical factors such as sales, inventory levels, raw materials, and availability of labor and equipment. The variety of sizes, styles, fabrics and colors induces significant complexity into the problem. Adding to the complexity, and thus potentially increasing total production costs, are setup the changeover costs, the question of appropriate sizes, and the necessity to meet customers‘ demands competitively (Cooklin G. et al., 2006).

Current industry approaches for performing cut order planning range from manual ad hoc procedures to customized proprietary software. Many apparel manufacturing facilities are still using unsophisticated methods, depending on the expertise of one individual who has the necessary data and decision making tools only in his or her memory. Profit margins in this industry severely limit capital investment, resulting in few resources for computing equipment. Commercial software for cut order planning has been developed, but effective application requires extensive customization and the necessary hardware for implementation (Hands C. et al., 1997).

The cutting room has a greater effect on excessive manufacturing costs than any other department concerned with the actual production of garments. The revolution in the garment industry took place as a result of the introduction of CAD/CAM techniques. CAD/CAM systems are becoming more affordable during the whole time (D. J. Tyler, 2008). Today it is advisable to use CAD/CAM systems wherever it is economically justified (Knox A., 1994, Gradiar M. et al., 1997).

Handmade markers are time consuming, and if you change your mind about the layout you have to start over from the beginning. Making patterns on a CAD system allows very precise drafting and measurements. But the real advantage is that each pattern is stored on the computer and adjustments can be made very quickly and easily. CAD systems allow the marker maker to play with the pieces

until it gets a good layout that minimizes waste. Reduced labor costs and faster production are the benefits. The better the layout is, the less fabric we have to buy on the first place, and much less textile waste is generated (Tincher W. C. et al., 1993).

The checked fabric represents special problem for creating markers due to greater fabric loses in the marker, due to requirements for pattern matching in finished garment. The current paper investigates the effect of the method of marker making on marker efficiency for plain and checked fabrics of various pattern repeat.

EXPERIMENTAL

Two method of marker making for checked fabric are used for two garment types using Lectra PDS system. The pattern pieces in the marker are fitted in two different ways:

1. Fitting of pattern pieces in the marker with an increase in surface area of the pattern piece (blocking). Blocking is used to increase the surface of some pattern pieces in the marker, for the subsequent cutting-out. Increasing of the surface of cutting piece is performed in X-axis and Y-axis depending on the pattern repeat. Increased surface cutting part is shown in Figure 1.

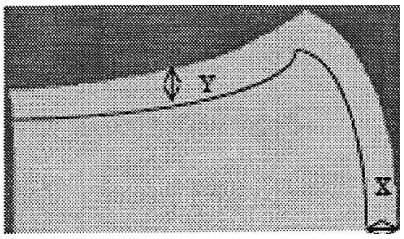

Figure 1: Cutting piece with increased surface

The software allows adding blocking values i.e. increasing of the surface of pattern area in two ways: central and not central. Central is when there is increasing of the pattern surface at all sides of piece, and not central is when it added to one side of piece. Figure 2 shows the blocking dialog for setting blocking values.

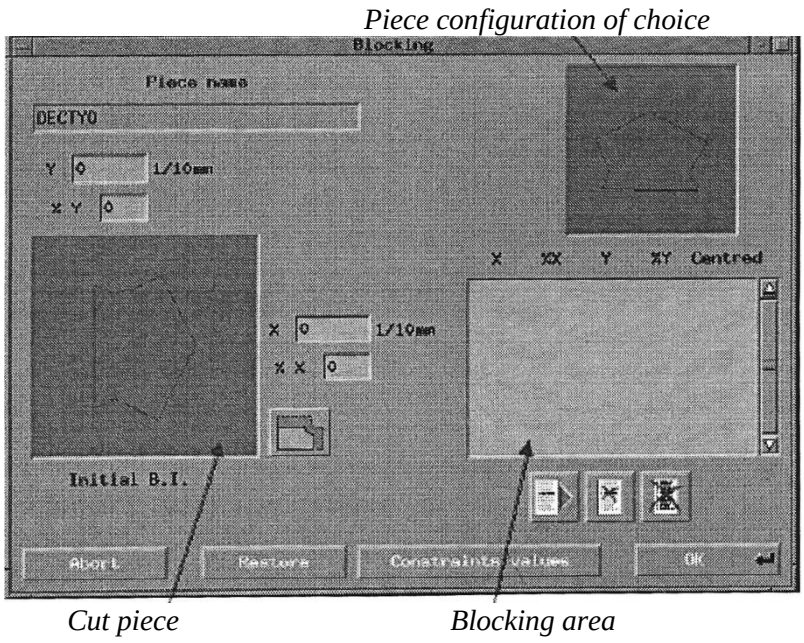

Figure 2: Dialog blocking

2. Creation of the markers for checked fabric using dynamic connection of the pattern pieces (linking). This method of fitting pieces in the marker allows the creation of new connections between different cutting pieces. In this type marker making, the pieces which must have pattern matching in the finished garment are selected in working area with all characteristic points and notches visible and the link is achieved by linking these points on two or more pieces.

The Figure 3 shows the process of creating a link between the two pattern pieces of the marker.

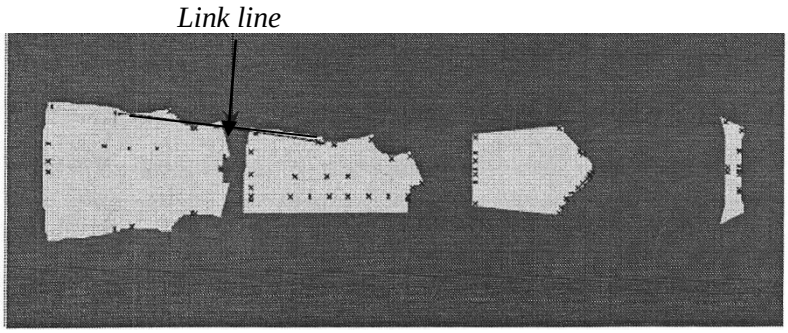

Figure 3: Link line between two pieces

Markers for checked fabric for ladies skirt and trousers are created. The pattern repeat for checked fabric is 3x4cm, 5x7cm and 7x10cm. For comparison the marker for plain fabric is also created. All the markers are of garment size 40 and fabric width of 148cm.

The demands for satisfying fabric pattern matching for this style of women skirts requests matching of the horizontal pattern lines at side and front and back seam, as well as at the pocket and front piece of the skirt.

The matching of fabric pattern at this trousers style requires matching of the horizontal pattern lines at central front seam of the trouser fronts, the pattern lines at the side seams and the matching of the front pocket piece and the front.

RESULTS AND DISCUSSION

The results of marker efficiency for whole set of checked pattern repeats using two method of marker making are shown in Table 1.

Table 1: Ladies skirt marker efficiency using methods of blocking and linking

Fabric	Method of fitting to pattern cutting	
	Blocking	linking
Plain color	74.3%	
Checked fabric of pattern repeat 3x4cm	63.0%	65.0%
Checked fabric of pattern repeat 5x7cm	62.2%	65.5%
Checked fabric of pattern repeat 7x10cm	60.8%	64.0%

It can be seen that the marker efficiency for ladies skirts is greater when using linking method in for every pattern repeat. The difference is greater at the largest pattern repeat of 7x10cm.

Figure 4 shows the marker of women's skirts size 40 made for checked fabric of pattern repeat 7x10cm with the method of blocking. Utilization the marker is 60.8%, while figure 5 shows the marker for women's skirts size 40 made for checked fabric of pattern repeat 7x10 using linking method where utilization is 64.0%.

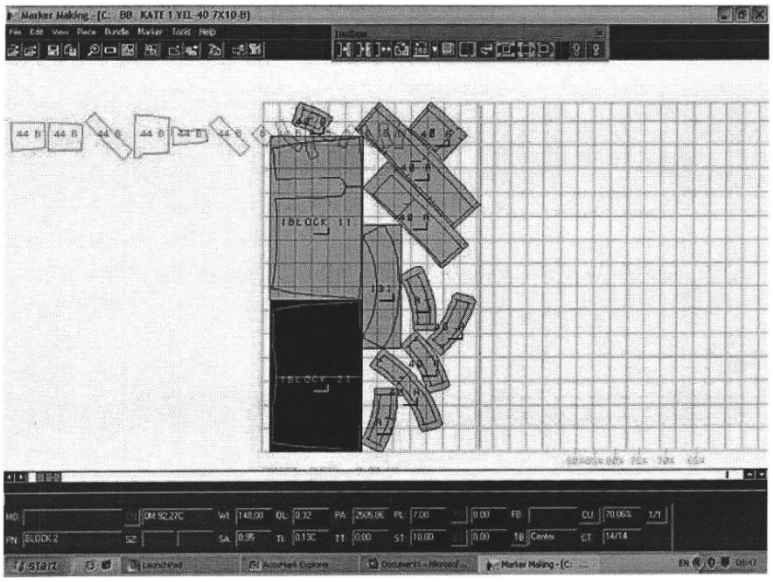

Figure 4: Marker for skirt for checked fabric of pattern repeat 7x10 using blocking method

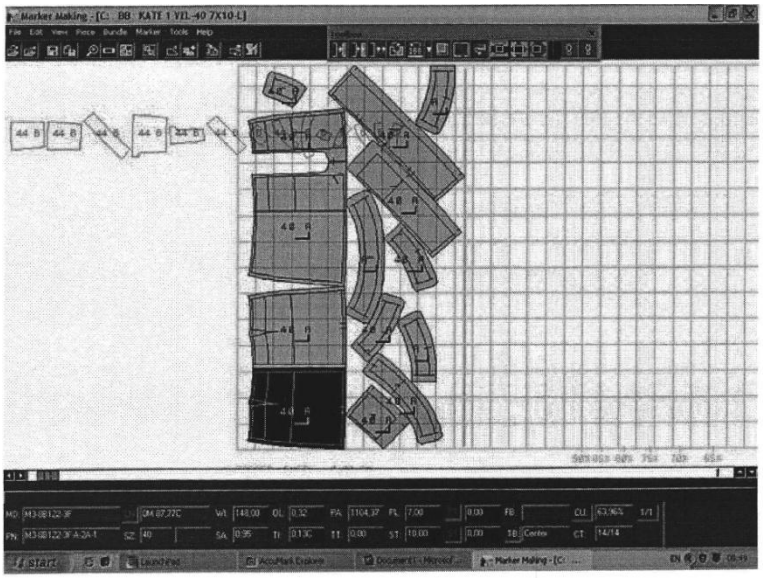

Figure 5: Pattern cutting for skirt from a pattern repeat fabric 7x10using linking method

Comparison of the degree of marker efficiency for women's trousers using blocking and linking method is shown in Table 2.

Table 2: Marker efficiency of women trousers with two method-blocking and linking

Fabric	Method of fitting to pattern cutting	
	blocking	linking
Plain color	82.8%	
Checked fabric of pattern repeat 3x4cm	73.2%	79.0%
Checked fabric of pattern repeat 5x7cm	77.3%	79.3%
Checked fabric of pattern repeat 7x10cm	76.1%	78.4%

The results show greater efficiency when using linking method of marker making for all pattern repeats. In this case, the greater saving in efficiency between two methods is obtained for patter repeat of 3x4cm.

Figure 6 shows the marker for women's trouser size 40 made for checked fabric of pattern repeat 3x4 using blocking method. Utilization the marker is 73.2%. Figure 7 shows a marker for ladies trouser size 40 made for checked fabric of pattern repeat 3x4 fitted using linking method. Utilization the cutting pattern is 78.8%.

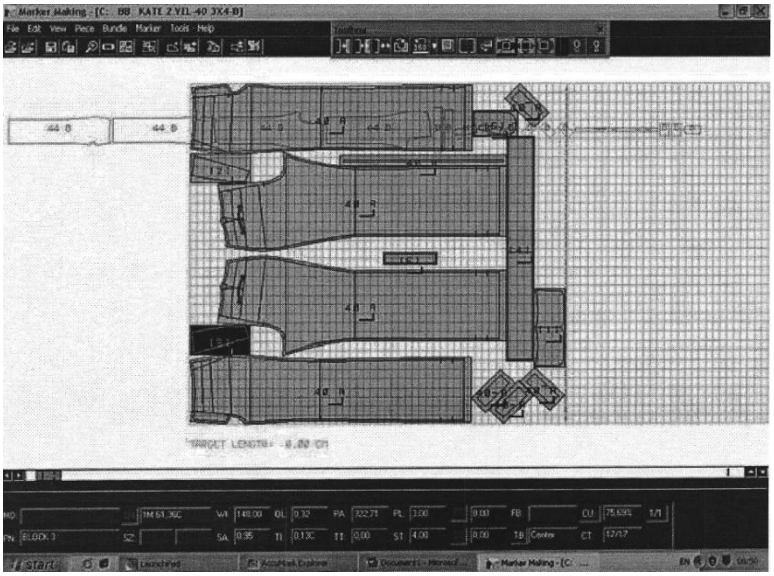

Figure 6: Pattern cutting for trouser from a pattern repeat fabric 3x4 with the method-blocking

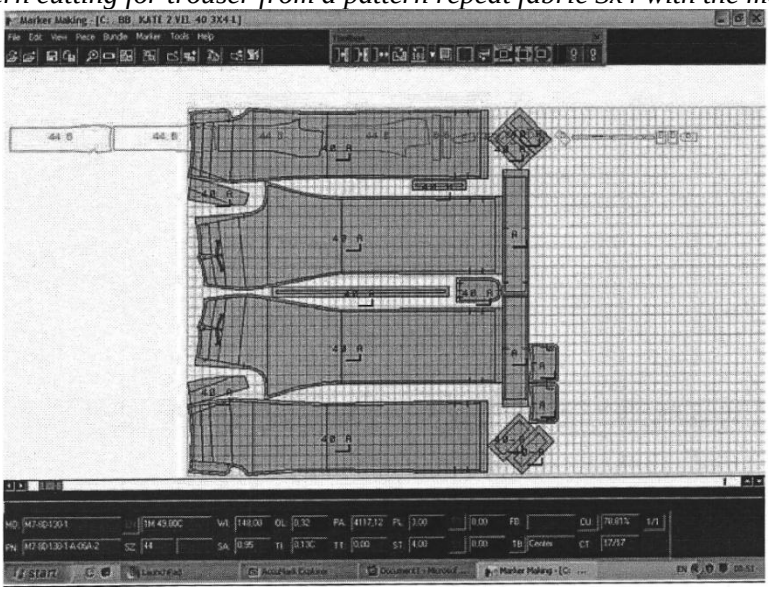

Figure 7: Pattern cutting for trouser from a pattern repeat fabric 3x4 with the method-linking

CONCLUSION

The application of two method of creating markers for checked fabric for the two types of garments shows the differences in marker efficiency.
The markers created by linking method prove to have greater efficiency for both garment types, skirts and trousers, in all patter repeats.

The method of marker making for checked fabric is limited by the properties of the fabric i.e. regularity of pattern repeat, which determine which methods of marker making can be applied.
The difference of marker efficiency using two methods generally increases with the size of pattern repeat.

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SODIUMCHLORITE BLEACHING OF COIR FIBER

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ABSTRACT

Sodium chlorite of bleaching, with different chlorite concentrations and different processing times, coir fiber is examined. The color strength, lightness (L*), whiteness (Stensby) properties and weight loss (%) of bleached coir fiber were investigated. Sodiumchlorite bleaching on coir fiber resulted in lower color strength, higher lightness and higher whiteness values. 40 g/l sodiumchlorite bleaching process with varying application times resulted in white coir fibers. The longer the 40 g/l sodiumchlorite bleaching process is the whiter the coir fiber. Sodium chlorite can be recommended for coir fiber bleaching. However, possible significant weight and strength losses should be kept in mind after sodium chlorite bleaching.

Key words: Coir fiber, Coconut, Bleaching, Sodium chlorite, whitess, color strength

INTRODUCTION

Intensive growth of world population and the lack of comfortable natural fibers lead to new researchs of other fiber alternatives for more sustainable world. The utilization of sustainable natural fibers like coir etc. represents an attractive area from an environmental perspective. Coir fiber obtained from the husk of ripe/matured coconut has a limited field of use. eg: door mats, floor mats, brushes, matresses, upholstery padding, sacking and horticulture and soil erosion control (1). Some of its different usages are shown on Figure 1.

a)Door mat (13) b) Organic growing medium (13)

c)Upholstery padding (14) d) Brush (14)

Figure 1. *Different materials made from coir fiber*

Coir fibers are the fibrous material between the internal shell of the fruit and the outer skin of the husk (2) (Figure 2).

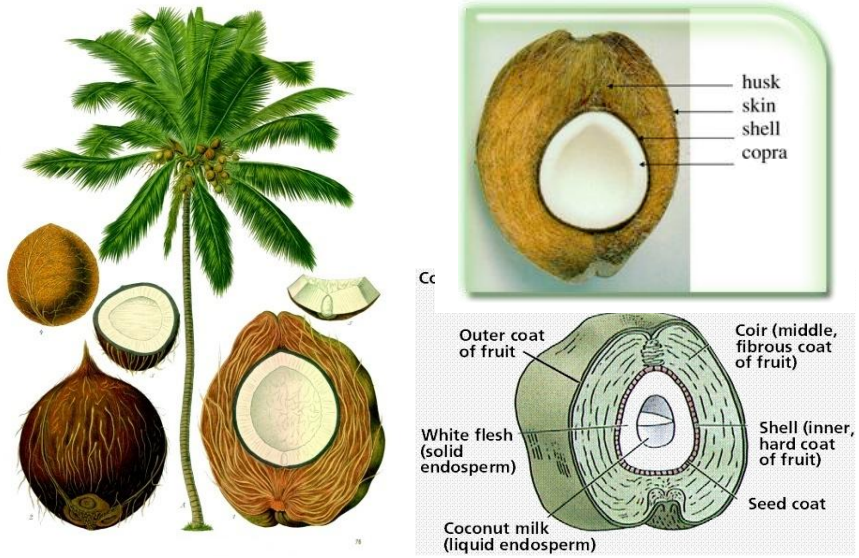

Figure 2. *Coconut fruit, coconut tree and coir fibers (3,16) and cross section of coconut fruit (15)*

Common name of coconut fiber is Coir. Its botanical name is *Cocos Nucifera* and its plant belongs to Arecaceae family which is also known as palm (3). Coconut trees grow up in the tropical zones of the world but the main production is in the Asian countries (4) (Figure 3). Wet tropical area of Asia including countries Indonesia, Phillippines, India, Sri Lanka, Malaysia and Thailand are covering about 86.7% of the total world coir fiber production (2).

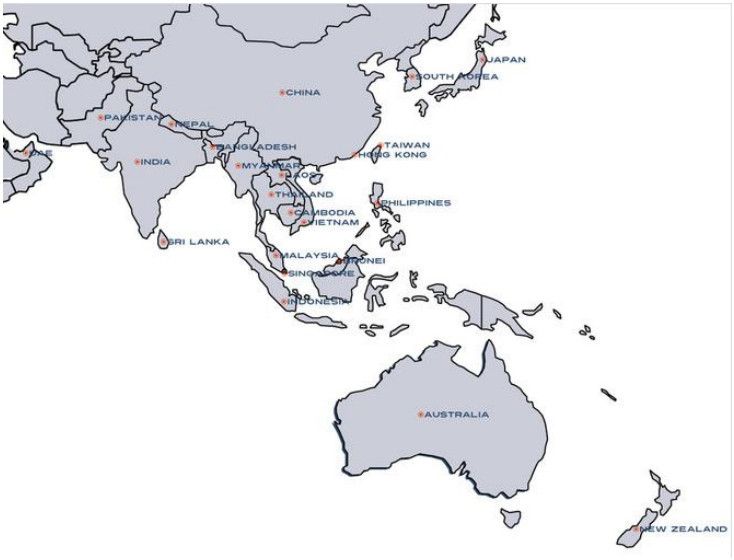

Figure 3. *Coconut growing zone of the World (17)*

Lignocellulosic coir fibers are inexpensive available among other natural fibers, not brittle, non-toxic, environment friendly and also it can be modified chemically (10). They have low thermal conductivity and bulk density (12). Coconut fibers are mainly composed of 35.6% cellulose, 32.7% lignin, 15.4% hemi-cellulose, 5.1% pectin and 3.0% extractives, which effect the chemical properties in the pre-treatment processe (2,3). This composition also makes this fiber environmental friendly because of thier biodegradable decomposition in the nature in 20-30 years (5). Extraction of fibers from the husks is time consuming and labour intensive process. After separation of the husk from the shell of the fruit, it has to be retted in brackish water for about 3-6 months or in lagoons with an anaerobic bacterial fermentation for 10-12 months. Shorter retting times may also be suitable for coarse brown yarns (6). As an alternative, mechanical processing can be used after 5 days of wetting

in water. The quality of the fiber depends on the subsequent procedure routine consisting of breaking/crushing of the husk, washing, cleaning, drying, hackling and combing (2).

Figure 4. *Natural raw coir fiber (18)*

The natural color of coir fiber is brown or slightly different shades of brown (Figure 4). As a lignocellulosic plant fiber extracted from the fruit of the coconut, its cellulose fibrils embedded in the lignin matrix are aligned along the length of the fibre, which render tensile, flexural strengths and also rigidity to the fiber (11) (Figure 5).

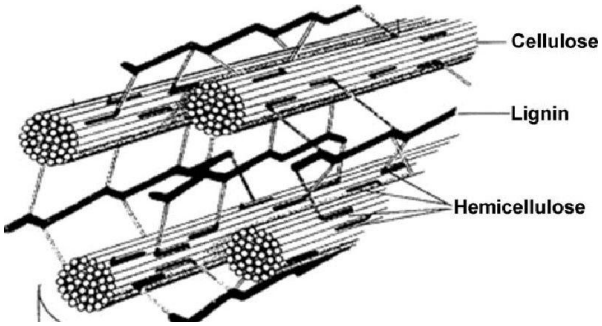

Figure 5. *Schematic Diagram of lignocellulose fiber example (19)*

Washing or boiling do not effect the cellulose, lignin or hemicellulose composition of the fiber but reduce the extractives like water soluble content (12) (Figure 6). There are very limited few studies about the bleaching of coir fiber in order to obtain lighter coloured fibers (2,7,8,9).
In brief, as a result of bleaching process;
- The dark colour of the coir fiber can be lighter and/or yellower, while removing the colour substances or converting them colourless components (2,7)
- The waxy and fatty acids are removed partially (7,8) and
- The fibers are disintagrated because of amorphous components (hemicellulose and lignin) removal, which hold the fibrils together (7,8,9) and determine colour (2)

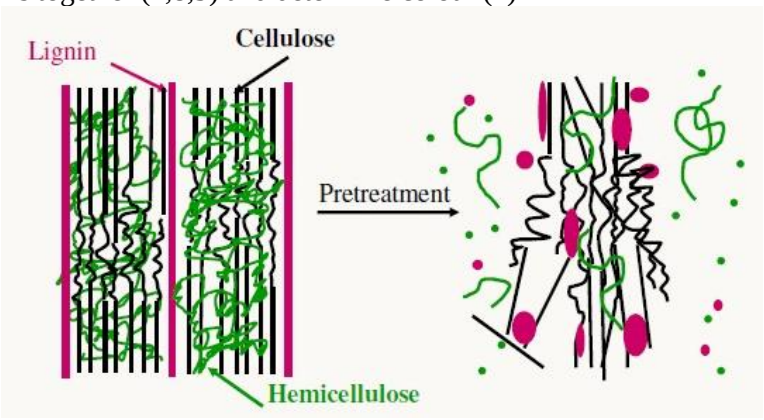

Figure 6. *Schematic effect of pretreatment on lignocellulose fiber (20)*

In this study, sodium chlorite of bleaching, with different chlorite concentrations and different processing times, coir fiber is examined. The color strength, lightness (L*), whiteness (Stensby) properties and weight loss (%) of bleached coir fiber were investigated.

EXPERIMENTAL

100% coir fiber plain woven fabric is utilized fort his study. Conventional sodium chlorite bleaching process is carried out at 95°C with 1:30 liquor ratio at pH 4 (with acetic acid) (21). 1g/l wetting agent is also added to the bleaching bath. In order to determine the optimum bleaching conditions for coir fiber, wide variety of sodiumchlorite (100%) concentrations (10, 20, 30, 40 g/l) were applied for different bleaching processing times (30, 60, 90, 120 minutes). After bleaching, coir fiber samples are treated with 10g/l sodiumsulphite at 20 C for 30minutes with 1:30 liquor ratio in order to remove any chlorine residue. Following the bleaching treatment, the lightness (*L**) and K/S values of the coir fiber samples were determined using a Datacolor 600 spectrophotometer. Each sample was measured from four different areas, and the average value was calculated.

RESULTS AND DISCUSSION

The color stregth (K/S) and the lightness (L*) values of bleached coir fiber fabrics are shown on Figure 7 and 8, respectively. In general, as the sodiumchlorite concentration increased and conventional bleaching duration prolonged, the K/S (color strength) degrees of the bleached samples gradually decreased. And the colour of the coir fibers samples becomes lighter, yellower and greener as also visually.

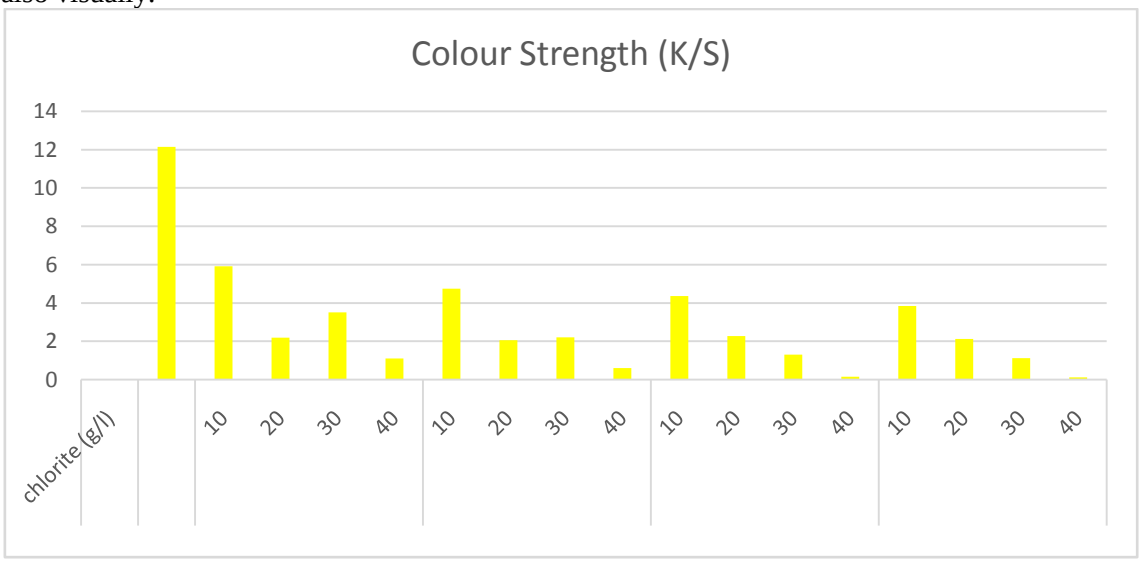

Figure 7. *Color strength of bleached coir fibers with sodiumchlorite*

The lightness value of greige fabric was 48.1. Broadly speaking, as sodiumchlorite concentration increased and conventional bleaching duration prolonged, the degree of lightness generally gradually increased. Also the colour of the coir fiber is yellower and greener visually. These lightness results were in line with the K/S values. The lower the color strength (K/S) is the higher the lightness (*L**) values. For example 40 g/l sodium cholorite bleaching for 90 minutes resulted in nearly 95 for lightness value with very low K/S value.

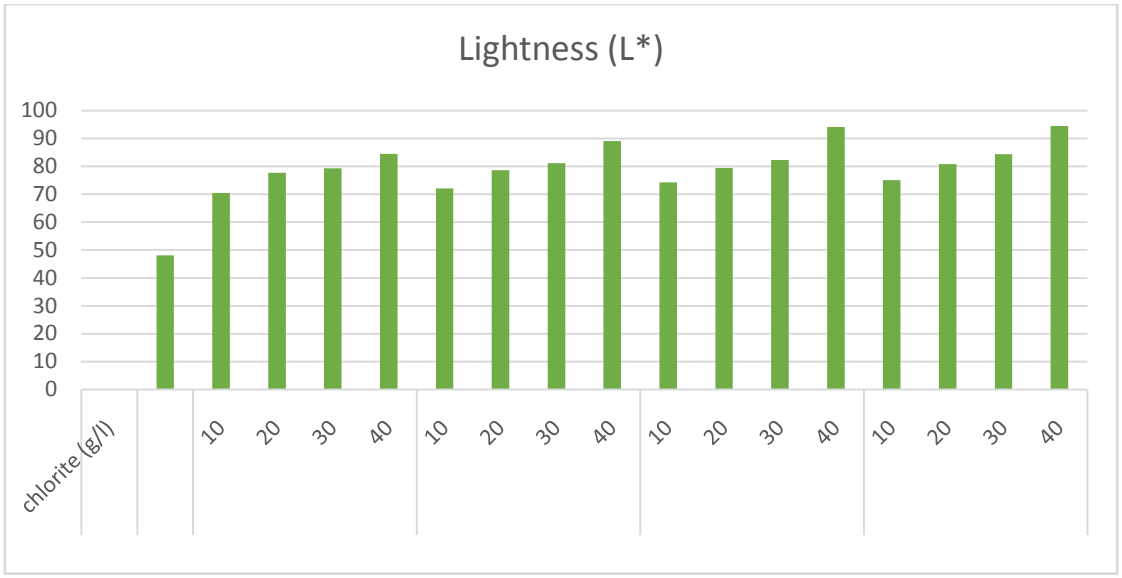

Figure 8. *Lightness performance of bleached coir fibers with sodiumchlorite*

Similarly, 120 minutes conventional chlorite bleaching with 40 g/l sodiumchlorite led to the highest lightness degrees on coir fibers and the lowest color strength values. Longer chlorite bleaching processes than 120 minutes could be carried out for coir fibers with higher sodiumchlorite concentrations. However, this was not a good option, since coir fibers even were disintegrated after 40 g/l sodiumchlorite bleaching for 120 minutes. This is clearly visible from weight loss values of respective bleached coir fibers (Figure 10).

Figure 9. *Whitness values of bleached coir fibers with sodiumchlorite*

The whiteness values (according to Stensby) of the samples treated with 40g/l sodium chlorite are shown in the Figure 9. These are the whitest coir fiber samples in this study. As it can be seen that the longer 40 g/l sodiumchlorite bleaching resulted in higher whiteness values.

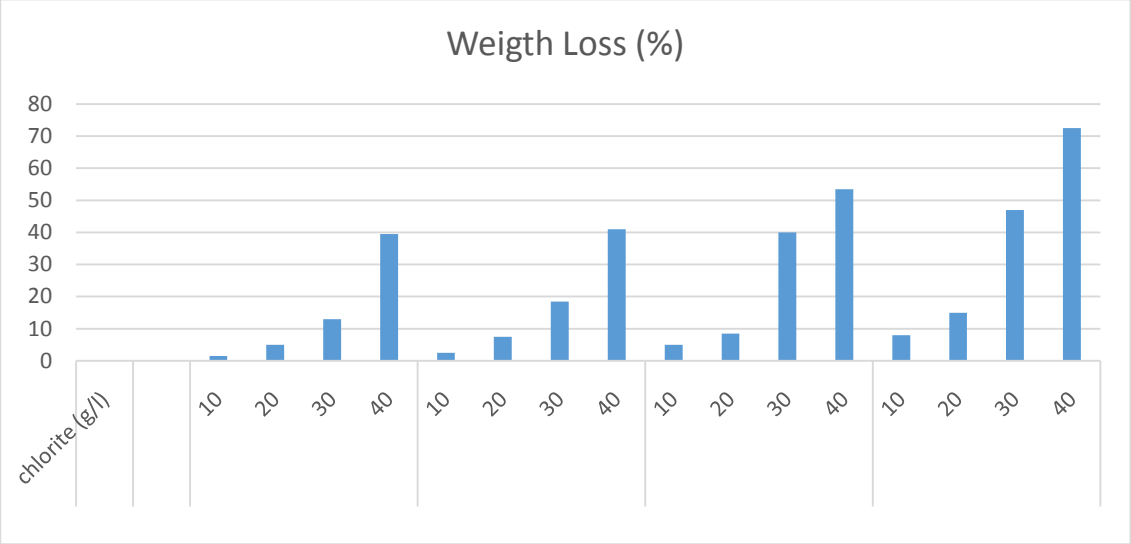

Figure 10. *Weight loss (%) trends of bleached coir fibers with sodiumchlorite*

The whiteness value of greige coir fiber was less than 20 Stensby (Figure 10). However, the longest 40 g/l sodiumchlorite bleaching led to the whiteness value of 73.1 Stensby leading to very White appearance. From the above results, it is right spot to mention that the maximum lightness (*L**) value of 94.5, the maximum whiteness value of 73.1 Stensby and the lowest K/S value with 0.1 was obtained for coir fibers with conventional sodium chlorite bleaching using 40g/l sodiumchlorite at 95 °C for 120 minutes. But the weight loss of the coir fiber sample was about 72.5% due to the disintegration of the coir fiber during agressive bleaching conditions. Therefore, the coir fiber bleached with 40g/l sodiumchlorite at 95 °C for 60 minutes seems to have moderate values of lightness (89.2), K/S colour strength (0.6), Stensby whiteness (42.5) and also lower weight loss (41%) than the whitest sample.

CONCLUSIONS

In this study, lightness, whiteness and color strength properties and the weight loss degrees of coir fibers were investigated before and after different sodiumchlorite bleaching processes. Sodiumchlorite bleaching on coir fiber resulted in lower color strength, higher lightness and higher whiteness values. 40 g/l sodiumchlorite bleaching process with varying application times resulted in white coir fibers. The longer the process is the whiter the coir fiber. However, these processes led to significant weight loss. Sodium chlorite can be recommended for coir fiber bleaching. However, possible significant weight and strength loss should be kept in mind after sodium chlorite bleaching.

ACKNOWLEDGEMENT
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COMPARATION OF FUNCTIONAL GROUPS CONTENT DETERMINED BY DIFFERENT METHODS

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ABSTRACT

Referent cotton yarns, obtained by rigorous alkaline scouring and oxidative bleaching, were oxidized by potassium periodate. Different periodate concentration and oxidation time were used to obtain low-, middle- and high-oxidized cotton. Periodate oxidized cotton yarns were treated with sodium chlorite to convert aldehyde to carboxyle groups. The aldehyde group was measured through conductometric titration, Ca-acetate method and TTC before and after conversion with sodium chlorite.
Application of different periodate concentration gave satisfactory results for achieving low-, middle- and high-oxidized cotton yarns even after relative short time of 30 min. Within method for determination of aldehyde groups on low-, middle- and high-periodate oxidized cotton yarns, good agreement and correlations were obtained between conductometric titration and Ca-acetate methods. From the other side tetrazolium method (TTC) is in good agreement and correlated well with conductometric titration and Ca-acetate methods regarding low- and middle- aldehyde groups content.

Key words: oxidation, cotton, carboxyl groups, calcium-acetate method, conductometric titration.

INTRODUCTION

Recently, cellulose bearing functional groups gained increasing interest due to their promising properties for different value-added application. Cellulose is non-toxic biodegradable polysaccharide and can be easily chemically modified. A very promising path to obtain functional groups in cellulose is oxidation which is a quite frequent procedure in cellulose chemistry, used to impart special properties on the cellulosic fibers [1]. Cellulose oxidation can be selective, achieved with KIO_4 or TEMPO, or non-selective achieved with $HClO_4$, permanganate, hydrogen peroxide etc. Selective oxidation by KIO_4 results in formation two aldehyde groups on C2 and C3 atoms [2-4]. The resulting aldehyde groups can be further converted to carboxylic through oxidative conversion by sodium chlorite [5]. Functional groups, like aldehyde, carboxyl and their combinations, can serve as useful intermediates for cellulose-based specialty materials, such as gels, absorber for heavy metals and dyes, as well as carrier for enzymes and biopolymers [6].

Different amount of carboxyl groups required for various uses. More than 70 % carboxyl groups are needed for gels formation and nanotechnology, 18-21 % for highly hemostatic surgical dressing for gauze and 3-13 % for absorbable sutures, textile with hemostatic activity [7-9].

The quickly and easily measurement the carboxyl groups with cheap and easy applicable methods are required from scientists. These methods should be well correlated with each other and should give reproducible results also.

The goal of this paper is to compare easy applicable methods for aldehyde and carboxyl groups content in periodate oxidized cotton yarns, treated with different periodate concentration and treatment time. For that reason conductometric titration, Ca-acetate method and TTC were used before and after conversion with sodium chlorite.

EXPERIMENTAL

Material

Piled, ring-worsted cotton yarn with linear density of 30 x 2 tex spun with knitting twists (330 twists/m) was used in this study. Before oxidation rigorous alkaline scouring and bleaching were done to remove all non-cellulosic components from the cotton. After periodate oxidation the treated yarns

were demineralized, treated with sodium chlorite to convert aldehyde to carboxyl groups, and demineralized again at the end of the process.

Pretreatments of cotton yarns
Alkaline scouring were done using 20 g/l NaOH in presence of 2 ml/l Felosan NOG anionic surfactant and 1 ml/l Wetol SAN nonionic surfactant, 30:1 LR at 95 ºC for 90 min. Bleaching were done using 6 ml/l H_2O_2 (30%), 1 ml/l Wetol SAN, 2 ml/l Na_2SiO_3 at pH 11.2, 30:1 LR at 95 ºC for 30 min. Both processes were carried out in a Linitest apparatus.

Oxidation with KIO_4 was done using 0.05, 0.1, 0.2, 0.4 and 1 g KIO_4/g cellulose at pH 4, 50:1 LR at 60 ºC for 30, 60 and 120 min.

Demineralization
Oxidized cotton yarns were demineralized in a 0.2 M HCl, 50:1 LR at 25 ºC for 30 min.

Conversion of aldehyde to carboxyl groups by oxidation with sodium chlorite. Conversion was done using 0.905 g $NaClO_2$/g oxidized cotton in 1 M CH_3COOH, 50:1 LR at room temperature for 48 h, as described by Saito and Isogai [5].
After each stage the cotton yarns were washed with deionized water until the conductivity was lower than 5 μS/cm and dried at room temperature.

Testing methods

Determination the carboxyl groups by Ca-acetate method. On the basis of published Ca-acetate method [10], the following modified method was used. 1.2635 g cotton yarn were treated in a 100 ml 0.07 M Ca-acetate solution 2 h at 25 ºC with frequent shaking, to facilitate complete ion interchange. Than 25 ml portion of the calcium-acetate solution were titrated with 0.007 M NaOH, using phenolphthalein as indicator. The carboxyl groups content were calculated as followed:

$$COOH\ \ (mmol/g) = \frac{4 \cdot 0.007 M \cdot V\,(NaOH)}{m}$$

Where: 0.007 M is concentration of NaOH, *V* (NaOH) is volume (ml) of NaOH solution used for titration, *m* is weight of cotton yarns (g).

Determination the carboxyl groups by conductometric titration was done as described by Saito [5]. The carboxyl content was calculated from the titration curve.

Determination the aldehyde groups through differences between before and after conversion of aldehyde to carboxyl groups by $NaClO_2$. These analyses were done after conversion of aldehyde groups to carboxyl groups with $NaClO_2$. The difference in carboxylate content, obtained with Ca-acetate and conductometric titration methods, before and after the conversion with $NaClO_2$ yields the aldehyde content in a cotton yarns.

Aldehyde groups by tetrazolium method (TTC) [2], were determined as followed: to 0.5 ml of 0.01 M 2,3,5-Triphenyltetrazoliumchlorid TTC (Merck) and 0.5 ml 0.3 M KOH, a sample of cotton yarns is added and heated in a water bath at 100 °C for 10 min in an open 10 ml tube. After immediate cooling to tap water was added methanol until a 10 ml mark is reached. Aldehyde groups were analyzed on the basis of formazan formation, determined by measuring the absorbance at the wavelength of 482 nm using Perkin Elmer Lambda spectrophotometer. To prepare a calibration graph, 0.05 ml of 0.1, 0.05, 0.025 and 0.01 % solution of glucose were added to the reaction system.
The obtained values of all measurements are always an a average of the three estimations.

Analysis of variance. Investigated parameter were analyzed by main effects analysis of variance (ANOVA), considering the oxidation time (variable A) and periodate concentration (variable B) using the STATISTICA 6 program.

RESULTS AND DISCUSSION

Initially rigorous alkaline scouring and oxidative bleaching were used in order to obtain a well-defined reference substance. They were chemically oxidized with different concentration of perodate during different treatment time, in order to obtain low-, middle- and high-level oxidized cotton yarns. With periodate oxidation carboxyl groups, as measured through conductometric titration and calcium acetate method, remained quite unchanged (Table 1). Within periodate oxidation, the aldehyde groups were introduced rather selectively. The obtained aldehyde groups in the oxidized cotton were converted to carboxyl by sodium chlorite.

Table 1. Carboxyl and aldehyde groups on periodate oxidized cotton determined by Ca-acetate, conductometric titration and tetrazolium (TTC) methods before and after conversion with sodium chlorite

Treatment	Oxidation time (min)	Periodate Concentration (g KIO_4/g cell)	COOH (mmol/kg) and CHO (mmol/kg)								
			Ca-acetat method			Conductometric titration			TTC method		
			COOH before	COOH after	CHO	COOH before	COOH after	CHO	CHO before	CHO after	CHO
R			61,29	125,44	64,15	88,00	107,11	19,11	22.55	12.69	9.86
A			54,50	65,85	11,35	54,44	88,22	33,78	14.32	8.48	5.84
AB			54,27	64,27	10,00	44,22	62,67	18,45	14.78	13.17	1.61
KIO_4	30	0.05	50,17	103,51	53,34	70,44	128,22	57,78	81.79[a]	14.49	67.30
		0.1	49,12	149,30	100,18	67,67	200,34	132,67	193.84[a]	14.70	179.10
		0.2	52,81	460,35	407,54	67,11	458,67	391,56	313.55[a]	14.77	298.80
		0.4	69,47	793,567	724,10	64,95	713,665	648,715	286.32[b]	17.99	286.30
		1	70,00	1384,21	1314,21	67,33	1278,22	1210,89	255.55[b]	24.04	231.50
	60	0.05	43,51	137,19	93,68	63,133	253,33	190,20	138.02[a]	17.98	120.00
		0.1	51,58	213,33	161,75	63,33	337,33	274,00	205.79[a]	18.94	186.80
		0.2	71,14	569,51	498,37	52,89	596,22	543,33	284.81[b]	17.56	267.20
		0.4	72,51	1029,24	956,73	57,55	998,00	940,45	200.70[c]	14.91	185.80
		1	72,40	1762,57	1690,17	56,00	1624,00	1561,11	235.18[c]	16.15	219.00
	120	0.05	56,84	156,49	99,65	72,33	303,00	230,67	165.09[a]	17.90	147.20
		0.1	58,95	282,11	223,16	65,00	453,67	388,67	199.48[b]	17.61	181.40
		0.2	72,63	718,25	645,62	62,89	711,00	648,11	254.55[b]	20.20	234.40
		0.4	73,33	1254,85	1181,52	64,00	1224,00	1130,00	262.11[c]	22.53	239.60
		1	75,32	1852,40	1777,08	59,00	1736,67	1677,67	222.86[c]	26.94	195.90

Note: R - raw; A - Alkaline scoured; AB - Alkaline scoured and bleached; a - without destruction, b - partially destructed, c –completely destructed

The difference in carboxylate content, obtained with Ca-acetate method and conductometric titration, before and after the conversion with sodium chlorite yields the aldehyde groups content. Conductometric and Ca-acetate methods gave comparable results for the aldehyde groups content. The trends in the obtained results of all samples for periodate concentration and oxidation time used were similar also. Increasing the periodate concentration or reaction time, the aldehyde groups content was more considerable. Main effect of ANOVA analysis also confirm that periodate concentration and oxidation time have significant influence on aldehyde groups content (Table 2). In the case of cotton yarns oxidized with 0.4 and 1 g KIO4/g cellulose, more extensive oxidation conditions were used to obtain cotton yarns with unusually high content of aldehyde groups. Used method are in good agreement and correlated well (Figures 1-3) regarding low, middle and high aldehyde groups content in the periodate oxidized cotton yarns.

Table 2. Evaluated p-values for significance of periodate concentration and oxidation time for all investigated properties

Variables	CHO (mmol/kg)	
	Ca-acetate	Conductometric
Oxidation time (p_A)	0,01064	0,00033
Periodate concentration (p_B)	0,00000	0,00000

Comparing aldehyde groups obtained by conductometric titration and Ca-acetate methods with TTC method some discrepancies was observed. Up to the 0.4 g KIO_4/g cellulose, and 30 min oxidation time, results obtained by used methods were in good agreement (Table 1) and correlated well (Figure 4). For oxidation with concentration greater than 0.4 g KIO_4/g cell and 30 min results discrepancies was considerable. A possible reason for this could be the presence of aldehyde groups generated during the oxidation, which may depolymerize cellulose in the alkaline conditions. Alkaline conditions have a degradation and decomposition effects on the oxidized cellulose [11,12]. Degradation effects may not be significant into cellulose which have only a low degree of oxidation, but it becomes increasingly important to cellulose with higher degree of periodate oxidation.

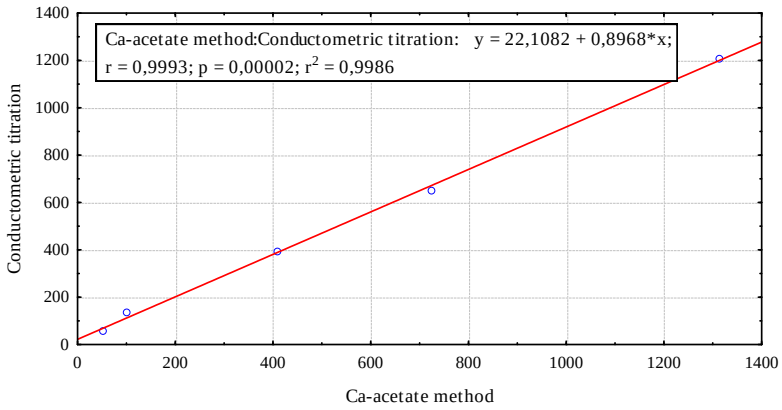

Figure 1. Correlation between aldehyde groups of periodate oxidized cotton treated with different concentration for 30 min using conductometric titration and Ca-acetate methods

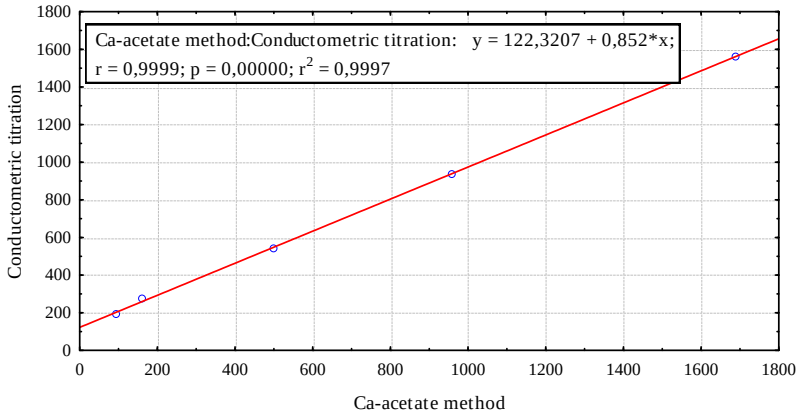

Figure 2. Correlation between aldehyde groups of periodate oxidized cotton treated with different concentration for 60 min using conductometric titration and Ca-acetate methods

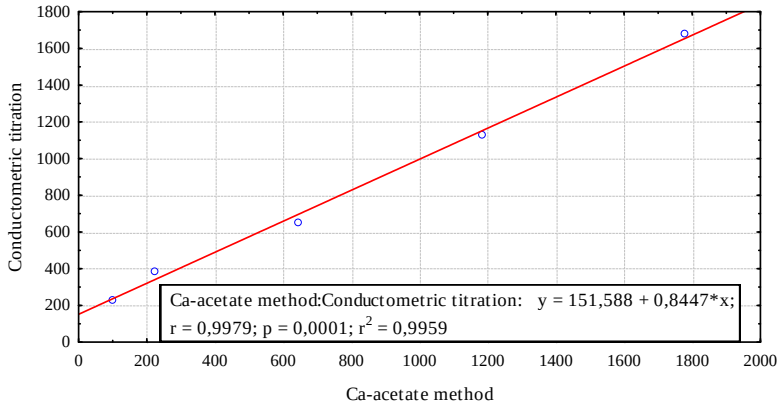

Figure 3. Correlation between aldehyde groups of periodate oxidized cotton treated with different concentration for 120 min using conductometric titration and Ca-acetate methods

Degradation effects of yarns to fibers were visible observed during determination of aldehyde groups content with TTC method (shown in Table 1). It reflects in decreasing the aldehyde groups content in higher concentration and time of treatment. Conversion of aldehyde to carboxyle groups with sodium chlorite eliminated any kind of possible decompose effect due to highly alkaline conditions during TTC method.

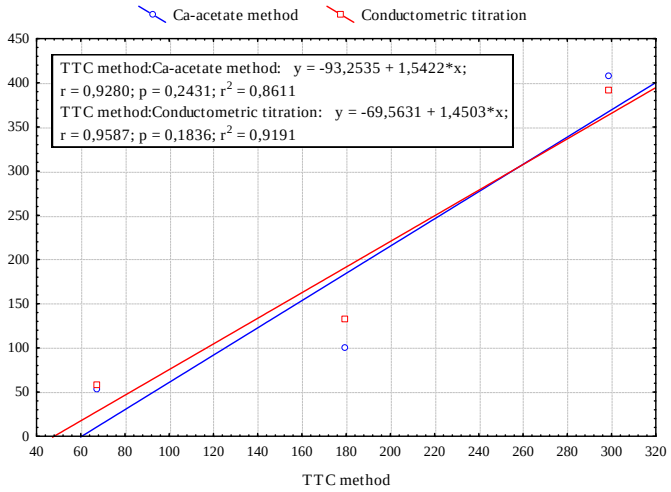

Figure 4. Correlation between aldehyde groups of periodate oxidized determined with conductometric titration, Ca-acetate and TTC

CONCLUSION

According the results obtained from the experiment, following conclusion can be done:

- Concentration of periodate and treatment time are good variables for obtaining low-, middle- and high- concentration of aldehyde groups. Both of studied variables have significant influence on the aldehyde groups. It was confirmed through ANOVA Statistic analysis.
- Alkaline reaction conditions used in TTC method has destructive effects on the highly oxidized preriodate cotton yarns. Up to the destruction of periodate oxidized cotton yarns, tetrazolium method (TTC) was in good agreement with conductometric titration and Ca-acetate method.

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EFFECT OF DAMAGE ON THE STEMS OF FLAX FOR THE PRODUCTION OF LONG FIBER

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ABSTRACT

On the yield and quality of the long flax fibers affect different factors. Flax stems are damaged during harvesting machines. Damages have a different nature. They have different effects on the yield of long fiber. The paper presents the results of a study of this problem

Key words: Quality, flax, fibers, damage

INTRODUCTION

During the harvesting of flax, stems are getting damaged by harvesting machines [1]. Those damages can affect on the quality and quantity of already made fiber. It can be proved by research of many scientists. Research of flax stems properties was conducted by G.Hajlìs, Y.Morozov and S.Yageliuk. These scientists established regularities of the diametrical compression of a flax stem. They drew the chart of the correlation of the conditioned tension to the relative deformation of the stem during compression. Properties of flax stems and deformations in them caused by machine units are examined in the book "Mechanics of vegetable materials" by G.Hajlìs [2]. Scientists L.Chursìna and O.Verbytsky [3] explored influence of humidity of the flax stem on the output and quality of flax raw materials.

After the harvesting on the stem can be such damages [1]:flattening with or without split formation, twisting, breaching with separation of the stem and the covered and breakingstem. Character of the damages has been given on the table 1.
After the harvesting on the stem can be such damages [1]: flattening with or without split, twisting, breaching with separation of the stem, the bending, breaking stem.

Table 1: Classification of damage to the stems of flax

Typesofdamage	**Causesofdamage**	**Natureofthedamage**	**Part of the number of all the damages, %**
flatteningwithout split formation	diametrical compression of a flax stem with a slight pressure	slightflattening of the stem with no visible cracks along the clamped parts	52
bending	bend the stem at its compression by straps machine	Stem bent at any angle	4
flatteningwith split formation	diametrical compression of a stem flax by straps machine with a large pressure	The stem is crushed and with visible cracks along the clamped parts	12
twisting	creeping belts relative to each other in pulling throat	formative lines stem curved and arranged in a helical line	2
breaching with separation of the stem	A high pressure in the pulling throat, slippage	In a separate section of the stem bark is stripped, fiber are fibered	3
breaking stem	Big and sharp obstacles in the way of the stem	Stem partially in cross-section is cut	2

How can different kinds of those damages effect on quality and quantity of fiber we researched experimentally. Flax stems was spread out on the field and brought to trust by the thermal lobe. Stems

were harvested carefully by hands to avoid the damages. Flex was homogenetic and brought from the same field.

MATERIALS AND METHODS

For each experimentwasidentifiedwetness, diameter, length and ripeness of each stem.

Stems were broken artificially.For the covered breakthe bending angle of the stem should have less than 90, for uncovered it should have more than 90. For flattening with split formation was used researching machine (figure 1).

Figure 1: Researching machine with pulling throat

The pressure in the pulling throat was 300 kPa and there was no slippage. Forflatteningwithoutsplitformationstemwasclampedinthemachineandeasilybittenintheclampedzone.Bre aching with separation of the stemobtained at a pressure of 300 kPa and a speed slipping belts relative to each other equal to 36% of belt speed.Stems for the experiment was ripped at the experiment day. Then stems were dried up and threshed up by hands.

After inflicts damage to stems dried, threshed by hand. Then thrashed stems passed to the laboratory of the VolynInstitute of agricultural production of the National Academy of Agricultural Sciences for technical analysis in accordance with ГОСТ 10330-76 9 (Scutched flax fibre. Specification).

RESULTS AND DISCUSSION

Technical data analysis showed that the damage stems have almost no influence on the quality of the fiber, but affect the output of long fiber. The best performance on the exit of long fiber obtained from the stems intact. Those figures are lower when flattening happens without cracking (1-2%). As for other types of damage, the output of long fiber from the stems of these injuries is significantly different from the output of long fiber from the stems intact. So flattening and curling the crack leads to a decrease in the yield of long fiber 6..7%. The strongest influence on the decrease in the yield of long fiber having an outdoor break and rupture with the bundle of wood fibers. Inthesecases outputoflongfiberwas 10,5-11,2%.

Undamaged stems give the highest yield of long fiber. We assume that a unit or 100%. Then from the same weight of stems with damage in the form of wood fracture received less long fiber, about 99% or 0.99 of the amount of fiber, which would be obtained if the stems are not damaged.

The results are shown in table 2. These table give an idea of the impact of each type of damage separately for fiber yield, ie, show the degree of manifestation of qualitative features

Table 2: Proportion of long fiber output from damaged stems from the exit of long fiber from the stems intact

Typesofdamage	the proportion of the output of long fiber
Stemswithoutdamage	1,0
Bending	0,99
Flatteningwithoutsplitformation	0,99
Flatteningwithsplitformation	0,92
Twisting	0,92
breakingstem	0,89
breaching with separation of the stem	0,89

We can see from the table that some kinds of damages have the same affect. We can see thre same groups of them:

- flattening without split formation and the bending,
- flattening with split formation and twisting,
- breaching with separation of the stem and breaking.

Breaching with separation of the stem and breaking strongly affect on the long fiberproducting, so there should not be much of those damages.

CONCLUSION

After the harvesting on the stem can be such damages: flattening with or without split, twisting, breaching with separation of the stem, the bending, breaking stem. Breaching with separation of the stem and breaking strongly affect on the long fiber producting. It is necessary to eliminate these types of damage during harvesting of flax

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[5] ГОСТ 14897-69 Солома льняная. Технические условия (Elax straw. Specification)

SILK SERICIN AND IT`S APPLICATIONS

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ABSTRACT

Silk is formed from two main proteins known as fibroin and sericin. Fibroin has beenused in several biomaterial applications, while sericin is regarded as a wastematerial in thetextileindustryuntilrecently. Sericin has recently been found to be useful for various useful activities of several industries due to its unique biochemical and biophysical properties. It is a biomolecule of great value since it has antibacterial features, UV resistance, oxidation resistant, moisturizing capabilities, biodegradability. Sericin founds many different applications in medicalindustry, cosmeticsector, functional materials and textile area.

Key words: Silk, Silk Sericin, Sericin Applications

INTRODUCTION

Improved analytical methods and tools of moleculer biology lead to different usage for silk related substances. Silk is composed of protein-based high molecular weight polymers, often associated with insects, silk worm [Figure:1] and or bweaving spiders [1]. Silk fibers are fibrous proteins which are synthesized in specialized epithelial cells of the line glands in the organisms. Silk fibroin polymers are composed of repetitive protein sequences and provide structuralroles in cocoon formation, nest building, traps, web formation, safety lines and egg protection. [2]

Figure:1 Silkworm (B. mori) [3]

STRUCTURE OF SILK FIBERS

Silk is a continuous strand of two filaments cemented together forming a cocoon of silk worm, (*Bombyx Mori*). Silk filamentis composed of a couple fibroins, which is held together by a gummy substance called silk sericin. Silk fibroin is the protein filament fiber of the silk worm and they have important chemical and physical features. [1,4]. The composition of the silk of *Bombyxmori* is shown in Figure 2.

Component	%
Fibroin	70-80
Sericin	20-30
Wax matter	0.4-0.8
Carbohydrates	1.2-1.6
Inorganic matter	0.7
Pigment	0.2
Total	100

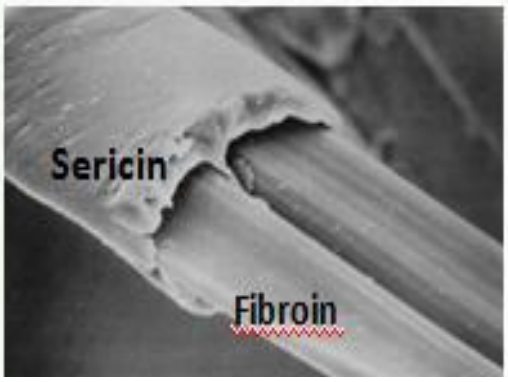

Figure 2: Composition of silk fromBombyxmori [5]

SILK SERICIN

Sericin,known as silk gum protein, isproduced by silkworms. In raw silk, the majorcomponent is fibroin (about 70%), andabout 30% of the silk component is sericin polymer.Because of its many reactive groups such as hydroxyl,carbonyl and amino groups in thesericin, sericindisplays special reactivities andfeatures[7]. Sericin is generallyconsidered a wastematerial in thetextileindustry. To manufacture lustrous silk from thedried cocoons of silkworm, fibroin is separated from sericin –the other main component of the cocoon – by a degumming process and the sericin is mostly discarded in the wastewater.It is estimated that out of the 1 million tons (fresh weight) ofcocoon production worldwide, or about 400 000 tons of drycocoon, and therefore approximately 50 000 tons of sericin could be recovered from the waste solutions[8,9].

SILK SERICIN EXTRACTION

Silk derived from silkworm *Bombyxmori* is a natural protein that is mainly made of sericinandfibroinproteins. Sericin recovery reduces the environmental impact of silk manufacture. Sericin is a water-soluble protein. When sericin is dissolved in a polar solvent, hydrolyzed in acid or alkaline solutions, or degraded by a protease, the size of the resulting sericin molecules depends on factors such as temperature, pH, and the processing time. Silk sericin can be derived with soap boiling process, water process, and enzyme process (trypsin, pepsin, papain) (Figure:4) [10].

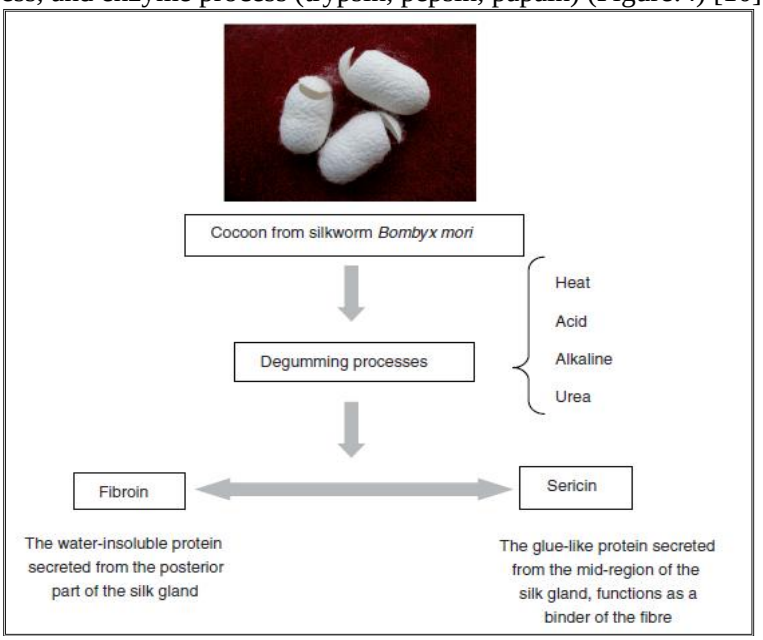

Figure:4 Adegummingprocessofsilk fiberfromSilkBombyxmori [8]

SERICIN APPLICATIONS

Sericin is a natural macromolecular protein derived from silkworm *Bombyxmori*which constitutes25-30% of thesilk protein. It is a biomolecule of great value since it has antibacterial properties, UV resistance, oxidationresistance andhas hydratingproperties. [11,12]

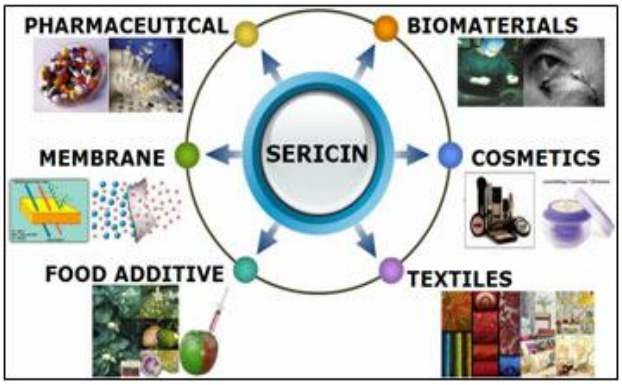

Figure:5Potential Sericin Applications [13]

a) Functionalbiomaterials
It is difficult to make pure sericin into membranes that are enough strong and resilient.Evenso, sericin protein can be formed into a thin film attached to othermatrix. Sericin-coated film is used on the surfaces of refrigeration equipment dueto its antifrosting action.
b) Biodegradablematerials
Environment-friendly biodegradable polymers can be produced by sericinblending. Also sericin-containing polyurethane have great thermal and mechanical features.
c) Membranematerials
Sericin can be used to make membranes for use in separation operations such as reverse osmosis, dialysis, ultrafiltration, microfiltrationetc. Pure sericin is not easily made into membranes, but membranes of sericin cross-linked,blended, or copolymerized with other substances can be made quiteeasily.
d) Medicalbiomaterials
Silk fibroin-based wound dressing that could speedуphealing and could be peeled off without damaging the newly formed skin. Film made of sericin and fibroin has agreat oxygen permeability and it is similar tohuman cornea in its functional features [10].
e) Cosmeticindustry
Thesecharacteristicsincludebiocompatibility, biodegradability, antibiotic-antibacterialactivity, antioxidant behaviour, anti-tyrosinase activity, anticarcinogeniceffects, UV protective properties, and coagulant andmoisturizing capabilities for cosmetics industry [8,14].
f) Textileindustry
Silk fibres made from fibroin have many uses in textiles,mainly because of itsunique properties such as water absorbency, dying affinity,thermo-tolerance, luster and insulation properties. It is also araw material for producing precious fabrics, parachutes, tirelining materials, artificial blood vessels and surgical sutures. [8,5] Sericin-coated fibers can prevent abrasive skin injuries and the development of rashes [10, 15]. Thesporescoloniesdecreasedafterthepre-treatmentwith sericin. Besidesthe tensile strengths were increased approximately 5 times after the treatment with 2% sericin. [16]

CONCLUSIONS

Silk sericin regarded as environmentally unfriendly waste product derived from the silk manufacture. However, it has been proven to have great potential for many industrial applications. Along the several stages of producing raw silk and textile, sericin can be recovered for other uses. Besides, sericin recovery reduces the environmental impact of silk manufacture. Sericin protein is useful because of its

unique properties. Because of its eco-friendly and useful features, sericin is promising candicate for many different applications such as in textile and medical areas.

ACKNOWLEDGEMENT
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MODERN CLOTHING RETAIL

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ABSTRACT

Small sales or retail sales is the way to make all activities related to the direct sale of products and services to target customers / consumers, for personal and not commercial use. In practice, there are a number of different types of sales and category / formats of stores that sell fashion products and retail ranging from shopping centers to market.Management of retail companies, ranging from specificity of clothing, product range and customers psychographic profile must make complex decisions about the way of selling clothes.The selection of the way of selling, determines the selection of the right location, format / category of the sales object, the concept of the building, and so on.In theory and practice of modern retail the view that activity adds value to customers is present.

Key words: Retail; fashion goods; types of sales; formats of stores; the additional value.

INTRODUCTION

Any company that sells products to target customers deals with in fact, retail. With that it does not matter whether they are manufacturers, wholesalers or retailers themselves. Also, it is less important whether the sale is done in person, by phone, via vending machines or the Internet. It is irrelevant where the sale takes place in a small environment, or whether it is a shop, street, market, fair or the home of consumers.
In practice there exist numerous types of retail sales, such as: retail sales through various sales points; electronic retail sales, sales of "door to door", field sales, sales through vending machines, etc.

The sales strategy and distribution of a highly engaged producing companies that produce garments is not easy to define. This is do to primarily peculiarities of clothing as a product of individual consumption and psychological factors that influence decision-making by customers.
+
The most important decisions to be taken by retail companies is to establish one or more methods, as well as a commitment to their own or someone else's retail facilities and their formats... Selecting the retail sales, determines the choice of type of stores, their category / format, location, organization, training of sales staff, etc.

In practice there are different ways to sell retail clothing. The most widespread way of retail sales is through its own stores. In the last two decades there has been a dramatic growth in retail sales through multiple shopping malls (shopping centers). Electronic retailing is used by companies for certain types of clothing. In some countries, regardless of the specific problems, catalog sales of clothing retail are used.

In recent years, more and more talk has come about the value-added sale, as well as a series of creative improvements during the sales process to deepen the customer's experience (4.9). It is indicated that there are more ways the stores can add value. Also different categories or forms of stores depending on the segments of fashion have been developed. Retail companies that sell fashion products must make complex decisions about macro and micro locations of the retail facilities. Selecting a macro or a broader commercial space presupposes consideration to the characteristics of the area, and the people, traffic accessibility and competition. Analysis of micro-locations includes adjacent buildings, traffic characteristics and purchasing habits.

The design concept of retail store must provide its differentiation compared to the competition, and to be in line with the expectations of target customers.

FORMS OF RETAIL SELLING OF CLOTHING AND TYPES OF STORES

In practice various forms of retail trading companies exist, which can operate in several ways. Some of them have their own sales facilities. Other practitioners sell through retail outlets other retail companies. Third they opt for catalog or greenmarket sales and so on. Lately, there has been an increase in internet sales.

Specific forms of retail: catalog and online sales

Catalogue sales

Retail sale through catalogs is a form of direct selling that is based on the development of a catalog with photographs of clothing, their prices and delivery to home addresses of customers - by mail.

Catalogue sales during the 80s of the last century, has taken on new forms. Earlier catalog sale was aimed at those customers who could not pay the purchased clothing -upfront. This way of selling has had to assume a weekly repayment. Clothing that was then promoted was often of poor quality and wasn't considered fashion clothing. However, the price of clothing was lower, but the delivery to the addresses of customers, was very slow.

The changes within catalog sales have started when some retailers have launched their own catalogs, through which they offered high quality and aesthetically very appealing fashion products. The catalogues also contained fabric patterns from which the offered models were made of. Benefits of the new catalog were the express delivery of clothes in within 48 hours, as well as payment by credit card.

Unfortunately, problems of delays in delivery were not fully resolved. However, a new standard in the sales catalog by mail was established.

Catalogue sales in recent decades, experienced expansion in Germany, because German manufacturers are known for the quality of their products and the respect of delivery deadlines. Many companies have hired well-known designers and models, and delivery time of 48 hours is strictly adhered to (1.158).

Catalogue sales have become a market with good prospects.

Electronic Retailers

Electronic retail has become a reality that is largely used by known retail companies. At the same time it is possible to distinguish three main types of retail sales: TV shopping channels and parts of the program; commercial and informative programs and the Internet. The Internet provides the possibility of checking the price through buyer's administration, the availability of products at different websites, which is considerably cheaper than traveling to retail stores. Sales takes place 24 hours a day, reducing the cost of leasing retail facilities, reducing staff employed, reducing procurement, increasing market area and so on.

However, many questions open and remain open when it comes to selling clothing. First of all, will the customers show enough interest to buy clothes over the Internet. An important question is whether the lower costs of obtaining the information needed to make informed decisions on purchasing over the Internet contribute to increasing price of competition?

Likewise, retailers are wondering how in terms of e-commerce, implement a strategy of differentiation of supply, ie the range of clothing. Another question remains open and refers to whether the producers zaobilatiti retailers and directly sell clothes to customers via the Internet.

Likewise, retailers are wondering how in terms of e-commerce, implement a strategy of differentiation of supply, ie the range of clothing. Another question remains open and refers to whether the producers can bypass retailers and sell directly to customers via the Internet clothing. Focus is also on the issues of privacy, intellectual property, speed and reliability of network security and protection of the customers. Many countries have taxed or plan to tax electronic sales. Answers to these questions, by all accounts, will depend on the development of technology, because the existing provides a solid basis for conducting electronic retail stores. It will primarily depend on whether customers will, to a greater extent, accept this form of sales.

Types of retail companies and categories / formats of stores

The main types of retailers and selling facilities through which the sale of fashion garments include: specialty shops, shops with various assortment; multiple retail chains, independent fashion house, outlets, boutiques, franchises, shopping centers, department stores, supermarkets and hypermarkets, discount stores; desorted shops with clothing; secondhand shops with clothes, markets, etc.

Specialized stores

Specialized stores are, generally speaking, the most common type of sales of consumer goods at retail. (3,316) The largest percentage of these shops sell groceries, but also selling garments and footwear. They offer fashion garments at a higher price range, while the clothing of moderate to low selling prices are within the hypermarkets, discount stores and supermarkets.
Such outlets require adequate planning and a selling atmosphere.
Closely specialized shops focus on more narrow part of the assortment. Within a given store may vary several subtypes, such as:

-***Branded apparel shop***, and specialty shops for the sale of a certain brand. They usually open on the basis of concessions or franchises given by company-manufacturers. They have retail space ranging from 3-100 square meters (Benetton, Levi's) Through these stores manufacturers are protected from the sale of counterfeits.

-***Niche shops*** or retail facilities specialized for only one article can offer products of one or more manufacturer. They usually sell: socks, underwear, caps, hats, ties… These shops are small and located on frequented locations, such as underground passages; within mall centers and within larger shops ("store in store").

- ***Stores of particular lifestyle*** or specialty shops for customers who harbor a certain living style. For example in Harley Davidson stores they are selling clothes, shoes, cosmetics, cigarette cases, lighters and various elaborate products intended for customers who harbor a specific style.

Large retail chains are involved in the development of shops of a certain lifestyle. An example is the US trade company "The Limited", which has launched a series of chains focused on specific customer segments: The Limited Stores - stores of fashion women's clothing at moderate prices, intended for modern women aged 20-40 years; Limited Express-store fashion and sportswear designed for women aged 15-25 years of age.

Shops with different assortment

Shops with various assortments are called so because they offer a wide range of products such as clothing for women, children's clothing, shoes, etc. Regardless of specialization these shops continue to attract customers. Customers have remained loyal to traditional trade names, revealing that they now have the same choices as well as multiple chain stores. The main reason for their survival is the ability to adapt to customer needs, in choosing the range. As long as they closely monitor customer behavior, such flexibility can provide this type of store survival in times of economic instability.

Multiple chain store

Multiple chain stores offer customers one type of clothing, such as clothing for women or for men - usually in one range of prices. This is the most common type of fashion clothing stores. However, current customers are often dissatisfied with the image and range of these stores. That's why these companies began to explore the possibilities for complying with the regional tastes. Research of the market will indicate the purchasing power of buyers, the right location and range of clothing that is required. This will allow the determination of the appropriate range, price and servicing customers. It is estimated that these fashion houses have about 70% market share in Western Europe. (ja, 155)

Independent fashion houses

Independent fashion houses, occupy an increasing share of the conveyance of clothing. Customers are attracted to a greater individual choice and personal service at a high level.
The biggest problem faced by the fashion houses is their "vulnerability" to sudden changes in the local economy.

Outlet Stores

Outlet stores are the type of stores, which is common in the world. They have an assortment of quality models of clothing from the previous season, which is offered at significantly lower prices.
Outlet stores offer customers high quality fashion garments from known manufacturers.
In addition to fashion garments for women and men, they offer for baby clothes, underwear and home textiles.

Outlets continuously enrich their product range, service level and information in order to offer customers an added value.

In practice there exists a special type of outlet stores - the so called factory outlets. Featuring shops of an open type of known manufacturers of clothing, in order to solve some of the problems such as the sale of surplus; accelerating the collection, control of discounted brand-name models, etc… Companies - owners of fashion brands such as Levi's and Ralph Lauren, sell through these stores their unsold inventories, returned deliveries, canceled orders, and so on.

Boutiques

Boutiques are the type of stores that usually cover a relatively small area. They differ in the categories of fashion items they sell, the location and level of education of sales staff.
The world's leading fashion houses in the highly specialized sales areas - boutiques, sell high fashion garments with limited access to customers of high society. Boutiques usually carry the name of a fashion designer. The range often diversifies so that the clothes complement footwear, perfumes, supporting details, bags and the like.

Luxury fashion brandes, characterized by top quality, high prices, the uniqueness of which is associated with the name of the designer or historical heritage, high aesthetics, prestigious location and well-trained staff are also sold through boutiques.
Design signatures such as Versace, Armani or Tommy Hilfiger may override the importance of other characteristics of the product (5,171).

The influence of the designer is not only related to the garment, but also for the regulation of retail space, presentation and advertising. It is important to highlight the connection between designers with famous people, and therefore boutiques in which they stop by.

Through boutiques clothes of the fashion design segment are sold. Clothing of mass or popular fashion

may also be sold in boutiques.

Franchises

Franchising as a way of selling clothing, is a concept that was not immediately met with the approval of Western Europe.

Franchising is implemented by engaging franchisees that have adequate assets and conduct the sale of clothing of franchises. Franchisees are required to pay the franchisor a certain smaller percentage called royalties.

Franchisee has the right to use the name, image and know-how of the franchisor.
Franchisee, in accordance to the arrangement may have the following advantages:
- Complete promotion at the national level
- The name of the franchisor is usually well known
- Franchise has a good position in the market

Franchisors, through the franchising system, have a number of benefits, such as the distribution of clothing for the entire national market, at no cost to the functioning of the points of sale, which are usually in good locations.

Some franchisers help inexperienced franchisees, by conducting a complete sale. In other words, they select a range of clothing that the franchisee is going to sell and also track inventory.
The famous Italian fashion company "Stefanel" has a large number of franchises in Europe. "Stefanel" helps franchisees, by providing information on fashion trends, design, presentation, and presentation of goods, computer data processing and the like.

Franchising as a way of selling is ideal for rapid expansion. The requirements of modern customers linked to individualism, initiate by the franchisor, a greater freedom to the franchisee.

Shopping centers

Shopping centers represent market institutions, as of recent. According to a broader understanding, in the mall there is every group of trade and other ancillary facilities.
A close understanding of shopping malls involves only planned expressed Architecture continent aimed at trade, catering and other companies.

Shopping malls in the narrow sense represent the modern market institutions that allow the concentration of supply and final demand. On the supply side retailers, caterers, providers of professional services appear (lawyers, consultants, hairdressers, etc.). Shopping malls have become a destination for family outings, during which they do their weekly or special purchases.

The shopping malls are designed and built by specialized development companies. They, based on projects fundraise resources from independent investors. Trade and other companies lease space in shopping malls.

Shopping malls operate as single entities whose management determines the rules of conduct of renters in it. Common locations of shopping malls are rims of large cities. The image of shopping malls depends on the attractiveness of the renters.

For successful operation of shopping malls, it is essential that optimal parking space and adequate gravitational area is provided and that it has a sufficient number of customers.

In addition to a large assortment of clothing offered to customers, the shopping malls have an area for

catering, leisure, rest, banks, post offices, travel agencies and a like. The newly built shopping malls on the outskirts of major cities, can have in their complex: department stores, boutiques, traditional shops, etc. It is usually built in locations with landscaped parking because buyers come to purchase in their cars.

Department Stores

Department stores represent the beginnings of a modern retail system. They have pioneered new solutions in the design of retail space in developed urban areas (319). The performance of retail sales at clothing stores, department stores, usually is by the self-service system.

Department stores have, in recent years attempted to regain the popularity that they had, because they were endangered by the trend of expansion of different types of stores. Also, they lost customers who have switched to shopping malls outside city centers, which have better access, parking spaces and a large range of clothing.

However, department stores are able to use the space they have at their disposal, in order to operate according to the "action within the action" (-with shop-in-a-shop). This type of business is known as concessions. Widespread use of concessions or exemptions to compliance tastes of a large number of customers for clothing. However, critics point to the negative effects of concessions, since then the department stores appear as a kind of bazaar.

Management of department stores must carefully manage the retail space. With the vast amount of various goods, image and operational trade policy, everything should be clear.
In adapting the stores to market demands, cases revealed the strengthening of specialized stores with narrow and uniform range. With its equipment, the level of service and the structure of the range, there are:

- discount department stores
- luxurious department stores

The discount department stores reminiscent of hypermarkets because they are big ground buildings where the clothing is purchased by the self-service system. Its image is based on the basis of low and at the same time unique prices.

Luxury department stores offer mainly fashion products, mainly clothing, but also footwear, accessories and cosmetics. Disproportionately, the majority of the circulation is on women's fashion clothing. Besides fashion products for personal use, luxury department stores sell so-called household fashion items (textiles, decorations, lighting, small furniture, toys, branded products and a like. Harrods in London, Saks Fifth Avenue in New York and Galerie Lafayette in Paris- are typical examples of luxury department stores.

The development of department stores is significantly affected by the fact that they are traditionally located in central urban areas, on a highly entable, but also expensive locations.

Supermarkets and Hypermarkets

Buying clothes in supermarkets and hypermarkets is not a new phenomenon in Europe. In France, there are retail facilities where most people purchase their clothes. In a range for women and men, casual and ceremonial clothing is offered. These clothes are exclusively produced for supermarkets and hypermarkets. As part of its supply policy they provide socks, hosiery and knitwear.
Supermarket chains, such as "Monoprix", gained a high reputation by selling fashionable, quality clothing at affordable prices. (3,237)

Sales area of supermarkets is in the range of 400-2000 square meters, while sales area of the

hypermarket exceeds 2000 square meters. The range of supermarkets assortments is between 3000-15000 items.
The range of hypermarkets assortments is from 2000-40000 items. Hypermarkets are self-service stores.

Discount stores

The discount stores or shops with lower prices are not just a phenomenon of countries or areas with weak purchasing power of the population. Discounters are increasingly popular in developed Western Europe, where a significant percentage of the clothing sales is through them. Clothing arrives from different sources. Most often, the goods imported from countries with low cost of production and labor (China, Turkey, Laos, etc.).

However, in discount stores they sell quality clothes that remained unsold at the end of the previous season.

Shops with desorted clothes

Shops with desorted stores offer fashion garments of famous designers at significantly reduced prices (40-50%). The main sources of supply are desorted supplies of department stores and specialty shops at the end of the season, unsold stocks of producers, failed and canceled production series and these a like. The success of shops is based on customer loyalty.

Shops with previously used clothes (second hand)

The emergence of stores that offer already worn or used clothing is the result of a long-lasting economic crisis in many countries. Very low purchasing power of a large part of the population, where the largest part of earnings is spent on food and utilities, leaves little money to buy new clothes. On this basis sales system of offering worn clothing develops.

Markets

Markets have for centuries been a traditional place of sale of textiles and clothing. Markets usually offer sellers to start a business with a low-cost lease and a short supply. In general, markets are places where people can buy cheap clothes, that other traders, often rejected, calling it "secondary."

Some markets have become popular. There are many fashionable markets, as like "Canden Lock" in London and "The Trade Hall" in Halifax, where you can find exclusive clothing (1.157). Many young designers feel that given markets are attractive sites for starting their own business.

SALES FORMATS AND VALUE ADDING TO FASHION ITEMS

Two authores, Shaw and Jakson (5, 1o4), note eight sales formats that add value, when it comes to fashion products. There are the following ways:

- Pre-selection and assortment adjustment
- Negotiation of money valuation adjustments
- Shredding orders
- Benefits about the time and place of purchase
- Providing information to customers
- Providing support for product-service and refund
- Loans to customers

The world's leading fashion houses sell high fashion garments in highly specialized and individualized

sales areas with limited access to potential customers who represent a narrow range of people from high society.

Clothing items created in fashion design, are sold through different sales formats. In addition to sales through highly specialized and individualized retail space, fashion designed clothing is distributed through independent and specialized stores and exclusive department stores.

Clothing from the so-called. mass or popular fashion are sold in independent, specialized department stores, specialty stores and specialty shopping malls of higher level.

The other two authors (5, 105), Hines and Bruce grouped all retail companies selling fashion items in four categories:

a) The specialized fashion retailers which is the basis for specialization-fashion product. They focus on a narrow and specific range of products. They clearly define the target group of customers, based on age, sex, or some specific interests as to sport (Nike and Reebok). Given retailers operate in small shops, such as boutiques, or near airports, railway stations or major shopping areas. Such sites are Oxford Street in London or Fifth Avenue in New York.
b) Fashion designers as retail fashion houses as type of international retailers, who must have a distinctive international profile in the fashion industry. This is achieved by maintaining two fashion shows a year in one of the world's major fashion centers such as Paris, Milan, London and New York. Shops and boutiques, bearing the name of the designer sell their own brands. They are located in prestigious locations in major and other important cities. Such retail fashion house are Gucci, Valentino and Chanel.
c) Retailers of a general type are shops that have in their assortment fashion and non-fashion products. Such are: Maarks & Spencer, Harrods and Sogo. Their shops are situated within the main shopping centers and tourist sites.
d) Retailer companies of a general type that offer a wide range of merchandise and fashion accessories. The prices of their products range from low to medium, and the location is in the city center.

SELECTION OF A RETAIL LOCATION

Location for retailers is lately a more complex problem than before. Today's customers prefer locations of stores that will allow them quick shopping or to be offered additional facilities. Selection of the most appropriate location includes two phases:

a) The choice of macrolocation
b) The choice of microlocation

The choice of macrolocation or the wider commercial area, presupposes the collection of information and data on its economic, demographic, social, cultural and other characteristics. The given fashion company is primarily interested in the potential of the area in terms of sales of its clothing. They must consider the following factors:

- Population, occupation, age, marital status and others.
- The characteristics of the area in terms of accessibility, local legislation, etc.
- Competition in terms of the number and types of competitors

Areas that are economically and socially underdeveloped are appropriate macro-locations for the sale of objects of everyday consumption, such as supermarkets, discount stores and the like. It's not a very attractive area for companies selling fashion products. However, the fashion industry ensures the availability of clothing at different price levels. It is a decision on the management of the retail company's on whether a given geographical area is corresponding to his store. Also, it is necessary to

investigate the population of the area, because each group of potential customers who belong to an older age-has different needs. Thus, for example, an aging population, most cares about the price and quality. Occupation is a very important fact when it comes to the needs of fashion products, because, usually, the clothing should be in accordance with professional customer orientation. Women, who want a career as a growing segment are the main customers of fashion products, since they need clothing for their professional and social life. Stores and shops that offer items of clothing for women should be located in prime locations in major cities, where they work, and usually live.
When analyzing the characteristics of the shopping areas, retail companies must establish traffic accessibility in terms of the quality of the road network and free parking spaces. Because of this, shopping centers in cities are sure to build an underground garage.
Local legislation should also be thoroughly considered, to determine whether they might be a nuisance to realization of the planned sales. Thus, for example, in some countries, work is banned on Sundays, which, for retail companies, is a major problem.

Competition can be a positive indicator of the potential of a shopping area, because it provides the frequency of potential customers. However, too many competitors could cause a real "war" in prices.
Availability of qualified vendors on a given area is also an important factor when making decisions about macro-location retail outlets.
Selection of micro location is actually choosing the specific place that offers the best chance for successful operation of a retail outlet. (5, 194)
The following factors are important:
- Environment, in terms of neighboring buildings
- Traffic characteristics (pedestrian traffic, driveways and the like.)
- Purchasing habits

Locating an object between two of the previously set stores that are not direct competitors, may be a favorable opportunity to open a retail store. An advantage also may be a close location to stores that offer a complementary range of products (children's equipment close to the shops for women).
Pricing policy is an important element, because it is not good to locate the store in which the products offer a higher price level -in the area of the discount stores.
Traffic opportunities related to the microclocation, should also thoroughly consider when it comes to attracting potential customers in the future store.

THE CONCEPT AND DESIGN OF RETAIL STORES

The concept is the brainchild of a retail outlet or designed framework that should result in the original design of a given object. This will allow customers to easily identify the given object and to differentiate it in relation to the competitive retail facilities.

Today's competition in retail requires a unique set of stores that offer assortment of fashion products.
Retail fashion companies understand that the physical environment of their retail stores should set them apart from the competition to the same extent as their range does.

Thus, for example (5, 196), the layout of stores H&M is directed to its target market, which constitutes of the younger population. Chrome and glass that make up the sales area devoid of decoration perfectly sets the scene for clothing in the fashion trend.

So, before the decision is made of which form the interior and exterior of the retail facility will be, retail companies must determine their goals, the image that they want to achieve, as well as the characteristics of their target market. However, when developing the overall concept of retail store space, retail companies need to bear in mind that customers are different. For example, there are potential buyers who planned to go shopping, but also those who want to see an assortment of the retail store, which may encourage them to do something and buy it. Customers in the first group expect products to be visible, that is a complementary assortment stacked close together to easily get

in and out of stores.
To the other group of customers enough space to move around can be offered, so that the range of products can easily be seen, along with attractive lighting, notices, etc...

5. CONCLUSION

There are many different distribution channels to make the product reach the target customers. Large companies, manufacturers of clothes, often have their own sales facilities. On the other hand, there are various forms of retail trade organizations. Some have their own sales network, or the models can be ordered by mail through catalogs. Some garments can be sold through electronic sales.
The most important types of stores in retail and are specialty shops, shopping centers, independent fashion houses; discounts; boutiques, department stores, outlets, franchises, supermarkets and hypermarkets, shops with used clothes, shop with desorted clothes; multiple chain stores; shops with a mixed assortment; trading markets and so on.

Management of retail companies, coming from the specificity of clothing as personal consumption products, their use, types, levels of fashionability, width and depth of assortment, cultural characteristics, geographic areas, urbanity and the purchasing power of potential customers -must make effective decisions on the location, the type of stores, their format, concept, etc.

Reputable researchers of retail clothing sales show of delivering added value to customers, which is directly dependent on the level of retail formats, their concept, education of the retail staff an a like.

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IMPORTANCE OF DETERMINATION THE ORGANIZATION DEVELOPMENTAL STAGE AND TOP MANAGEMENT CHARACTERISTICS IN PROCESSING INDUSTRY MANAGEMENT

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ABSTRACT

The successful management greatly depends on the formation and characteristics of the top management team, which should transform in accordance with the organization developmental stage. This is due to the fact that the development path of the organization and the character of the top management are crucial in planning and implementation of the management activities. Process approach trough the organization, implementation of International Standards and Six-sigma methodology, investments in new technologies, improvement of product's quality by improvement of employee's motivation are only a part of the required management activities in processing industry organizations that aim to reach TQM as the best way of securing competitiveness on the market. The implementation of any positively verified methodology conducted in a wrong developmental stage of the organization and by the wrongly formatted management team can have catastrophic consequences for the organization. That is why it is necessary to adjust the implementation of planed, needed or desired methodologies and activities with the determined organization developmental stage and accordingly transformed management team.
This paper based on a case study in a Macedonian organizationaimed 1) to examine the relation between the organization developmental stage and the characteristics of the management team and 2) to give directions for management activities. The study combines two methodologies, methodology for determination of organizational developmental stage and methodology for evaluation of the management from the aspect of their PAEI characteristics. The results showed that the analyzed company is in the transition period between Go-Go and Adolescence stage with an adequate top management team by its PAEI characteristics. The results from both methodologies 1) confirmed the positive relation between the developmental stage of the organization and the characteristics of the top management and 2) gave a framework for management activities that are necessary to be undertaken at that point and activities for which is too early to undertake.

Key words: management, processing industry, organization, developmental stage, PAEI code

INTRODUCTION

The beginning of every organization is just an idea. The path that will lead from idea to realization, from being to persistence, from group of people who work on achieving a goal to structured organization with determined organization objectives, is long and complex. There for, the development path of the organization and its internal needs and transformations is of crucial importance in planning and implementing management activities.

Numerous researchers that were exploring the organizational development have adopted the concept of "being" in the biological sense of its meaning and suggested models of life cycles of organizations from birth to death. Models differ depending on the number of stages of the organizational life cycle, criteria used as basis in dividing the development stages as well as their application.

This research is using the organizational life cycle theory of Isach Adizas. According to this theory, the optimal life cycle of the organizational development includes the following growing stages – Courtship, Infancy, Go-Go, Adolescence, and Prime. After reaching the stage of Prime, the organization will stay in the stage of Stability or it will start its aging through the stages of Aristocracy, Early Bureaucracy, Bureaucracy and Death. In each of the stages of growth, the organization is facing a set of challenges that in theory are classified as normal problems (changeable by nature). If these problems are not identified and dealt in time, they intent to transform into pathologic problems that may cause death of the organization at any time. To optimize the life cycle

course, knowledge and consultations are needed for more effortless overcoming of the normal problems anticipated for each of the development stages. The most important stage for optimization is the stage of Stability that restrains aging of the organization (2,3,4,5).

In order to achieve a well-managed organization, management must perform four different roles: P-A-E-I. (P)roducing the results for which the organization exists, (A)dministering systems and process for efficiency, (E)ntrepreneuring for leading innovation and change, and (I)ntegrating so the different parts of the organization work together for long-term accomplishment. These four roles together are sufficient for any organization to be well managed. However, if one or more of the roles is deficient the result is mismanagement, manifested by problems such as falling market share, lower profits, high staff turnover, slow response to changes, etc.

PAEI is a powerful management tool that can be used to gain helpful insights into people, a company, a project, a product, and a wide range of other phenomenon that are important to management. This four prominent leadership styles (P, A, E, and I) Adizas found in different quantities in various stages of the organizational lifecycle.

The four roles in the PAEI model are:
Producer – This person holds responsibility for the product or service that the business offers. They ensure the business goals and objectives are met and ensure that the product or service delivers what it is expected to.Producers are results orientated and work incredibly hard to get these results.
Administrator – This person has a focus on how tasks are done. They are process driven and look at the way things are done. They look at processes, rules, policies and procedures. They take a logical and analytical approach to their role. They take their time to ensure things are done correctly. Added to that, Administrators are great at developing policies and processes that the business requires.
Entrepreneur – These are the ideas people. Incredibly creative and great at producing ideas to solve problems in the business. Often optimistic, they look at the bigger picture and imagine the vision rather than the practicality of getting there. They can also spot potential threats to the business and even though they are somewhat disorganised and illogical in their thinking they add lots of value to the tea.
Integrator – This person is relationship driven and works hard to bring people together. They create a harmonious environment and are very empathetic.They work methodically and focus on the process and people rather than the overall result.They ensure that everyone is listened to and they listen to everyone.

To ensure the PAEI model works well, the business needs to ensure that a mix of all 4 roles make up the management team.

Companies are more likely started by ENTREPRENEURIAL type of managers, which posses more creative skills. After developing the business concept, the leader must then begin to PRODUCE, introducing the product/service to the market, creating and satisfying the needs and then keeping up with demand. To continue developing, the company needs to add two more roles to its portfolio. The ADMINISTRATION role will drive for greater efficiency and maximize its returns. Then, as it grows, the business will need to recruit more people, and the leaders must ensure that individuals become fully INTEGRATED and work as a cohesive team.
The goal of the research presented in this paper is with combines two methodologies, methodology for determination of organizational developmental stage and methodology for evaluation of the management from the aspect of their PAEI characteristicsexamine the relation between the organization developmental stage and the characteristics of the management teamand give directions for management activitiesfor the determined organization developmental stage.

METHODOLOGY

The research is conducted in a Macedonian organization that consists of three production plants. The organization accounts 300 employees and a top management executive board of five members. The research usedMethodology for evaluation of management PAEI code and results from Methodology for determination of the organizational development stage.

The methodology for determination of organization developmental stage uses newly designed questionnairebased on the theory of Isach Adizas regarding organizational life cycle. The questionnaire is consisting of 13 questions accompanied with two or three obtainable answers for each question. The questions are based on the normal problems anticipated in each development stage of the organizational life cycle. The factors that are causing these problems and are covered by the questionnaire, are the following:

- organizational orientation, structure and functionality;
- delegation of jurisdictions and authorizations;
- policy of organizational development;
- finances and costs;
- relation between the company and its founder.

The research used one copy of the questionnaire for determining the development stage of the organization, which wasanswered consensually by allfive members of the top management. The obtained answersare compared with the theoretically anticipated normal problems by development stages. The development stage of the organization is determined by the record of which development stage has the most coincidence between the theoretically anticipated normal problems of the development stage and the obtained answers.

The evaluation of the management PAEI code was conducted by interviewing all five members of the top management individually. The questionnaire used for this evaluation is based on Adizas's PEAI management roles theory and is consisted of 33 questions. The questions are focused on:

- direction of the focus and the activities at the time of conducting work tasks;
- relation with the co-workers;
- typical classification of the issues that are causing dissatisfaction at the time of conducting work tasks;
- way of working and perception of problems;
- reaction in conflict situations.

The answers were scored with 0, 1 or 2 points, which summarized will give result from a minimum of 0 to a maximum of 20 points for each PAEI characteristic. Based on this result, the magnitude of the PAEI characteristics was evaluated and PAEI manager's code is created. The evaluation of the PAEI characteristics used the following principles:

- 0-5 points - absence of the characteristic;
- 5-15 points - presence of the characteristic;
- 15-20 points - prominence of the characteristic.

The manager's code is articulated by use of uppercase letter for the characteristic that is prominent and lowercase letter for the characteristic that is present. Accordingly to PEAI theory, the PAEI manager's code was used for defining profile for every manager individually and common profile for the management team.

RESULTS

Defining the organization developmental stage

The results showed that the analyzed organization is at the transition period between Go-Go and Adolescence stage (figure 1). The following recommendation for undertaking activities was given:

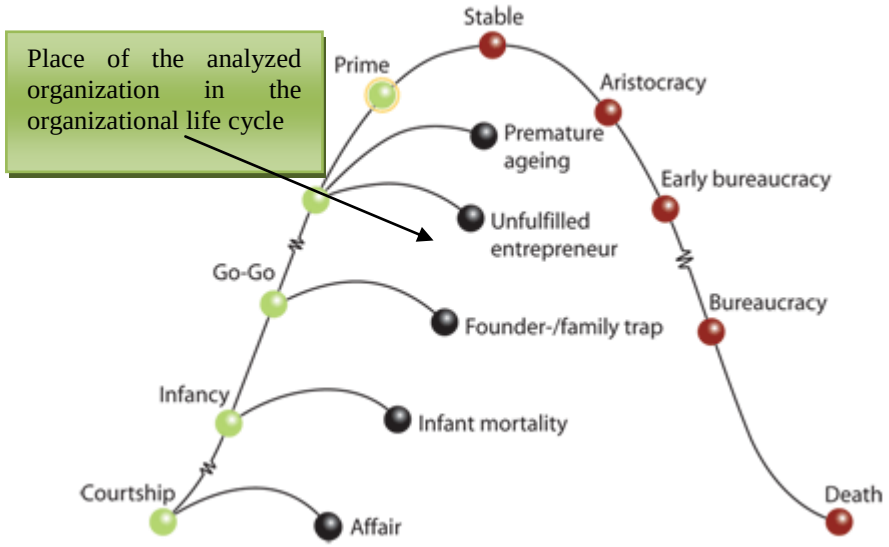
- transparent delegation of authorizations and not only obligations;
- designing and implementation of rewarding system;
- redefining and institutionalizing of working positions and responsibilities trough rules and policies;
- structuring organization not around people but around processes;
- improvement or the founder's position regarding decentralization of the decision making and management of the organization;
- careful change of the organizational goals that will be based on exact information from the analysis of the process data.

Evaluation of management PAEI characteristics

The results showed the following magnitudes of the PAEI characteristics for every member of the top management team (figure 2).

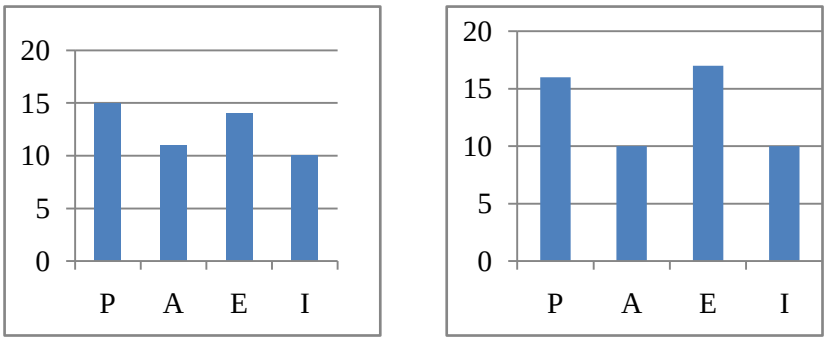
Using Adize's PAEI theory, the following managers profiles were defined:

Manager 1 and 2 - PaEi – This manager profile is characterized with activities directed toward accomplishment of production services required by the customer and creation of new ideas and projects. Managers with this kind of profile are prepared to take risk and to perform the working tasks independently. The focuses of their activities are **what** and **when** the things should be done. They prefer co-workers that are dedicated to their work and are impressed by new ideas and projects. Their usual complains refer to not having enough time and often not being understood by the co-workers. Usuallythey are fast in their working performance and are able to see things both locally and globally, they can function in both structured and unstructured processes but their focused more on results then processes.

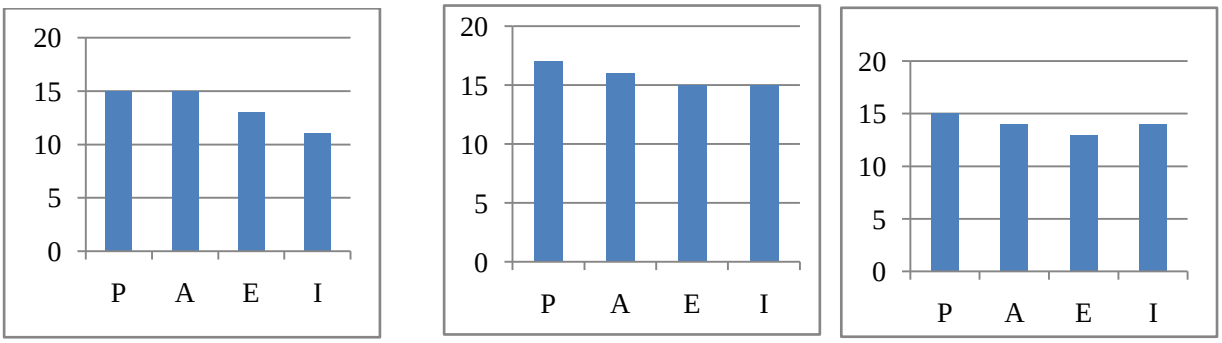


Source: Adizes Isak, Upravljanje zivotnim ciklusom preduzeca, Novi Sad, ASEE, 2007 (modified)

Figure 1. Development stage of the analyzed company



a) manager 1 - PaEi *b) manager 2 - PaEi*



c) manager 3 – PAei *d) manager 4 – PAeie) manager 5 – Paei*

Figure. 2Magnitude of PAEI characteristics for5 managers

Manager 3 and 4 - PAei - This manager profile is characterized with activities directed toward accomplishment of production services required by the customer and creation and implementation of working procedures and rules. Managers with this kind of profile are not always prepared to take risk. The focuses of their activities are **what** and **how** the things should be done. They prefer co-workers that are dedicated to their work and are wheeling to adopt to their new requests. Their usual complains refer to not having enough time and having co-workers that are not doing things in the right way. Usually they are precise in their working performance, usually they see things locally and they can function better in structured processes.

Manager 5 -Paei - This manager profile is characterized with activities directed toward accomplishment of production services required by the customers. Managers with this kind of profile are not always prepared to take risk. The focuses of their activities are on **what** should be done. They prefer co-workers that are dedicated to their work and their usual complains refer to not having time for anything else but their work because nobody works but them. Usually they are fast in their working performance but they see things locally, they can function in structured processes but their focused more on the processes then results.

If we combine manager's codes of all the members, we can define the manager's code of the top management team. The analyzed management team has prominent **P** characteristic, presents of **A** and **E** characteristics and almost an absence of **I** characteristic. The profile of the team can be defined as:

- focused on what has to be done to satisfied the customers' requests at the moment;
- prepared to start structuring the organization on roles and procedures;
- prepared to take over the E role of the fonder in full;
- not having enough sense for the importance of integrated employees.

DISCUSSION

The determined transition period between Go-Go and Adolescence stage of the analyzed company requires transformation of manager's code from PaEi, which is typical for Go-Go stage to pAEi code which is need in Adolescence stage. The defined code of the top management team as PAEi needs to be transformed by emphasizing A and E management roles on the account of P role. This transformation will provide condition from successful transition of the organization from Go-Go to Adolescence stage.

Recommended management activities that are necessary to be undertake steamed from the determined developmental stage of the analyzed organization. These recommendations need to be specified in accordance with the nature of the company and the defined capacity of the top management team by its PEAI roles. The meaning of the transformation of PAEI roles of the top management and specified management activities that are needed for successful transformation of the analyzed company are given in Table 1.

Table 1. Overview of the management team PAEI role transformation and required management activities

PAEI manager's role transformation	**Required management activities**
Keeping the magnitude of E role will provide vision for setting new organizational goals	In the case of this transition period E role refers to the E role of the team and not the founder, which will improve the founder's position regarding decentralization of the decision making and management in the organization by transparent delegation of authorizations and not only obligations. The team will have to carefully change and specifically define the organizational goals from quantity to quality production, which will put under additional control the investments undertaking and cost
Reducing P role is necessary for changing focus of the company	With the new goals set, the company has to change the focus from local to global satisfaction of customer's requests. The focus should be changed from market to product
Keeping the magnitude of A role will provide conditions for creating organized, systematized and stabile company	Redefining and institutionalizing of working positions and responsibilities trough rules and policies and structuring the organization not around people but around processes can be provided by implementation of one of International Standards (ISO 9001:2008)
Presence of I role is sufficient for this transition period	The priority of increasing magnitude of I role will be necessary for designing and implementation of rewarding system after all of the above is accomplished

CONCLUSION

The implemented Methodology for determination of the organization developmental stage defined the organizational stage of development of the analyzed company and gave directions for management activities which are needed to be undertaken in order of successful transformation of the organization.
The methodology for evaluation of manager's PAEI characteristics gave the manager's profiles and the profile of the top management team. In accordance with the defined organization developmental stage,directions for the transformation of the top management team in order of successful transformation of the organization were given.

With the knowledge of where the organization is headed and what kind of top management team is required, is much easier to identify the necessary management activities which conducted by the transformed top management team will have successful implementation and maximum positive results and effects on the development of the company.

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INTERNET APPLICATION FOR ELECTRONIC CLOTHES SELLING

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ABSTRACT

In this paper we presented system for electronic clothes selling. We created an application in ASP.NET MVC programming language which should enable clothes selling from different manufactures and brands via the internet. Electronic sales of clothing in the world is present for many years, whereas our brands are now opting to offer this type of sale. Our application gives several contributions. The first is the development of fashion industry by selling products from Serbian manufactures, but also from manufactures from other countries in Balkan region. Another contribution is selling clothes of fashion designers. Through our application, they will be able present their work to a larger number of people. Third, and perhaps most important contribution, is an affirmation of students and other young designers that will have an opportunity to present their work. Our application will include development of fashion clusters. For tailoring of designs presented by design students and young designers, we will need their involvement.

Key words: E-store, fashion designers, fashion brands, fashion clusters

INTRODUCTION

Electronic shopping (e-shopping) represents a form of electronic commerce that allows customers to directly buy goods from sellers using World Wide Web. E-shop evokes physical analogy of buying products at shopping center. The process is called business-to-consumer (B2C) online shopping. The largest of these online retailing corporations are Alibaba, Amazon and eBay.

On the territory of Serbia, as well as a larger part of the Balkans, clothing sales over the Internet has yet to take effect. Some of the services for electronic payment are just recently available to people in these areas. Lack of electronic competence and low standard make computers with a permanent connection to the internet not yet available to everyone. All that makes that Balkan region partly lags behind the developed world when it comes to electronic selling. Companies that sell clothing have just recently started to offer their products via the internet.

In this paper, we presented a system that should allow product selling of local fashion brands, as well as local designers. Our goal is to use internet to offer product to much larger number of potential customers.

RELATED WORK

Online shopping was first introduced by Michael Aldrich in 1979. His system connected a TV to a real-time transaction processing computer via a telephone line. He believed that videotex, the modified TV technology with a simple menu-driven human–computer interface, was a "new, universally applicable, participative communication medium — the first since the invention of the telephone". This enabled closed corporate information systems to be opened to outside customers not just for transaction processing but also for e-messaging and information retrieval (Aldrich M., 1979). During the 1980s he designed, manufactured, sold, installed, maintained and supported many online shopping systems, using videotex technology (Aldrich M., 2011). These pre-date the Internet and the World Wide Web, the IBM PC, and Microsoft MS-DOS, and were installed mainly in the UK by large corporations.

Big step forward in e-shopping was invention of World Wide Web by Tim Berners-Lee in 1990. Another important technological innovations were online banking, Netscape's SSL v2 encryption standard for secure data transfer. Both of these innovations emerged in 1994. The first secure retail transaction over the Web was either by NetMarket or Internet Shopping Network in 1994. Immediately after, Amazon.com launched its online shopping site in 1995 and eBay was also introduced in 1995. Alibaba's sites Taobao and Tmall were launched in 2003 and 2008, respectively.

E-commerce B2C product sales totaled $142.5 billion in USA in 2011, which represents about 8% of product sales in the Unites States. Clothes were sold online in worth of $26 billion which represents 13% of the domestic market. Forrester Research estimates that the United States online retail industry will be worth $279 billion in 2015.

For developing countries and low-income households in developed countries, adoption of e-commerce in place of or in addition to conventional methods is limited by a lack of affordable Internet access.

E-STORE APPLICATION

Electronic selling store created in this research allows clothes selling for both domestic brands and fashion designers, as well as for students from department of fashion design and textile science from our country and from the region. The aim of this application is to connect fashion designers and brands from the area of the Balkan, and to allow customers to view and order different products from one single point. This would facilitate development of the whole region because each manufacturer will use our electronic store to place its products on regional market (Aileni R.M. et al., 2011).

Our application, named BalkanFashion, enables easy and transparent access to products via the web browser which is very important in order to achieve the highest possible number of visits and customer satisfaction (Liang T-P. and Lai H-J., 2000). Everything we need in order to access e-store application and view products is a personal computer with internet connection. The application is accessed through a web browser, so it does not need any additional installation on customers' computers.

Access to the application is enabled to different types of customers. Following users will be able to access BalkanFashion e-store application:

- Unregistered users - those are users that have access to some basic parts of application, but haven’t pass the registration process. They are able to view products, order them and read fashion blogs.
- Registered users - those are users that have passed the registration process. Beside the unregistered user options, they can exam their ordering history and collect extra points and coupons in order to obtain discounts in the following purchases. They can also manage their data (personal data, address, etc.) in order to more quickly pass the ordering process in the next purchase.
- Bloggers - are registered users that can manage their own blogs through content management system
- Brand administrators - are administrators that can place new products on the store. These products can later be viewed and ordered by customers. Those products are created by brands or well-known fashion designers.
- Student designers - are registered users who send their fashion designs in order to be displayed on the site. However, before their designs take place on official site pages, they must be approved by the fashion administrators.
- Fashion administrators - are special type of administrators. Those are eminent designers and professors from Textile science faculties. Their job is to approve student designs if they believe that they are worth to be presented in the e-store application.
- Super administrators - are special type of administrators that have access to all parts of the application

Each of previously defined user types can access the application with its unique username and password (except unregistered users). Depending on which user type a user belongs, it can gain access to different content through menu items. Users are not given access to the parts of the application that are not intended for user type to which they belong. Protection of unauthorized access to some parts of e-store is realize using ASP.MVC forms authentication. Registered user data are encrypted and stored within the cookie on the user web browser, so that entire application possess a high degree of security. All payments on the site are made through trusted and secure payment systems (PayPal, Skril) so that all users can be absolutely sure that their personal data will not be misused and funds removed without their approval.

After starting the application, we have layout that is shown in Figure 1. In the upper part of the window we have slider. It shows currently active promotions and announcements for new collections of certain brands that can be purchase through e-store application. In the central part of the application layout, on the left side we have menu that allows product filtering. Filtering can be done by brand name, designer name, or by category to which certain product belongs (trousers, skirts, shirts …). Main part of the page is attended for product display. Left image on Fig. 1. shows all products that are displayed based on search criteria. When we click on some product, we obtain its detail view, which is displayed on right image on Fig. 1. At any moment, we can add product to cart by clicking Add to Cart button.

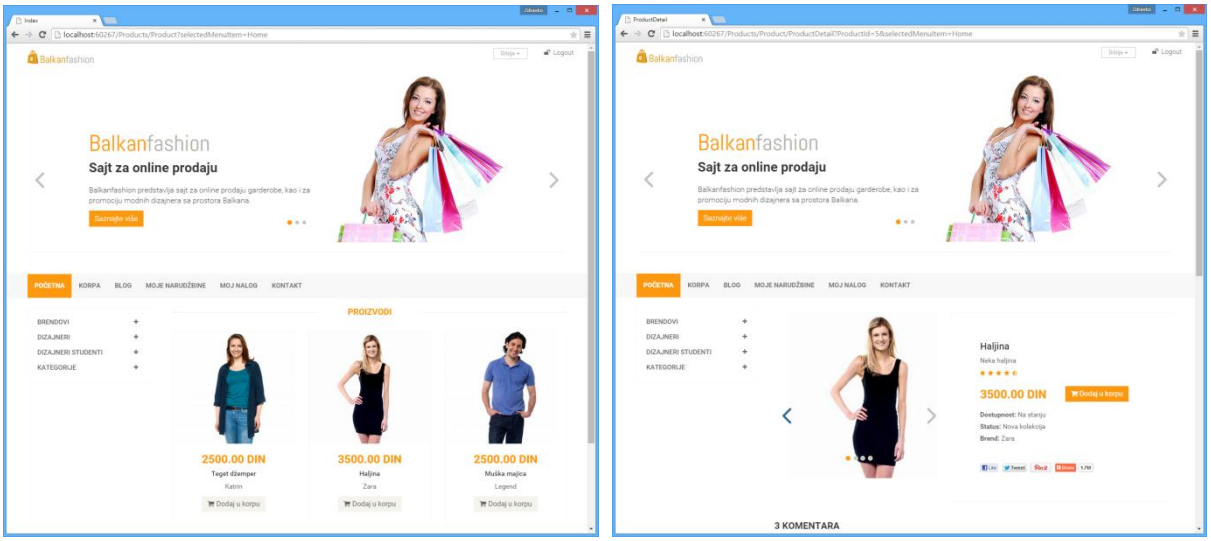

Figure 1: Product details in BalkanFashion e-store application

Page that displays cart is shown in Fig 2. On figure, we can see all products that are added to cart. We can also manage number of ordered items (increase or decrease) or remove some product from the cart. This page also allows customer to enter discount code or to use some of its bonus point, and to calculate shipping costs depending on delivery area.

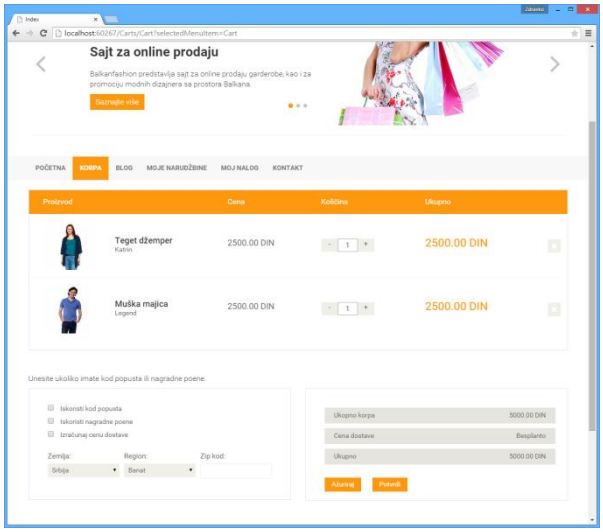

Figure 2: Cart in BalkanFashion e-store application

Placing an order requires some additional steps from customer. When he has finished with adding products to cart, he must enter exact delivery address. Delivery address will have influence on shipping costs. Last step is selection of appropriate payment system. In current version, application allows payment through PayPal and Skril payment systems. If the customer correctly enters its payment information and has sufficient funds in the account, ordering process completes. Customer gets notification message and can monitor current state of its order.

CONCLUSION

In this paper we have presented system for electronic clothes selling. Goal of our system is to allow clothes selling from brands and well known fashion designers, as well as clothes designed by students and young designers. By developing our application and engaging larger number of brands and designers, we will enable development of electronic sales and market expansion, as well as the inclusion of fashion clusters.

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COMPRESSIVE BEHAVIOR OF THE WARP KNITTED SPATIAL TWISTS AND THEIR USE IN VARIOUS APPLICATIONS FOR MAKING CUSHIONS

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ABSTRACT

In this paper an experimental study on the warp of three-dimensional compression behavior of warp knit knitted fabrics in a variety of applications designed to create cushions. The knitwear is produced based on the knitting machine fineness of 18 with two warp yarn with the change of different structural parameters, including the angle of inclination of spatial and yarn fineness, thickness twists and outer layer structure .Diagrams and test results are used to analyze the behavior of these compression base of knitted and knitted fabrics the effect of each of the structural parameters.
Based on the obtained results have proved to be an ideal base braided twists class energy shock absorber cushions for different applications and their energy or capacity that can be easily adapted to the specific needs of various end-use simple its structural parameters with the help of diagrams efficiency.

Key words: warp knitted knitting, slope angle, thickness twists, compression, structural parameters, cushions.

INTRODUCTION

The materials used for making cushions lose kinetic energy and thus affect the mass of the maximum load while retaining (or acceleration) below a certain value [1]. They generally absorb kinetic energy under mechanical compression action on the relatively constant pressure over a wide range of relocation.

If the cushions were properly designed with extended by moving the appropriate level of constant pressure, the material cushions to absorb most of the energy supply and influenced her. With increased energy absorbing shock with increased transfer and one constant pressure, protected object could not withstand a concentrated high energy - or high - load, the impact of which would result if the mass directly affects him.

There are a large number of materials and structures with the aforementioned functions for applications cushions: air bags, films, fibers rubberized cushions, and polymer-based foams are some typical examples. However, despite their promising properties cushions and low prices, inferior comfort properties makes these materials and structures unfit for the protection of the human body. The warp of knitting are knitted spatial three-dimensional textile structure consisting of two separate knitted outer layer is connected but separate from, the spatial yarns, which are generally monofilaments [2]. The knitwear is produced on Raschel machine with two warp yarns and their three elements or external layers of knitted and spatial yarn, knitted together in a single process with a wide range of variation of structure. In addition, the materials that are commonly used for spatial twists are Multifilament polyester and monofilament, which are very commercialized product with low costs. Low price, high productivity, and wide variations in the structure of the warp-knitted spatial twists makes them very attractive for various applications [3-6]. This is normal behavior that require material in compression [1]. In the published results, a relatively constant load on the stage of the plastic tray (plateau) were observed. These results showed that the base knitted spatial twists are a new class of alternative candidate materials for applications cushions. However, the plateau phase, which is located in the literature [4-6] is not significant and plateau phases are reported in the literature [3] is too short as well. In other words, the total energy absorbed in the plateau area of the reported twists is not sufficient to identify them as a good material for cushions. Therefore, in this study the behavior in compression of the base - knitted spatial knitted knitting specially developed for various applications cushions in order to extend the zone of the plateau to reasonably control the load level on a plateau

phase. To this end produced a spatial warp knitted knitting on Raschel machine fineness of 18 with two-warp yarn and with the change of structural parameters, including spatial cross between layers of knitted knitting with a pitch angle and**.**

THE EXPERIMENTAL PART

Samples of knitting and knitting supplies

Samples with different twists laying yarn were made on Raschel machine with six fineness 18E guide (lege rail). Polyester multifilament with a diameter of 0.2 mm was used as a spatial yarn to connect the two outer layers of knitted fabrics. Knitting is done in four different structures - weaves, which are shown in Table 1. Composition of the chain with different tilting angles and movements are shown in Table 2. It was produced 11 samples Physical twists of the authors (Liu Yanping, Hu Hong, Li Zhao and HAIR Long) with an additional pattern that is made with spatial yarn diameter 0,16mm. During knitting knitting density is changed from 10 / rows per cm. In Table 3, the basic parameters of the structure twists.

Table 1. Chain notation of yarn guide bars for outer layers

Structure	GB1/GB6	GB2/GB5	Threading
Locknit (L)	1-0 0-0/3-2 3-3//	2-1 1-1/ 1-0 0-0//	Full
Chain+ inlay (CI)	0-0 0-0/ 5-5 5-5//	1-0 0-0/ 1-0 0-0//	Full
Rhombic mesh (RM) 1-	0 0-0/1-2 2-2/2-3 3-3/2-1 1-1//	2-3 3-3/ 2-1 1-1/1-0 0-0/ 1-2 2-2//	1 full 1 empty
Hexagonal mesh (HM)	(1-1 1-0/ 3-3 3-2)x3/(4-4 5-4 /3-3 3-2)x3//	(4-4 5-4/3-3 3-2)x3/(1-1 1-0/3-3 3-2)x3//	2 full 2 empty

Table 2. Chain notation of yarn guide bars for spacer yarns

Lapping	GB3	GB4	Threading
I	1-0 2-1/2-1 1-0//	2-1 1-0/1-0 2-1//	1 full 1 empty
II	1-0 3-2/3-2 1-0//	3-2 1-0/1-0 3-2//	1 full 1 empty
III	1-0 4-3/4-3 1-0//	4-3 1-0/1-0 4-3//	1 full 1 empty

Table 3. Details of the spacer knitting

Knitting	Top outer	Spacer layer	Bottom layer	Thickness outer layer (mm)	Areal density (g/m^2)	Bulk density (kg/m^3)	Stitches/cm^2
S1	L	II	L	7.5 2x0.06	1008.29x10.68	134.08x1.42	41.15
S2	CI	I	CI	7.57x0.08	900.11x9.01	118.87x1.19	37.95
S3	CI	II	CI	7.59x0.10	901.75x14.58	118.84x1.92	37.26
S4	CI	III	CI	7.40x0.06	923.20x.44	124.76x1.14	37.95
S5	CI	II	CI	5.64x0.03	790.63x14.51	140.08x2.57	34.98
S6	CI	II	CI	8.45x.09	1022.08x13.38	120.96x1.58	43.50
S7	CI	II	CI	10.62x0.10	1010.42x8.83	95.14x0.83	37.95
S8	RM	II	CI	7.20x0.05	830.05x11.53	115.22x1.60	39.33
S9	RM	II	RM	7.76x0.06	907.24x17.07	116.91x2.20	51.10
S10	HM	II	CI	7.56x0.08	812.70x6.61	107.50x0.87	37.95
S11	HM	II	HM	7.62x0.06	724.82x8.34	95.17x1.10	38.86
S12	CI	III	CI	7.06x0.09	746.53x6.81	105.68x0.96	39.44

COMPRESSION TEST OF THE KNITTED TWISTS SAMPLES

Testing samples of the device "Instron Worldwide Headquarters, Norwood, Massachusetts, USA," which has two circular plates of diameter 150 mm. Samples of the knitted knitting measuring 100 mm x 100 mm. Testing was performed at a speed of 12 mm / min until the deformation of the sample 80% at a temperature of 20 degrees Celsius and 65% relative humidity.The diagram shows the five experimental "compression pressure - strain curve. It was observed that there was no obvious difference in the test results under the two conditions of the test, except for sample S2. Figure 1 is

given Hierarchical chart of warp knitted ,Figure 2. Knitting process of spacer knitting. In Figure 3 data is 3D computer simulated image of warp knitted spacer knitting and Figure 4 is the data structures of spacer stitches and their force diagram.

Figure 1. Hierarchical chart of warp knitted spacer knitting

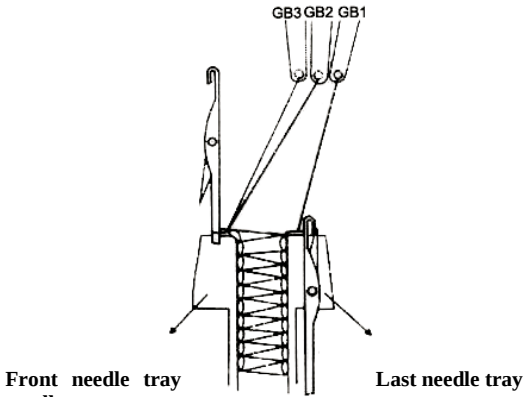

Figure 2. Knitting process of spacer knitting

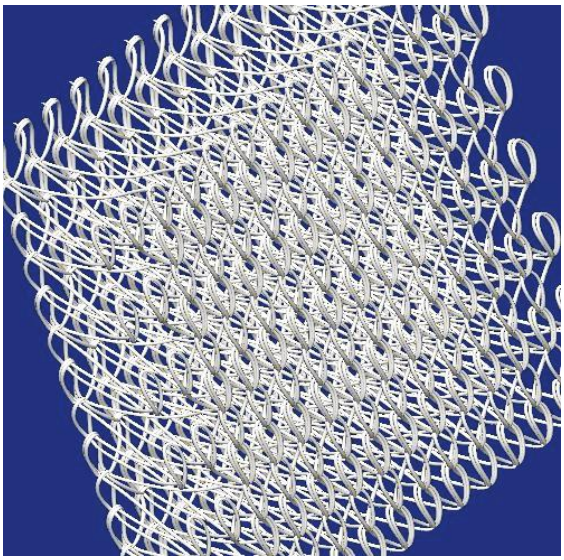

Figure 3. 3D computer simulated image of warp knitted spacer knitting

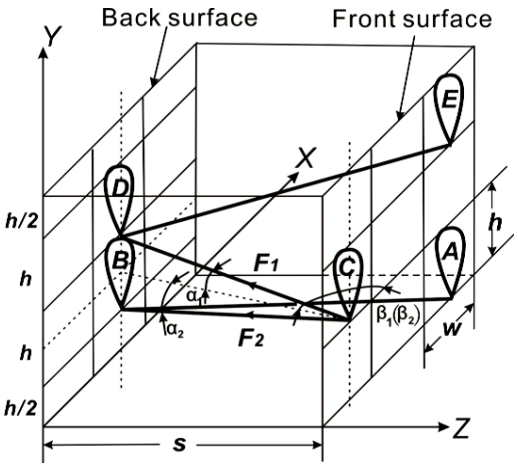

Figure 4. 3D structures of spacer stitches and their force diagram. h - stitch height, w - stitch width, s spacing distance; α1, α2, β1, β2 - inclined angles of spacer yarns.

Figure 5 gives the effect of spatial slope exceeds the compression behavior of spatial twists (a) pressure - strain curves, (b) the effectiveness of the diagram .As a result, keypress compression - strain curve S2 has a sharp drop in the plateau area, as is clearly shown in Figure 5(a). To avoid the influence of shear specimen twists outer surface layer of knitted knitting is attached to the panel prior to compression testing. The test result is also shown in Figure 5 (a). As expected sharp drop disappears. Diagrams curves for the samples S3 and S4 are also shown in Figure 5 (a) for comparison. It was found that the resistance to compression of spatial twists on the home and the elastic phase decreases as the tilt angle of the spatial yarn.

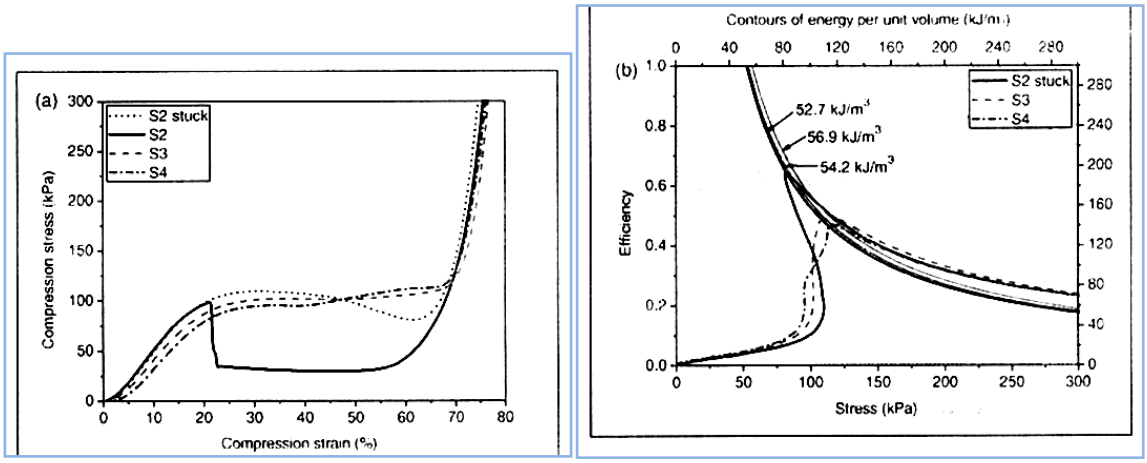

Figure 5. Effect of the spacer yarn inclination angle on the compression behavior of the spacer fabrics: (a) stress-strain curves; (b) efficiency diagram.

RESULTS AND DISCUSSION

Typical compression pressure-strain relationships and behavior cushions

Figure 6 shows a typical compression pressure - strain curves spatial pattern knitting (S1). To facilitate the analysis of the behavior of compression twists, the compression process is divided into four different phases, ie, the initial phase (phase I), the elastic phase (phase II plateau phase (phase III), and densification phase (phase IV) in accordance with changes tilting in the wrong corner. In the initial stage, the lower the tilt angle is observed due to compression of the loose outer layers and their inefficient limits for monofilaments. As every loose multifilament loop around a single filament may well limit the monofilament at this stage, there is a slightly slipping from monofilaments in the outer layers.

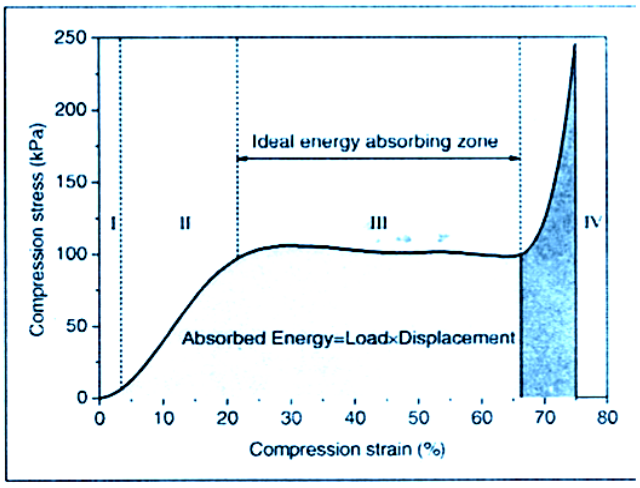

Figure 6. Typical compression stress-strain curve of a spacer knitwear

However, when knitting further compressed (compressed) in phase II, all compressed multifilament sutures are attached to alter the microstructure. At this stage, monofilament give way to a greater extent and they are better fitted than Multifilament sutures.Accordingly,the sudden increase the compression pressure, ie, tighter mechanical behavior of twists is observed. Almost constant prtisak obtained in phase III.The mechanism of deformation twists at this stage is very complicated, which could affect the twisting, rotating, cutting, and connectivity of monofilaments as well as contact the monofilaments with the outer layer.The most influential factor for a fairly constant pressure can be among the contacts on the

monofilaments, of which the boundary conditions at the ends of contact with the outer layers are not constant.

Compression of stage IV shows a rapid increase of pressure due to rapid densification around the twists. At this stage, the monofilament in the collapse of twists and contact each other, so it is actually received high stiffness. Previous analysis shows that the spatial twists possess good cushioning effect, because almost constant pressure in the compression phase III gets to the large displacement 3.6 mm, which is beyond half the initial thickness (7.52 mm) twists and corresponding stress almost 50%. This behavior is only an ideal condition for the absorbed energy. From the initial stages I to the end of Phase III, the area under the curve represents the energy absorbed in tissue rather constant pressure. It should be noted that the optimal energy absorbed material should dissipate impact energy, but will work under the permitted limits. Therefore, you should consider two criteria. One is the amount of energy needed to absorb the impact of the structure, and the second keypress with a particular area of influence to be allowed. As shown in Figure 2, energy absorbed from the knitted fabric is low in the phase of densification, but the stress increases steeply. In such circumstances, for specific applications, it is desirable to knit all the energy dissipated before reaching the stage of densification in order to prevent unpredictable emphasized the increased response at this stage. In addition, it is necessary to ensure that the keypress in the plateau area of twists reduce the maximum allowable pressure to protect the building. Accordingly, the amount of energy absorbed prior to phase densification and the pressure level on a plateau phase should be two key parameters need to be a warp - knitted knitting spatially in order to meet specific end-use requirements.

CONCLUSION

Both the compression pressure - strain curves and efficiency diagrams are used to explore the compression behavior of warp - knitted knitting for spatial applications cushions. The effects of various structural parameters including slope and spatial yarn fineness, the thickness of the outer layer of twists and structure were investigated. According to the experimental results and analyzes can be performed following conclusions.

*Warp spatial knitted knitting are ideal class energy shock absorber cushions for different applications. Their energy - absorption capacity can easily be adapted to comply with special conditions of end use simply by their different structural parameters.
* Diagram of efficiency is a good tool for analyzing the performance of these fiber cushions. For a given energy that is absorbed is a handy diagram efficiency for the selection of appropriate twists that operate at the level of allowable pressure.

*All structural parameters have obvious effects on the behavior of compression cushions and performance of spatial twists with lower spatial pitch angle of yarn, knitted knitting thicker, finer spatial yarn and larger mesh size in the outer layers can be used to lower the absorption of energy efficiency gains. In contrast, knitted knitting with higher spatial pitch angle twists, twists lesser thickness, coarser spatial yarn, and smaller mesh sizes of the outer layers can be used to absorb energy evening with greater efficiency. So, to design the spatial twists with the necessary compression behavior, selection of appropriate structural parameters is very important.

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RAW MATERIALS FOR MAKING GEOTEXTILES MATERIALS AND EXAMPLES OF SOME APPLICATION

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ABSTRACT

Multiaxial fabrics have a wide application in the field of prevention in the construction of sections of roads and railways, tunnels, dams, canals, irrigation and drainage, sports, landslides, dumping of secondary raw materials, and then in making filters for the purification of waste gases and water , fabric for protective suits intervention teams in emergencies and many other applications.
In order for such a product with a wide range of applications into production and had access to the European market must undergo the entire process of compliance with international regulations and standards.
This paper provides a brief overview of some types of raw materials and their characteristics for the production of geotextiles and an example of some of the many applications.

Key words: Geotextile fabric, standard, raw materials, verification, filters, infrastructure

INTRODUCTION

The development and production of geosynthetic fabric has great significance because of the very wide range of applications. Among other significant application in the urban infrastructure, environmental protection, agriculture, water management, health, forestry, goods production, manufacture of protective clothing and other economic fields.

To achieve adequate quality fabric is necessary to meet many requirements of the standard in terms of: mechanical, chemical, physical, biological and many other characteristics.

Multiaksijalnih fabric production in Serbia and their application in the field of infrastructure and urban systems would achieve the following objectives:
- winning new products with improved physical-chemical and biological characteristics compared to existing geotextile,
- the application of the best available technology in the world's production,
- to achieve minimal impact on the working and living environment, with the necessary resistance to UV radiation and radiological security,
- winning products will be more competitive than the existing fabric,
- the possibility of different applications, with a longer useful life,
- obtaining the products that would be competitive in the domestic and foreign markets,
- achieve an increase in employment and making profit from sales of new products
- a reduction in imports and a gradual substitution of similar materials for different applications and the need to protect the environment,
- enhancing local production and increasing exports,
- the possibility of creating a new business relationship with companies of a similar program, and other goals.

COMBINATION OF SOME MATERIAL FOR MAKING GEOTEXTILNIH FABRIC

Geotextile fabric, (Martin MAT-aramid, Martin MAT-UHMWPE, Martin MAT-carbon, Martin MAT-glass, Martin MAT-basalt), have excellent mechanical and physical properties and long life. The specificity of geosynthetic fabric is that it consist of two or more layers, of the slow at different angles. Such kind of production, there has been less deformed, easy shaping and manipulation with a cloth.

For the production of geotextiles used the following combinations of yarn PP/PES/fliz; PP/fliz;PES/fliz; PP/PES/glass; PP/glass; PES/glass; 100% glass; 100% PP; 100% PES; 100% PP with Flize; 100% PES with Flize; 100% glass Flize; The combination of fibers treated with resins Flize. Multiaxial fabric was prepared by passing (at angles in the range of (-22.5 ° to + 22,5º) of said yarn, so that the aforementioned examples of fabric can be infinitely combined, starting from the various combinations of staple fibers, the type and the fineness, with or without Fliza or termoflizelina, so that, practically, receives a variety of products.

This way of making the geotextile has a completely new approach to solving the problem of drainage, filtration,, separation, reinforcement and others.

Fig.1 shows the visual appearance of a couple of more possible combinations of geosynthetic fabric with different angles of the slow fibers.

Fig. 1. Some designs geosynthetic fabric.

For standard weaving looms are made fabrics of cotton and polyester in the mix in combination with conductive fiber, while the production line is based on multiaxial and multiaxial composite material for environmental and human protection in combination with different types of yarn, depending on the purpose of the material .

Technological line allows that after each layer Multi-Axis "sip" another layer of a material, whether it be a film, Viles, felt or other material, depending on the purpose of the fabric. In this way, practically, can be obtained with the fabric 7, or 8 different layers.

For the production of geotextiles used the following combinations of yarn PP/PES/fliz; PP/fliz;PES/fliz; PP/ES/glass; PP/glass; PES/glass; 100%glass; 100% PP; 100% PES; 100% PP with Flize; 100% PES with Flize; 100% glass Flize; The combination of fibers treated with resins Flize.

APPLICATIONS GEOTEXTILES FABRIC

Infrastructure applications

Waste materials are among the high-risk substances that threaten the everyday and pollute the environment, and to be a systematic approach to potential disasters, and environmental consequences if they continue to be ignored plans and programs within the strategy and legal provisions.

Using Multi-axis geotextiles represents an important link rounding process in favor of prevention were to prevent any consequences. For example, the use of fabric multiaksijalnih in waste disposal, is very topical because of its features that provide several decades of isolation and re-use for energy production (a California landfill pomrežene are underground pipes that accumulate methane and other gases by implementing them directly in the thermal power plants). Only some of the possible applications of geosynthetic fabric multiaksijalnih is given in Fig.2.

Fig.2. Areas of potential applications multiaksijalnih fabric

Respecting the requirements of EU technical norms and standards for specific applications, in order to protect the environment from pollution and processes arising from decomposition of waste at landfill sites contemporary, provides complete isolation of the landfill body and controlled disposal of waste flows, resulting in the degradation process. Isolation of DNA and slopes formed riverbed landfill is done in order to prevent the penetration of the straining filtrate and landfill gas in the land or soil and their uncontrolled abandonment of the site, which would result in pollution of soil, air, groundwater and surface water, as well as the possible emergence of gases in explosive concentrations and the undefined areas.

The application of the filters for the purification of oil, air and water

The world's developed special purpose different mobile and stationary structures filter oil. Some of them, in addition to the solid contaminants, with the possibility of contaminant the decontamination liquid (fuel and water), and can be used in various hydraulic systems.

Manufacturers of filter cartridges, are forced to find opportunities in terms increasing degree of filtration of solid particles, and the last time, and liquid contaminants (water, fuel, etc.), With the application of new technologies and new materials.

The oldest, but also the least efficient in terms of the degree of filtration, the metal filters. They are, usually, in a shape of a cylinder with a different perforation, and in terms of their efikasnost filtration the particle size may be 50, 100, 150, 200, 300, 500, 1000, 2000 and 3000 um. However, the trend of the last few year, such filters, was very progressive and they are, their structures and internal structure, have reached an enviable level of degree of filtration.

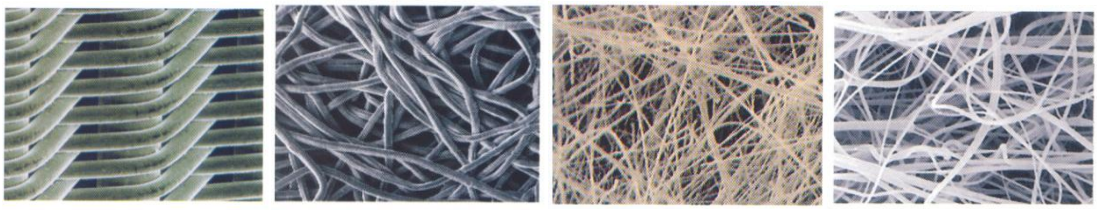
In Fig. 3 is shown in several different types of filter elements, that have the possibility of different applications and the degree of filtration of solid and liquid contaminants.

a) *b)* *c)*

Fig. 3. several types of filter cartridges of different applications and the level of filtering

Fig. 5b, Typ-Betamicron / Aquamicron for high levels of filtration, range 3, 10 μm, filtering capacity of water is 2.2 liters, the application of pressures above 10 bar, the label BN / AM.
Fig. 5c, Type-S-elements are used for suction systems above 1 bar, the range of filtering 75, 125 micron, the label S.

The structure of the filter elements may vary, based on type of material, and the workmanship, and of those factors mainly depend on the degree of filtering oil (Fig. 4).



a) b) c) d)

Fig. 4. Microscopic view several runs structures filter elements

Fig. 4a, the filter element from the wire mesh with the possibility of purification, the range of filtration 25, 40, 60, 100, 150, 200, 250, 500 μm.
Fig. 4b Typ Chemicron austeničnih of metal fibers, three-dimensional-dimensional structure, with a high degree of filtration and for the convenience of the use at high temperatures (> 400^0C), the range of filtration: 1, 3, 5, 10, 20, 25, 30, 40 , 60, 100 um.
Fig. 4c, Typ Betamicron composed of inorganic fiber mesh, with a high degree of filtering, band 3, 5, 10, 20 μm, with a low cost price.

Fig. 4d, is used for helical filters (filters in the form of a truncated cone) with the fibers of polypropylene or polyester in the form of dense and porous structure, range of filtration 1, 3, 5, 10, 20, 40, 50, 70, 90, 100, 120, 150 μm, is used to lower the pressure and the temperature to 80^0C with fibers of polypropylene and up to 100^0C with the fibers of the polyester.

APPLICATION OF CERTAIN MATERIAL IN PRODUCTION GEOTEXTILE-MULTIAXIAL FABRIC

Polycarbonat-PC

A carbon fiber is a long, thin strand of material about 0.0002-0.0004 in (0.005-0.010 mm) in diameter and composed mostly of carbon atoms. The carbon atoms are bonded together in microscopic crystals that are more or less aligned parallel to the long axis of the fiber. The crystal alignment makes the fiber incredibly strong for its size. Several thousand carbon fibers are twisted together to form a yarn, which may be used by itself or woven into a fabric. The yarn or fabric is combined with epoxy and wound or molded into shape to form various composite materials. Carbon fiber-reinforced composite materials are used to make aircraft and spacecraft parts, racing car bodies, golf club shafts, bicycle frames, fishing rods, automobile springs, sailboat masts, and many other components where light weight and high strength are needed.

The raw material used to make carbon fiber is called the precursor. About 90% of the carbon fibers produced are made from polyacrylonitrile (PAN). The remaining 10% are made from rayon or petroleum pitch. All of these materials are organic polymers, characterized by long strings of molecules bound together by carbon atoms. The exact composition of each precursor varies from one company to another and is generally considered a trade secret.

The properties of carbon fibers, such as high stiffness, high tensile strength, low weight, high chemical resistance, high temperature tolerance and low thermal expansion, make them very popular in aerospace, civil engineering, military, and motorsports, along with other competition sports. However, they are relatively expensive when compared to similar fibers, such as glass fibers or plastic fibers. In Fig.5, shows the appearance of the products of Polycarbonate (a), the microscopic appearance of the fabric of carbon fibers (b), as well as raw materials for the production of appearance of carbon fabric in the form of granules. Table 1 shows some characteristics of the PC-Polycarbonate.

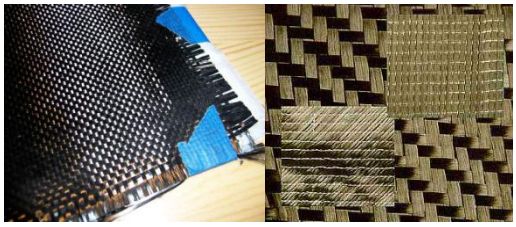


Fig.5. Appearance carbon products and raw granules
a) Carbon product, b) Microscopic appearance of carbon fiber

In Fig.5, shows the appearance of the products of Polycarbonate (a), the microscopic appearance of the fabric of carbon fibers (b), as well as raw materials for the production of appearance of carbon fabric in the form of granules. Table 1 shows some characteristics of the PC-Polycarbonate.

Table1. Characteristics of Polycarbonate- PC

No	Properties-Polycarbonate-PC	Test Method	Unit	Data
1.	Density	ISO1183	kg/m3	1.20 × 103
2.	Melt Volume Flow Rate (300°C, 1.2kg)	ISO1133	g/10 min	27
3.	Water adsorpton	ISO 62	%	0.23
4.	Tensile stress at Yield	ISO 527	Mpa	65
5.	Tensile stress at break	ISO 527	Mpa	65
6.	Nominal tensile strain at break	ISO 527	%	95
7.	Modulus of elasticity in tension	ISO 527	Mpa	2000
8.	Flexural strength	ISO 178	Mpa	90
9.	Modulus of elasticity in flexure	ISO 178	Mpa	2300
10.	Charpy impact strength	ISO 179	kJ/m^2	40
11.	Rockwell Hardness	ISO 2039-2	R, M-scale	R120,
12.	Heat deflection temperature under load (18.6 kg/cm2) (1.8Mpa)	ISO 75-1	°C	125
13.	Mold Shrinkage (MD)	ASTM D 955	%	0.5~0.7
14.	Linear expansion factor (MD)	ASTM D 696	cm/cm/°C	6.5 × 10-5

Polypropilen - PP

Polypropylene (PP), also known as polypropylene, is a thermoplastic polymer used in a wide variety of applications including packaging and labeling, textiles (e.g., ropes, thermal underwear and carpets), stationery, plastic parts and reusable containers of various types, laboratory equipment, loudspeakers, automotive components, and polymer banknotes. An addition polymer made from the monomer propylene, it is rugged and unusually resistant to many chemical solvents, bases and acids.

Polypropylene is a major polymer used in nonwovens, with over 50% used for diapers or sanitary products where it is treated to absorb water (hydrophilic) rather than naturally repelling water (hydrophobic). Other interesting non-woven uses include filters for air, gas, and liquids in which the fibers can be formed into sheets or webs that can be pleated to form cartridges or layers that filter in various efficiencies in the 0.5 to 30 micrometer range. Such applications could be seen in the house as water filters or air-conditioning-type filters. The high surface area and naturally oleophilic polypropylene nonwovens are ideal absorbers of oil spills with the familiar floating barriers near oil spills on rivers.

In Fig. 6, shows the microscopic appearance of the fabrics made from polypropylene and raw look at granulated. Table 2, shows the basic characteristics of polypropylene

Table 2. Characteristics of Polypropylene- PP

No.	Properties-PP-Polypropylene	Test Method	Value
1.	Melt Flow Rate 230∩, 2.16kg	D-1238	8.0 g/10min
2.	Density	D-1505	0,855 g/cm^3 – amorphous
			0.946 g/cm^3- crystalline
3.	Mold Shrinkage	HPC Method	1.60 %
4.	Tensile Strength at Break	D-638	350 kg/R
5.	Ultimate Elongation	D-638	>100 %
6.	Flexural Modulus of Elasticity	D-790	15,000 kg/R
7.	Hardness	D-648	115 R
8.	IZOD Impact Strength 23∩	D-256	3.0 g.cm/cm
9.	Heat Resistance 130∩	Air Oven	<500 Hour
10.	Heat Distortion 4.6kg/R	D-648	105 ∩
11.	Molecular formula	-	(C3H6)n
12.	Melting point	-	130–171 °C

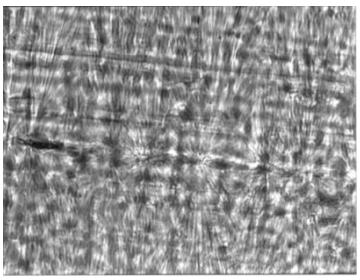


Fig. 6. Apparel fabrics and raw materials of polypropylene-
the microscopic appearance of the surface of the polypropylene fabric

Polyamid - PA

A polyamide is a macromolecule with repeating units linked by amide bonds. They can occur both naturally and artificially. Examples of naturally occurring polyamides are proteins, such as wool and silk. Artificially made polyamides can be made through step-growth polymerization or solid-phase synthesis, examples being nylons, aramid, and sodium poly (aspartate). Synthetic polyamides are commonly used in textiles, automotives, carpet and sportswear due to their extreme durability and strength. Table 3, some characteristics of polyamide PA.

Table 3. Shows some basic characteristics of Polyamide-PA.

No.	Characteristics-Polyamide (PA)	Value
1.	Density	1430 kg/m
2.	Young's modulus	3.2 GPa
3.	Tensile strength	75–90 MPa
4.	Elongation @ break	4–8%
5.	Notch test	4–8 kJ/m
6.	Glass temperature	>400 °C
7.	Melting point	none
8.	Vicat softening point	220(?) °C
9.	Thermal conductivity	0.52 W/(m·K)
10.	Coefficient of thermal expansion	5.5×10−5 /K
11	Specific heat capacity	1.15 kJ/(kg·K)
12.	Specific heat capacity	1.15 kJ/(kg·K)
13.	Dielectric constant at 1 MHz	3.5

Polyester (PEs)

Polyester is a category of polymers which contain the ester functional group in their main chain. Although there are many polyesters, the term "polyester" as a specific material most commonly refers to polyethylene terephthalate (PET). Polyesters include naturally occurring chemicals, such as in the cutin of plant cuticles, as well as synthetics through step-growth polymerization such as polycarbonate and polybutyrate. Natural polyesters and a few synthetic ones are biodegradable, but most synthetic polyesters are not.

Depending on the chemical structure, polyester can be a thermoplastic or thermo seet, there are also polyester resins cured by hardeners; however, the most common polyesters are thermoplastics.

Polyesters can be a variety of chemicals. Natural polyester and several synthetic polyesters are biodegradable, but most synthetic polyesters are not. Polyesters as the fabric used in manufacturing various kinds of clothing such as shirts, pants, jackets, hats and making the sheets, blankets, upholstered furniture, background in computer mice, etc. It is also used for making seat belts in cars, ropes, transport tape to reinforce the durability rubber and plastic, as well as depreciation and insulating material.

While synthetic clothing is often considered less natural compared to fabrics made of natural fibers such as cotton and wool, polyester fabrics can provide specific advantages over natural fabrics, such as improved resistance, durability and color retention. As a result, polyester fibers are sometimes used together with natural fibers to produce fabrics with improved properties and higher resistance to water, wind and the like. Fig. 7, shows the microscopic appearance polyestarskih fibers (a), the raw material in the form of granules (b) fibers prepared for further use (c) and one phase of fiber (d).

a) *b)* *c)*

Fig. 7. Show intermediate fibers and fiber content of polyester
a) Microscopic view of polyestarskog fibers, b) the final stage of fiber, c) intermediate of fiber

Table 4. Some characteristics of polyestera (PEs)

No.	Characteristics-Polyester (PEs)	Value
1.	Tenacity: 5	5-7 gm/den
2.	Elongation at break	15-30%,
3.	Elastic moduls	90 GPa
4.	Elasticity	good
5.	Specific gravity	1,38-2,7 g/cm^3
6.	Meting Point	250^{0}C
7.	T10, Values	1 – 6
8.	Tensile strength	4.84 GPa

Polyesters also used in production: PET bottles, tape films, tarpaulin, canoes, liquid crystal displays, holograms, filters, insulating tape, etc. Polyesters are widely used in the completion of production of high-quality wood products such as guitars, pianos, and the interior of vehicles and boats.

Fiber glass (FB)

Fiberglass (or fiberglass) (also called glass-reinforced plastic, GRP, glass-fiber reinforced plastic, or GFRP) is a fiber reinforced polymer made of a plastic matrix reinforced by fine fibers of glass. It is also known as GFK . Fiberglass is a lightweight, extremely strong, and robust material. Although strength properties are somewhat lower than carbon fiber and it is less stiff, the material is typically far less brittle, and the raw materials are much less expensive. Its bulk strength and weight properties are also very favorable when compared to metals, and it can be easily formed using molding processes. The plastic matrix may be epoxy, a thermosetting plastic (most often polyester or vinyl ester) or thermoplastic.
Common uses of fiberglass include high performance aircraft (gliders), boats, automobiles, baths, hot tubs, water tanks, roofing, pipes, cladding, casts, surfboards and external door skins.

Examples of glass filler (microspheres) and glass material (cut fibers and two fabrics) for plastics reinforcement: glass microspheres (or glass beads); diameter: about 300 µm, specific gravity: 2.5. Mineral filler mainly used to increase the stiffness of a thermo set resin and to make road safety markings;5 mm length chopped strands of fiberglass used to reinforce thermo set resins;
fibrous reinforcements for thermo set resins: two glass fabrics with different area density; fiber orientation: 0 and 90° (most common): weave pattern: taffeta (down left, area density: 550 g/m^2), and 2x2 twill (down right, area density: 280 g/m^2).

In Fig. 8, shows the appearance of fibers and microscopic appearance of fabrics made of Fiber Glass, and table 5, some characteristics of the two types of Fiber Glass: E-glass and S glass 2.

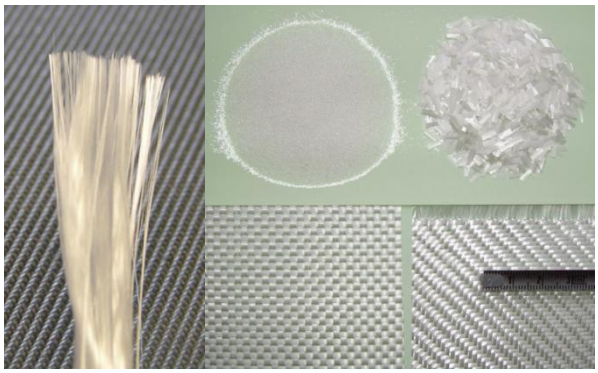


Fig. 8. Of fiber and micro fiber surface produced by voice.

Table 5. Some features of Fiber Glass

No.	Fiber type	Tensile strength (MPa)	Compressive strength (MPa)	Density g/cm^3)	Thermal expansion µm/(m·°C)	Softening T (°C)	Price $/kg
1.	E-glass	3445	1080	2.58	5.4	846	~2
2.	S-2 glass	4890	1600	2.46	2.9	1056	~20

Basalt fiber (BF)

Basalt fiber is made from a single material, crushed basalt, from a carefully chosen quarry source and unlike other materials such as glass fiber, essentially no materials are added. The basalt is simply washed and then sent to be melted down.

The manufacture of basalt fiber requires the melting of the quarried basalt rock at about 1,400 °C. The molten rock is then extruded through small nozzles to produce continuous filaments of basalt fiber. There are three main manufacturing techniques, which are centrifugal-blowing, centrifugal-multirole and die-blowing. The fibers typically have a filament diameter of between 9 and 13 µm which is far enough above the respiratory limit of 5 µm to make basalt fiber a suitable replacement for asbestos. They also have a high elastic modulus, resulting in excellent specific tenacity-three times that of steel. In table 6, shows some features of Basalt fiber.

Table 6. Some features of Basalt fiber

No.	Properties	Value
1.	Tensile strength	4.84 GPa
2.	Elastic modulus	89 GPa
3.	Elongation at break	3.15%
4.	Density	2.7 g/cm³

CONCLUSION

Quality requirements geosynthetic fabric is the realization of specific requirements defined by various standards and other technical standards to protect the safety, life and health of humans, animals and plants, the environment, consumers, property and other users.

Such a realization of the production of new geosynthetic / multiaxial fabrics achieve the following goals: winning new products with improved physical-chemical and biological characteristics compared to existing geotextiles, the application of the best available technology in the world's production, achieving a minimum negative impact on the working and living environment, the necessary strength radiation, radiological safety and others.

Geotextile fabric manufactured from different raw composition: Basalt fiber, glass fiber, polyester), polyamide, polypropylene, polycarbonate, which, depending on the characteristics of their condition and the way of construction.

The application is very diverse especially in infrastructure, agriculture, forestry, making items for different purposes, different performance of the filter cartridges for vazdug, water, oil and many other applications.

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REGENARATED PROTEIN FIBER: CASEIN

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ABSTRACT

The usage of mikbath for human skin has been known and applied since ancient times to keep the skin smooth and beautiful. When used appropriately, milk can be used in different formseffectively –rather than drinking. One of these form is wool-like casein fibers that developed in late 19th century. This fiber is known with its eco-friendly, sustainable, renewable footprintswith unique fiber properties.Additionally, casein fibers has ecological advantages with naturally biodegradability. It contains natural bacteriostatic elements. They don't kill the bacteria, but they prevent them from reproduction. It has a similar pH tothat of human skin, so it causes no discomfort to people with sensitive skin. Casein fiber also can commonly be used in blends with other fibers, especially with wool, rayon staple and cotton fibers. In this review, properties, production, environmental effects and application areas of this special casein fiber are described. This review provides an insight for this promising milk protein fibers.

Key words: Casein fibers, milk, eco-friendly, biodegradable, sustainable

INTRODUCTION

From thousands of years, humanbeings are using natural fibers obtained from both plants and animal sources. These natural fibers are used in different industries for making useful materials and having different kinds of applications(Ali M.A.& Sarwar M.I.,2010).At the beginning of20th century,as an alternate to natural fibers, new developments were carried out in the field of synthetic fibers but the generation of synthetic fibers involved many chemicals and harmful substances that were not favorable for the environment and society (Ali M.A. & Sarwar M.I.,2010). Alhough synthetic fibers may exhibitsome performance advantages such as easy care and antisoiling properties with satisfactory mechanical properties, they aren't favored by customers for poor comfortability and degradability leading to wastes. As an alternative to natural protein fibers and synthetic fibers' properties mentioned, regenerated protein fibers were manufactured(Chi F. & Chen H.,2010) (Karmakar S.R., 1999). Regenerated protein fibers are semi-synthetic products that are based on renewable resources (Van Dam J.E.G.,2008).Different sources of proteins can be used such as milk, soybeans, peanuts and corn. The generic name 'Azlon' was adopted by the FTC in the USA for any regenerated naturally occuring protein fiber, but no generic name has ever been assigned to this class of fibres in Europe (Mather R.R. & Wardman R.H., 2011).The general properties of regenerated protein fibres include the wool like attributes of resilience, warmth and soft handle. The strength is lower than wool and regenerated protein fibres don't contain cystine linkage, which results in more open structure. It was stated that these fibres are less successful than expected and never seriously challenged wool(Karmakar S.R., 1999).

CASEIN FIBERS

Casein, which is the first and the most known regenerated fiber, is the main milk protein which occurs naturally in the milk (Mangut M. & Karahan N., 2005)(Susich G.& Zagieboylo W., 1953).Since wool also is a protein fiber, a brand new raw material, milk is a substitute for wool, an abundant natural protein (Moncrieff R.W., 1954) (Cui L. et al., 2011)(Yang Y. Reddy N., 2012).The casein fiber has excellent properties such as silk-like hand feeling, soft and elegant luster, excellent wear resistance, stain resistance, moisture permeability and skin affinity (Yang Q., 2012).The chemistry of casein fiber, vertical and horizontal appearance of silk fiberare shown in Figure 1 and Figure 2, respectively.

$$R\text{-}NH_2+HCHO+H_2N\text{-}R \rightarrow RNHCH_2NHR$$

Figure 1. The Chemistry of Casein Fibre(Karmakar S.R, 1999).

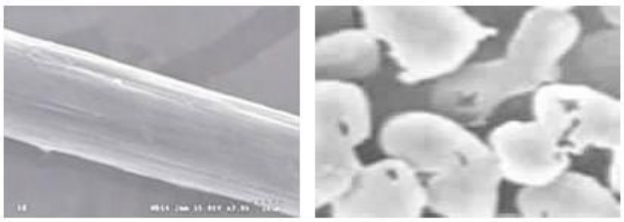

Figure 2.Vertical and Horizontal Picture of Fiber (Swicofil, 2013)

The Germanchemist Todtenhaupt patented a process for making casein into fibers in the early twentieth century.However,his company failed and little successful research seems to have been carried out until the 1930s when Ferretti, an Italian scientist, modified Todtenhaupt's method to improve the fibre's wet strength. The resulting casein fiber was produced commercially by the Italian textile conglomerate SNIA Viscosa (Brooks M.M., 2009).By 1940 at least eight countries were producing casein fibers including Lanital and Merinova in Italy. Lanital is the firstcommercial casein fiber manufactured (Fletcher H.M., 1942).In various countries,different trade marks of casein fiber such as *Aralac*' ve '*Caslen*' (USA), '*Lactofil, Casolana*' (Netherlands), '*Cargan*' (Belgium), '*Tiolan,Tiocell*' (Germany), '*Silkool*' (Japan), '*Fibrolane*' (Great Britain) were produced (Yang Y.& Reddy N., (2012)(Traill D., 1951) (Susich G.& Zagieboylo W., 1953).The original '*Lanital*' (France) was improved and manufactured under different commercial names like '*Merinova*' (Italy) and '*Wipolan*' (Poland)(Cook J.G., 2001).

Manufacturing

Fibrolane (Great Britain), and *Merinova* (Italy) were made by dissolving casein in sodium hydroxide, and then by extrusion into an acid/ salt bath. The fibres formed in this way is stretched as tow and partially stabilised by treatment with formaldehyde (Karmakar S.R, 1999). The manufacturing methods of Lanital and Aralac were similar. First of all, milk is skimmed to remove the cream. Then the skimmed milk is heated to 40 °C, and acid is added to coagulate the protein, which separates as a curd (Moncrieff R.W., 1954) (Cook J.G., 2001).Then,the fiber was seperated into short pieces and then formaldehydeis used in hardening process leading to covalent bonds occuring between macromolecules. Finally, fibers dried and bailed.

Fiber Properties

- **Handle:**Casein fiberhas wool-like warmth, softness and good hand (Brooks M.M., 2009).
- **Comfort:**It has similar pH to that of human skin, so it causes no discomfort to people with sensitive skin.
- **Colour fastness:**Casein may also be dyed with with direct and basic dyes but with poor wet fastness (Moncrieff R.W., 1954).
- **Healthy functions:**It contains natural bacteriostatic elements.
- **Physical properties:**The tenacity of casein fibers is about 0.8- 1.0 gram per denier, and the elongation at break is about 15 percent (Moncrieff R.W.,1954).
- **Chemical properties:**Like wool, casein is sensitive to alkaline(Cook J.G., 2001).

End-Uses

A small amount of fiber is used for 100% casein goods, but most casein fibersare commonly blended with other fibers such as wool, rayon, nylon, cotton, acetate and other synthetic staple fibers (Cook J.G., 2001)(Moncrieff R.W., 1954).It has many different application areas in textilessuch as yarn, fabric, underwear, apparel fabrics, T-shirt, bed linen, eyemasks, sportswear (Moncrieff R.W.,1954).

Figure3. Examples from apparel textiles which manufactured from casein fibers (Factodesign, 2015)

CONCLUSIONS

This review highlights about the history, production, properties and application areas of casein fibers. Casein fibers have many advantages forits use inclothing and domestic textiles due to its unique properties.Casein fiber is comfortable, healthy, light, soft, and exhibit excellent water transportation and air permeability. In addition, this natural based fiber is sustainable, biodegradable and renewable. It is resistant to fungus and insects. The usage of casein fiber is expected to increase in the near future due to its eco-friendly footprints.

ACKNOWLEDGMENT
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FROM SEAS AND OCEANS TO THE TEXTILES

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ABSTRACT

The seas accommodatenumerous species of plants and animals that provide vast amounts of chemical and biological compounds unknown on land. These chemical and biological materials obtained from marine are used as raw materials in many industries from medicine to textile. These materials can be used as fiber and/or auxiliary products in various steps of the textile processing. Chitin biopolymer, chitosan, which is a derivative form of chitin, and alginate produced from seaweeds. They can be used in the fiber form and also alginate can be used in textile printing. Moreover, chitin and chitosan are used for surface modification applications. Natural dyes and also textile fiber can be obtained from some mussel species. Also novel high performance fibers with superior properties can be obtained from the sea such as hagfish slime. There are many ongoing studies for better understanding the sea sources for many different applications. In this review, textiles materials from seas and oceans are explored and reported.

Key words: chitin, chitosan, chitin fiber, chitosan fiber, natural colorant, mussel, royal purple, hagfish slime fiber, mussel fiber, alginate, alginate fiber

INTRODUCTION

The Marine waters,*covering the two-thirds* of the Earth surface, contain secret treasures.Theseasaccommodate numerous species of plants and animals that provide vast amounts of chemical compounds unknown on land. The chemical and biological materials obtained from marine are used as raw materialsin many industries from medicine to textile.For instance, chitin, a biopolymer obtained from sea crustaceans, can be used in textile finishing processes or in the form of fibers[1,2]. Chitosan which is a modified carbohydrate polymer derived from Chitin have also same uses with chitin[1]. It is also possible to obtain fibers from alginate which is present in the seaweeds. Alginate has a common use in medical technical textiles and textile printing[3].

In addition to these materials based on sea plants or animals, some natural colorants can be produced from sea snails. This method is one of the oldest methods for coloration. Sea snails,giving purple color,are used for centuries to colorize textile materials[4,5]. Plentiful marine resources and their benefits to our lives are still under investigation. Some special fibers can be produced from marine species like hagfish and mussel. And some of these fibers exhibit superior properties even better then synthetic high performance fibers.

CHITIN AND CHITOSAN

Chitin, the second most naturally occurring polymer following cellulose, is a polysaccharide found in the outer skeleton of arthropods such as insects, crabs, shrimps, and lobsters as well as in the cell walls of some fungi and yeast[6,7]. Chitosanis a modified carbohydrate polymer derived from Chitin[2] (Figure 1).Both Chitin and Chitosan are natural resources which produced from waste products of the seafood industry such as crabing and shrimp canning[8].Chemical structures of chitin and chitosan are similar to cellulose[2].

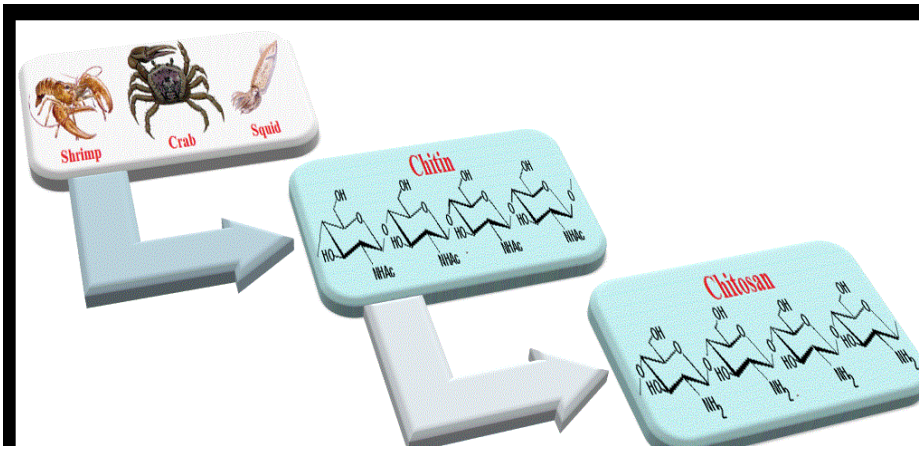

Figure 7: Chitin and Chitosan which produced from sea crustaceans[6].

One of the most important structural parameters for chitin and chitosan is the degree ofdeacetylation (DD)[2,7].Chitin becomes soluble in an aqueous acidic media, when its degree of deacetylation reaches approximetlyabout 50% (depending on the source of polymer) and it is called chitosan.Degree of deacetylation (DD) must be 80-85% or higher for commercial chitosan production.[9]

The methods of chitin and chitosan production can be categorized into two groups as chemical and biological. However, all of them have four main production stages: deproteinization, demineralization, decolorizationand deacetylation[9]. The chemical method of chitin and chitosan manufacturing is demonstrated in Figure 8[7].

Figure 8: Production of chitin and chitosan [8]

Properties of Chitin and Chitosan

Chitin and Chitosan which has similar linear structure with cellulose, natural and renewable polymers [8,10]. They have semicrystalline structures, good complex formation with metals and they are able to form films, fibers and gels[9]. These polymers have also some excellent properties such as biodegradability, bio-compatibility, non-toxicity andadsorption [2,7,8]. Chitin is highly hygroscopic and cannot be dissolved in water and in most organic solvents [8,10]. Also chitosan cannot be

dissolved in water however, it is soluble in acidic aqueous solution and in some selective N-alkylidinations[8].Chitin and Chitosan is able to bindwith negatively charged fats, lipids, cholesterol, metal ions, proteins and macromolecules[7,8]. In addition to its fungyistatic, hemostatic, antitumor, anticholesteremic properties, it has also regenerative effect on connective gum tissue and accelerates bone formation[8]. Chitin fibers exhibit non-allergic, deodorizing, antibacterial and moisture controlling properties [2] (see also Table 1).

Table 2: Properties of Chitin and Chitosan Fibers[2,7,8]

	Chitin	Chitosan
Specific gravity (g/cm^3)	1.39	1.39
Moisture (%)	10-12.5	16.2
Tenacity (g/tex)	1.2-2.2	0.61-2.48
Elongation (%)	7-33	5.7-19.3

Fiber Form of Chitin and Chitosan

Chitin can be processed in the form of films and fibers[2,9] (Figure 3). Wet spinning is commonly used for producing chitin and chitosan fibers because their high thermal degradation temperatures limit melt spinning process usage. Also dry spinning process is not so practical resulting from their high boiling temperatures [7]. In wet spinning processes, firstly polymer solution is prepared by dissolving the polymer in a 14% NaOH solution. After the solution is filtered, it is degassed and finally it is extruded through fine holes, spinneret, intoa solvent-coagulant system. It is possible to change spinnability of the chitin solutions with increasing temperature of the coagulation bath and the addition of suitable plasticizer to the spinning solution[7,9].

A viscose method from chitin xanthate is used inthe production of regenerated Chitosan fibers. Initially, chitin is transformed into chitin xanthate by treatment with 40% NaOH at room temperature. After the removal of caustic from the solution, chitin xanthate and crushed ice are mixed. As soon as the solution became ready for spinning processes, spinning solution is filtered, degassed and spun into a coagulation bath containing 8-10% sulphuric acid, 25% sodium sulphate and 1-3% zinc sulphate[7]. Regenerated Chitosan fibers also can be mixed/blended other fibers from natural and/or synthetic polymers for their bio-functions [10].

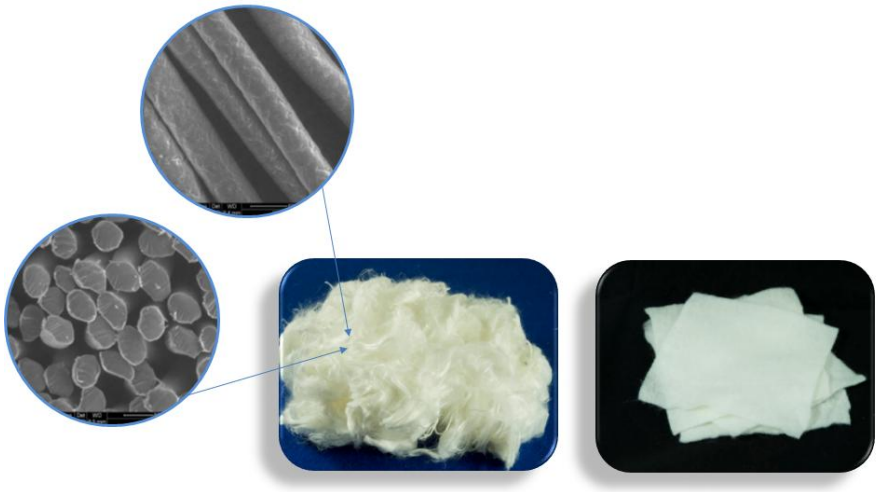

Figure 9: Cross sections and surfaces of Chitin fibers, Chitin nonwoven fabrics [7,11]

Textile Applications of Chitin and Chitosan

Chitin and chitosan are widely used in various industries ranging from health and beauty aids to water purification, biomedical applications, agriculture, biotechnology, nutrition, textile fibers and

treatments in the finishing process of textile production [3,7,10].Textile chemicals widely used in pretreatment and finishing processes of textiles are an inseparable part of textile industry[3]. However, textile industry and these chemicals mostly cause environmental pollution. Therefore, the use of biodegradable, non-toxic, sustainable, ecofriendly materials become very important. It is exactly for this reason, chitin and chitosan can be used in different steps in textile pretreatment and finishing processes[3,7]. After the modification of textile surfaces with chitosan or it's derivates,the properties of textile substrates can be improved [10].Also chitosan is able to remove dyes from the effluents [8,10]. Furthermore, both chitin and chitosan are suitable to utilize in medical textiles such as textile sutures, wound dressings[2,12], artificial skin [10] and medical diaphragms [10] (Figure 4). Pretreatment with chitosan enhancesthe dyeability of yarn/fabric with direct, reactive, sulfur and naphthol dyes and eliminates the shade differences between immature and mature fibers[8,10].Chitin and Chitosan can be used in drug delivery systems [8] andtissue engineering[7].

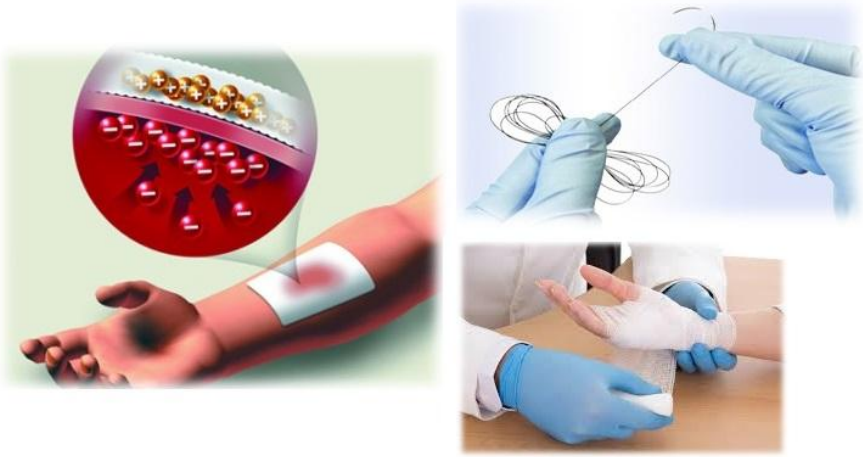

Figure 10: wound dressing [12], sutures [5] bandages [13]

3. ALGINATE

Alginate is a naturally occurring anionic polymer [14] that is abundant in the cell walls of multicellular marine algae which are also called as seaweedsin the form of calcium, sodium and magnesium salts of alginic acid (Table *3* and Figure 5)[7]. Also it can be produced from a bacterial source. Ascophyllum, Laminaria and Macrocystispyrifera are the most important brown seaweed species for commercial alginate production in the world [7].

Figure 11: Seaweeds containing alginate [5,15]

Table 3: Species of alginophytes that can be obtain alginate and their geographical regions [7]

Source of alginates	Sources of alginophytes
Ascophyllum	UK, France, Norway, Ireland
Ecklonia	South Africa
Macrocystispyrifera	USA, Mexico, Chile
Laminariadigitata	France, Iceland

Laminariahyperborea	Norway, Ireland, UK, France

Alginic acid was first discovered by Stanford in 1881and alginates derivation methods from algae were published in the 1930s. Today, alginate production in the world is about 33 000 tonnes per year[7]. Production alginates from algae is a multi-stage process.There are essentially two processes as calcium precipitation and acid precipitation for the preparation of alginates. Both processes start with the extraction of alginate. Firstly, raw or dried seaweed is washed with acid to remove cross-linking ions.This causes the alginate to become insoluble. Thenseaweed, washed with acid, is dissolved in an alkalinesuch as sodium hydroxide (NaOH). Following the filtration of solution by means of removing the cell wall debris and color, a clear and clean alginate solution is finally obtained.

After this point, the process can be performed in different two methods as calcium or acid.Although acid method is a more direct method that uses acid directly, Calcium method is the most common precipitation method in the alginate production (Figure 12).Calcium method requires an extra step. However, the handling-treatment of the fibrous calcium alginate and alginic acid is easier than acid method and also there is no need for expensive alcohol usage. In the acid process, alginicacid forms gelatinous precipitates and it is not easy to separate. For this reason, alcohol must be used for the conversion to sodium alginate and it makes the process highly priced.

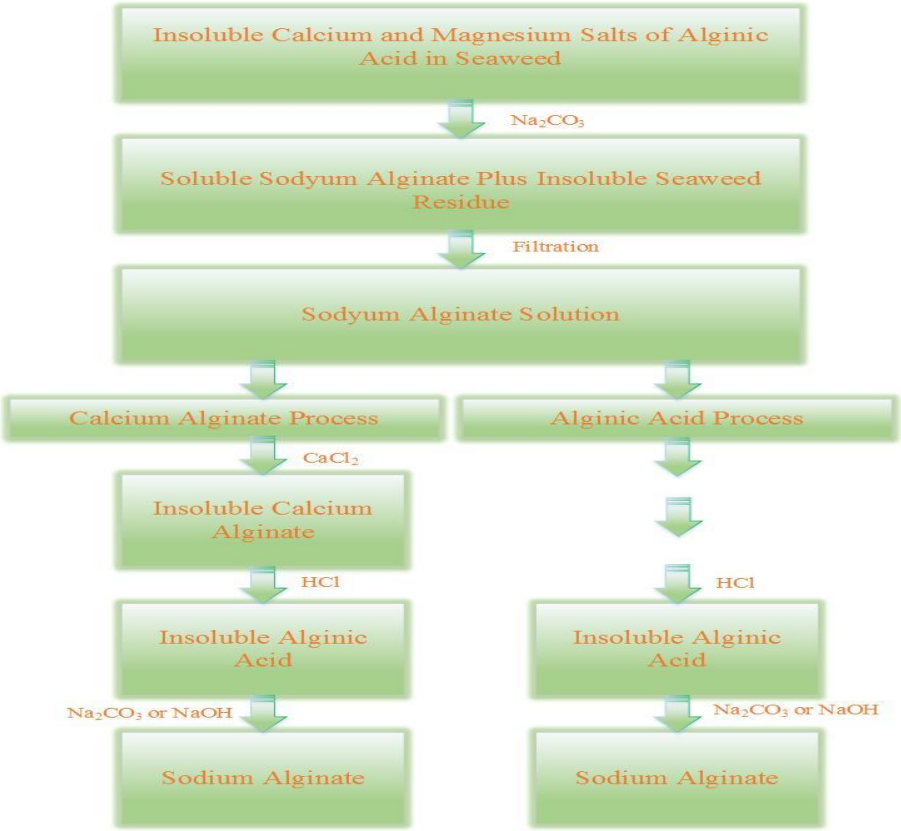

Figure 12: Production of Alginate[16]

Fiber Form of Alginate

Alginate is a natural fiber from sea-plants.Almost 200 to 250 kg of alginate can be derived from 1 ton dry algae that can be used to make 200 kg of fibers [17]. Production cost is acceptable, it is also possible to decrease the production costs with blending with other fibers such as cotton fiber[17]. Alginate fibers arecommonly produced using wet-spinning process[7]. Primarily, alginate is dissolved

in water in order to have homogenous solution [18] and this solution can be extruded through fine spinneret holes into a bath. Later, fibers can be stretched, washed and dried to produce alginate fibers in accordance to wet spinning process [18].Alginate fibers are used in different forms such as nonwoven, composite and special yarns especially in medical technical textiles [7] (Figure 7).

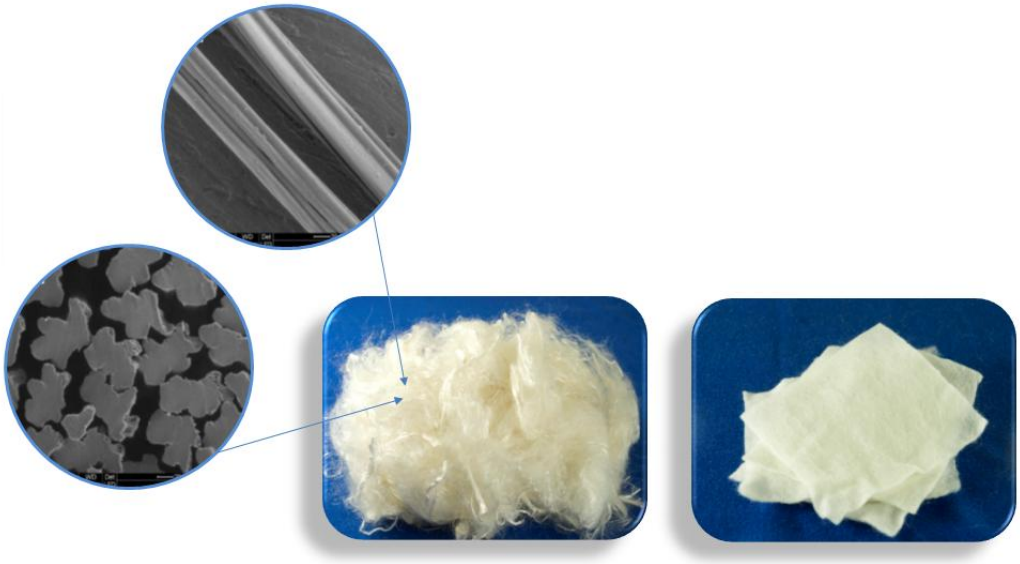

Figure 13: Cross sections and surfaces of Alginate fibers and nonwoven fabrics [7,11]

Properties of Alginate

Alginates have some outstanding properties such as non-toxicity, biocompatibility, biodegradability and hydrophilicity. They have also a relatively low cost [7]. Alginate is a non-irritant material and it is elastic enough to be drawn over the undercuts, but tears over the deep undercuts. Alginate has good surface detail, react faster at higher temperatures[7]. Alginate fibers do not have resistance to UV and all alginate fibers are non-inflammables. They have also good abrasion properties that are connected with their hydrophilic character. Fiber properties of alginate fibers are shown in Table 4.

Table 4: Fiber properties of alginate fibers [7]

Density (g/cm^3)	1.78
Tenacity (cN/tex)	11-18
Elongation (%)	5
Moisture sorption (%)	20-35

Textile Applications of Alginate

Alginates are commonly usedin the textile, food, pharmaceutical, paper and cosmetic industries (see also Figure 8). They have become very important substance especially for the textile production with their eco-friendly properties[7]. Besides,alginate can be used as fiber or fabric, it is possible to use this material for dyeing, printing or finishing processes for eco-friendly textile production [7]. In textile printing, alginate are used as thickeners for the paste containing dye[5]. Screen printing or Roller printing equipment can be used during printing[7,17]. Alginates also can be used in medical textiles (such as bandages, wound healings, etc.) owing to their properties such as biocompatibility, high absorption capacity, relatively low cost, mild gelation and low toxicity [7]. Furthermore, the inflammable and high strength properties of these fibers enable their use in production of protective textiles especially for firefighting products [7,17].

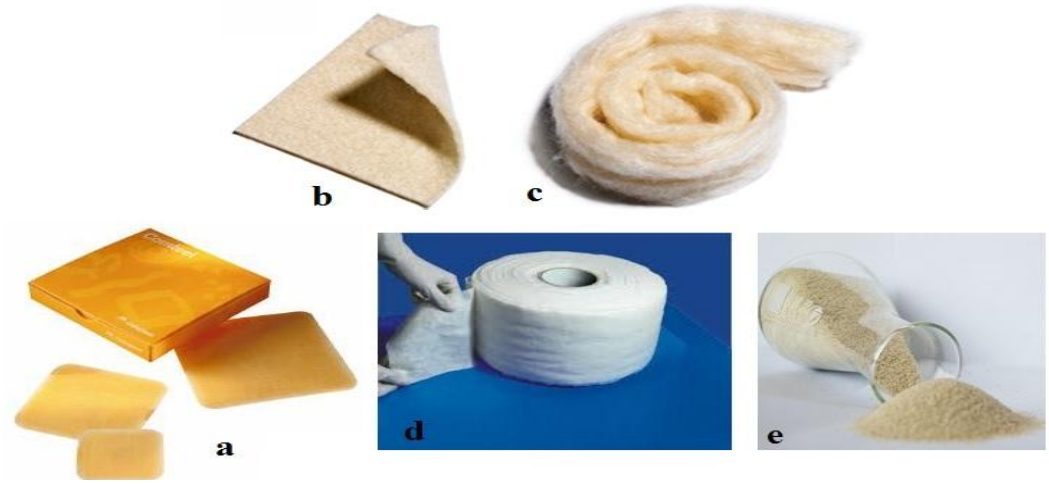

Figure 14: a) Alginate wound healing [19], b) Sheet alginate wound dressing[20],c) Strip alginate wound dressing[20], d) Alginate bandage [21], e) Alginate thickener for textile printing [5]

NATURAL DYES FROM MUSSELS

One of the oldest sea usage for textile coloration has been done with the usage of mussels since ancient times. It is a dye that is made from mucous secretion three species of sea snails called Murex Brandaris, Murex Trunculus (or Murex for short) and Thais Haemastoma[4,5,22]. Although the mucous is transparent or light yellow, when it is exposed to sunlight, the color of mucous changes into a pale blue and later it become purple[4,5,23].

According to a legend, this dye was discovered by Hercules at the first time in the history. While Hercules walking around the coast, his dog played with a Murex shell in her mouth. Hercules saw the dog's mouth which is turned to purple color. He was mesmerized by this excellent purple color [4,5,22]. After collecting the necessary shells, the dyes were extracted from the mussel and they were used to make the first Tyrian purple garment. Owing to this legend, this dye is also called as Tyrian purple or royal purple[4,5].

In order to produce enough dye to colorize a single garment, approximately 12000 Murex sea snails were needed (see also Figure 9). Production of natural dye from these sea snails necessitates some stages. Primarily, snails are carefully broken and the animal with broken shellsare immediately taken intothe jar[23]. They are leftin the jar to create fermentation in salt for 3 daysavoiding from all possible light sources[23]. Fermentation process can be completed up to ten days [4,5].

Figure 15: Murex Shells, Murex Shell's color, dyed fibers, yarns and fabrics with Murex Shell's purple natural dye [4,5]

CONCLUSIONS

Today various chemical and biological materials, which are obtained from sea creatures,create huge resources for many different industries. Not only textile industry but also many other industries use these materials,exhibiting unique properties.Day by day,their importanceis increasingto produce eco-friendly materials for eco-friendly life style.Although, only chitin, chitosan and alginate have commercial production, it is believed that there are still more substances, which can be obtained from sea creatures with superior properties, out there in the sea.

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CHARACTERIZATION OF CHITOSA PARTICLES VIA ATTENUATED TOTAL REFLECTION FOURIER TRANSFORM INFRARED (ATR-FTIR) SPECTROSCOPY, CONDUCTOMETRIC TITRATION , AND VISCOSITY AVERAGE MOLECULAR WEIGHT

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ABSTRACT

This paper gives the characterization of chitosan particles *via* attenuated total reflection Fourier Transform Infrared (ATR-FTIR) spectroscopy, conductometric titration, and viscosity average molecular weight. Molecular and packing structures of the chitosan chains in the crystal were observed using polarized light microscopy.

INTRODUCTION

Chitosan and its parent compound chitin are naturally occurring β-(1,4)- linked linear aminopolysaccharides. Chitosan, though less prevalent in nature, is a useful and easily accessible derivative of chitin. Both two polymers are biodegradable, renewable resources with versatile chemical and physical properties. As such, they are the subject of active scientific and commercial scrutiny [1]. Chitosan is the deacetylated derivative of chitin, which is the second most abundant polysaccharide found on earth next to cellulose. Chitin is the main component in the shells of crustaceans, such as shrimp, crab, and lobster. It is also found in exoskeletons of mollusks and insects and in the cell walls of some fungi [2-3]. Chitosan is a high molecular weight heteropolysaccharide composed mainly of β-(1,4)-2-deoxy-2-amino-D-glucopyranose units, and partially of β-(1,4)-2-deoxy-2-acetamido-D-glucopyranose (Figure 1).

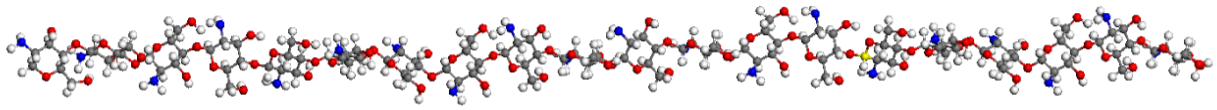

Fig. 1 *Molecular structure of chitosan.*

The physical properties of chitosan arise from its crystalline polymorph and biological activities. Crystal structure of the anhydrous form of chitosan provides knowledge of the molecular and packing structure of the chitosan chains in the crystal. Shear precipitated chitosan fibrids were examined by polarized light microscopy using a Nikon Labophot-Pol microscope (Nikon, Japan, Serial #951848). Photograph was taken with ISO400 mm film using a Nikon N6006AF camera (Nikon, Japan).

Chitin and chitosan are known for their excellent biological properties. Among the most important are biocompatibility with human cells, ordered regeneration of wounded tissues, immune enhancing activity, induction of immediate homeostasis, radical scavenging activity, and antimicrobial activity [4].

Chitosan is known to have high affinity for dyes belonging to the acid, direct and fiber reactive dye classes. Chitosan or modified chitosan is dyeable with vat sulfur, and disperse dyes. Basic dyes are the

only dye classes that have inherent low affinity for chitosan due to charge repulsion. The C(2) basic amine group in each glucosamine group of chitosan is a potential site for ionic interaction with acidic functional groups. Protonation of the basic amine group makes chitosan soluble in dilute aqueous organic and mineral acid solutions. In some cases the ionic interaction is strong enough to render the salt (especially, chitosan sulfate and sulfite salts [5] insoluble in aqueous solution, though the effect can sometimes be overcome by heat or treatment with an excess of other acids. Chitosan ionic interactions have been characterized in terms of binding behavior [6] and ammonium salt complex formation [7].

In this study, chitosan was characterized with FTIR, conductometric titration, viscosity average molecular weight and polarized light microscopy.

EXPERIMENTAL

Materials

Commercial samples of chitosan obtained from Sigma- Aldrich Company with a viscosity average molecular weight of 1.0 x 10^6 was confirmed using intrinsic viscosity and the Mark Houwink Sakurada equation, and deacetylation of 70% measured by acid base titration method. Other reagents used were analytically pure. The solvents used were lactic acid. Hydrochloric acid solution, 0.1N (N/10) (Certified), both obtained from Fisher Chemical, were used in acid-base titration method to determine the degree of deacetylation. Sodium Acetate Anhydrous (Fused Crystals/Certified ACS) was obtained from Fisher Chemical. All reagents and polymers were used as received.

Analyses and Characterization

Determination of the Degree of Deacetylation (DD) of Chitosan by Conductometric Titration

The degree of deacetylation of chitosan was measured by acid-base titration dissolving chitosan in an acidic solution by protonation of its amine groups. In this method, 0.0940g chitosan completely dissolved in 10mL of 0.1N HCl solution andwas titrated potentiometrically with a 0.1N NaOH solution.

Conductivity readings were measured using Orion Benchtop Conductivity Meter, Model 162. The results were obtained within 3-5 seconds after each addition of NaOH. To the solution, a conductivity probe (Orion Conductivity Cell, Model 013030) was submerged and the solution was stirred until the temperature became constant.

Conductivity readings were noted after adding the NaOHsolution. The readings were plotted as volume of NaOH solution versus conductivity. The graphs show two deflection points (see Figure 2).

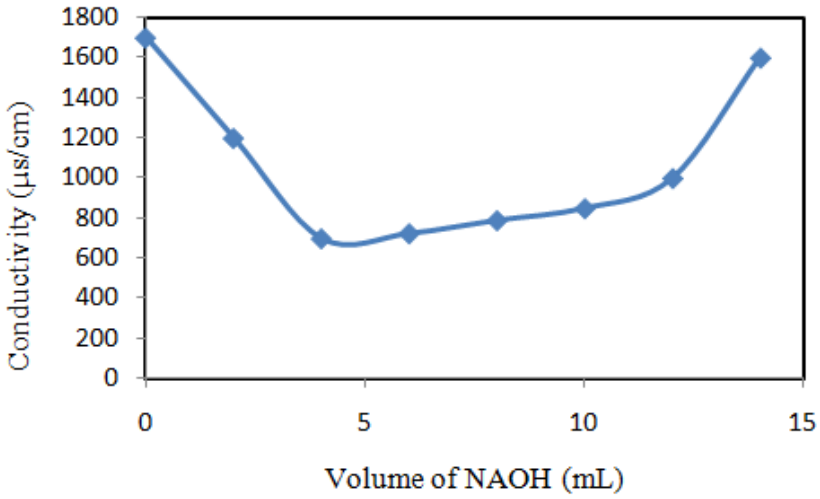

Fig. 2*Conductometric titration curve of deacetylated chitosan*

The number of moles of NaOH used between the first and the second deflection points equals to the number of moles of amino groups of chitosan sample, which was calculated by Equation1;

Number of moles of amino groups = [M_{NaOH}(mol/L) x $V_{(2-1)}$(ml)] / 1000 (Eq.1)

Where M_{NaOH} is molarity of standard NaOH solution and $V_{(2-1)}$ is the difference in volume between the two bending pointsand the degree of deacetylations were calculated using Equation 2 and the results are presented in Table 1.
Chitosan ($C_6H_{11}O_4N$) molecular weight is 161.16 g/mol.

Degree of Deacetylation (%)
= [No.of Moles of amino groups (mol) / (Amount of Chitosan in gm) / (Mw of repeat unit in g/mol)] x 100 (Eq.2)

Table 1 Chitosan having 70% degree of deacetylation calculated by conductometric titration method

Chitosan sample	**Reaction time (hours)**	**Amount of chitosan (gm)**	**Difference in volume between two deflection point (ml)**	**No. of moles of amino groups (mol)**	**Degree of deacetylation–DD(%)**
DD-70	0	0.0976	20.9-16.7=3.8	0.00038	70

Viscosity Average Molecular Weight (MW)

Although viscometry is not an absolute method for determining the MW of chitosan, it is one of the simplest and most rapid methods. The viscosity average molecular weight (M_v) of chitosan was determined by the following Mark-Houwink equation, where [η] is intrinsic viscosity determined from Huggings plot, and k and α are empirical coefficients that are dependent on the solvent systems, temperature employed, and the DD of chitosan.

$[\eta] = k M_v^a$ (Mark-Houwink equation)
$\eta_{sp}/ c = [\eta] + k_H [\eta]^2 c$ (Huggins equation)
$[\eta] = \lim_{c-o}[\eta]/c$

where [η] is an intrinsic viscosity (mL/g), M_v is the viscosity-average molecular weight, k (mL/g) and are empirical Mark-Houwink parameters, c is the concentration of solution (g/mL), $\eta_{sp}$is a specific viscosity, $k_H$is the Huggins coefficient, respectively.

Specific viscosity (η_{sp}) was calculated by using Equation 3;
$\eta_{sp} = (t-t_s) / t_s$ (Eq.3)

Where t is a sample flow timer and t_s is a solvent flow time.

The viscosity average molecular weight (M_v) of chitosan can be determined by the following Mark-HouwinkSakurada equation (Eq. 4), where [η] is intrinsic viscosity determined from Huggins plot (Figure 3) using Huggins equation (Eq.5), and k and α are empirical coefficients that are dependent on the solvent systems, temperature employed, and the DD of chitosan.

$[\eta] = k M_v^a$ (Mark-Houwink Sakurada equation) (Eq.4)
$\eta_{sp}/ c = [\eta] + k_H [\eta]^2 c$ (Huggins equation) (Eq.5)
$[\eta] = \lim_{c-o}[\eta]/c$

where [η] is an intrinsic viscosity (mL/g), M_v is the viscosity-average molecular weight, k (mL/g) and are empirical Mark-Houwink parameters, c is the concentration of solution (g/mL), $\eta_{sp}$is a specific viscosity, $k_H$is the Huggins coefficient, respectively.

The viscosity average molecular weight of the chitosan (70% DD based on the conductometric titration) was determined by the method of Wang et al. [8]. Dry chitosan was dissolved in aqueous 0.20 M acetic acid/ 0.10 M sodium acetate to give an initial polymer concentration of 1.0 mg/mL. a Cannon-Ubbelohde Semi-micro Viscometer (Size 100. L57, Constant = 0.01365 mm^2/s^2 (cSt/s)) was charged with chitosan sample and equilibrated to 30.00 ± 0.05°C in a constant temperature bath. The solutions were diluted according to the scheme shown in Table 2,and polymer sample flow times (η_p) were recorded for ten replications at each concentration and averaged. Specific flow times (η_{sp}) were calculated according to equation 6, where $\eta_p$is a sample flow time and η_s is a pure solvent flow time.

$\eta_{sp} = (\eta_p - \eta_s) / \eta_s$ (Eq. 6)

Table 2 Scheme of intrinsic viscosity measurement of the as received chitosan (DD-70)

C (g/mL)	0 (solvent)	0.001496	0.000714	0.0004	0.000266	0.000133
Time (sec)	98.52	196.076	152.954	123.762	113.66	105.214
η_{sp}		0.990215	0.552517	0.256212	0.153674	0.067946
η_{sp}/C		990.2152	773.617	640.5298	577.7232	510.8691

From Huggins plot (Figure 3) the intrinsic viscosity [η] was determined by extrapolating the linear regression of plots of η_{sp}/C versus *C* to zero concentration. The point at which the linear line touches the η_{sp}/C(y-axis) is the intrinsic viscosity. The degree of deacetylation which was calculated with the help of acid base titration method was used to determine k and a values. Then the average viscosity molecular weight was calculated with the help of [η], k and a by the Mark-Houwink Sakurada equation. The properties of original chitosan are provided in Table 3.

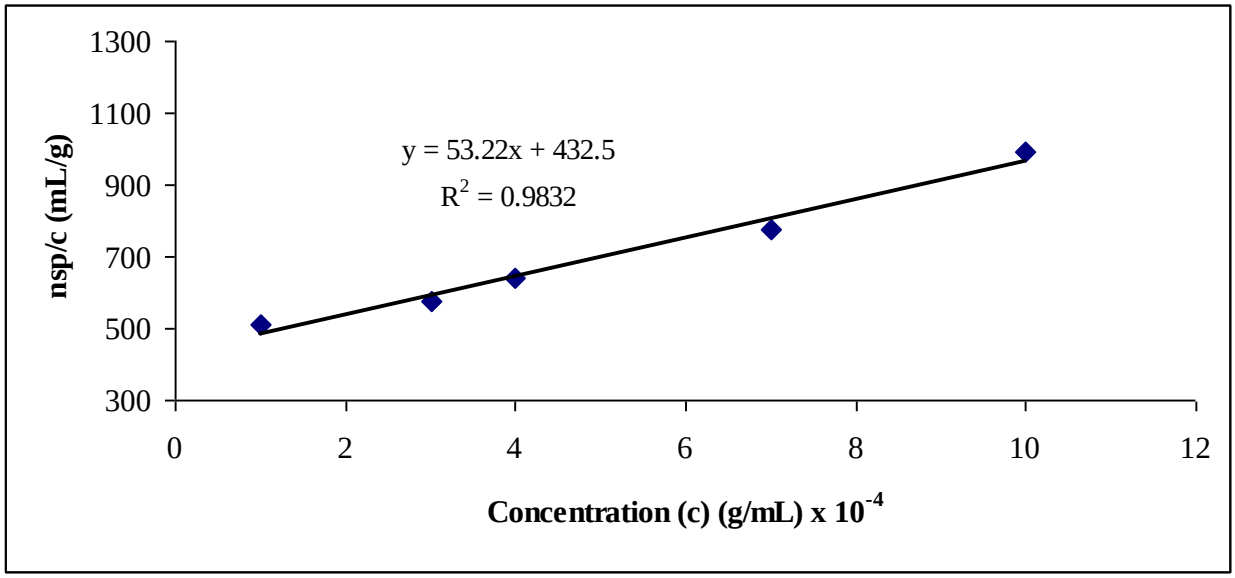

Fig. 3 Huggins plot of η_{sp}/c versus concentration for the as received deacetylated chitosan (DD-70) in 02 M CH_3COOH/0.1 M CH_3COONa aqueous solution.

Table 3 Properties of medium viscosity and original chitosan

Chitosan sample	Reaction time (hours)	DD (%)	K (mL/g)	a	Intrinsic viscosity [η]	Viscosity average molecular weight, M_v
Original	0	70	0.000122	1.10141	475.4	$1.0x10^6$

Dyeing of Chitosan Substrates

Acid salts are forming strong salts on chitosan. Chitosan fibrids were dyed separately for 30 min. to equilibrium with Acid Red 360 under isothermal conditions (ΔT=0). Isothermal exhaustion curves of dye on chitosan were obtained to establish the time required to reach equilibrium in the Acid Red 360 experiment (Figure 4). After dyeing, samples were removed from the dye bath, rinsed briefly in DI water to remove surface dye, and air dried separately with Telon Red AFG (Acid Red 360) Dystar with a concentration of 5g/L using exhaustion method.

Fig. 4 Dyeing procedure of chitosan substrates with Acid Red 360 by exhaustion method.

Microscopic Images
Shear precipitated dyed chitosan fibrids were examined by polarized light microscopy using a Nikon Labophot-Pol microscope (Nikon, Japan, Serial #951848). Photograph was taken with ISO400 mm film using a Nikon N6006AF camera (Nikon, Japan).

FTIR Spectroscopy
Infrared spectroscopy was performed on the samples using the Nicolet Nexus 470 Spectrophotometer FTIR infrared analyzer with AVATAR Omni Sampler in the Attenuated Total Reflectance (ATR) mode.

RESULT AND DISCUSSION

Chitosan was characterized by FTIR, conductometric titration, viscosity average molecular weight and polarized light microscopy.
FTIR Spectroscopy
The total reflection infrared spectra of chitosan samples (DD-70) is shown in Figure 5. FTIR spectra of chitosan shows characteristic bands at 3350cm^{-1} which refers to O-H stretching and N-H stretching (1^{o} amide). Aliphatic C-H stretching at 2929cm^{-1} and 2874cm^{-1}. Two absorption peaks at1650 cm^{-1} and 1595 cm^{-1} which refer to C=O (acetyl group) of secondary amide and NH_2 of primary amine. Two absorption peaks at 1425 cm-1 and 1385 cm-1 can be attributed to the C-H bending.

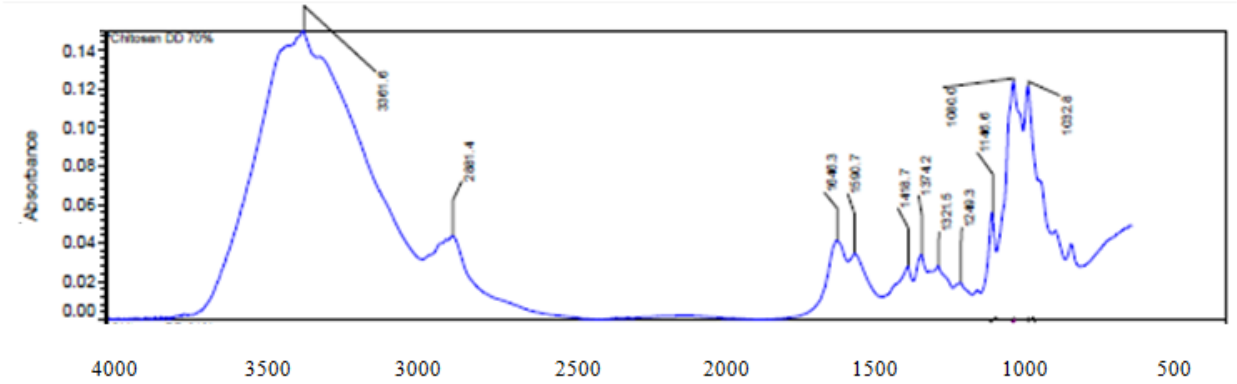

Fig. 5 Infrared spectroscopy of the chitosan sample

Microscopic Images
Chitosan shear precipitated fibrids were birefringent, showed positive birefringence (Figure 6), indicating that the predominant polymer chain orientation was parallel to the fibrid axis.

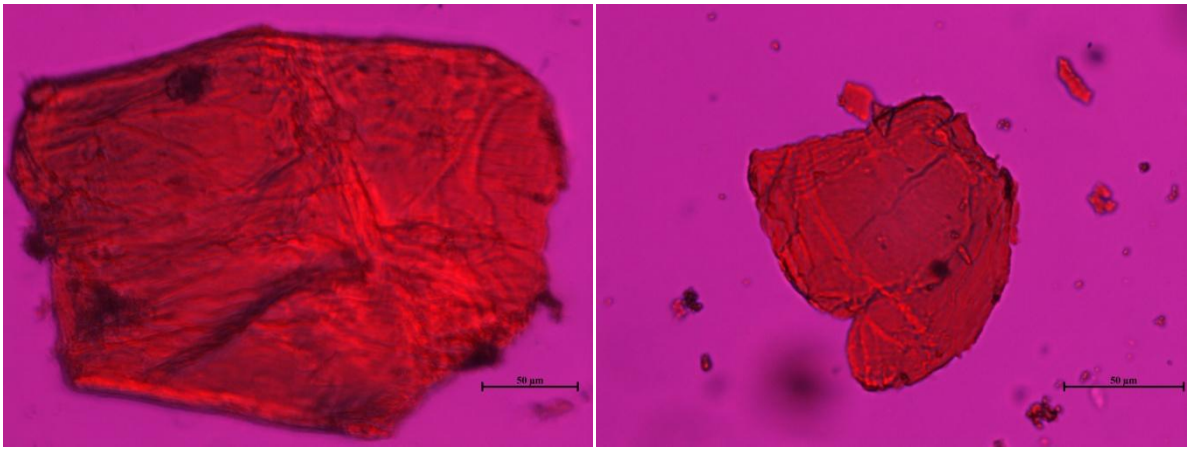

Fig. 6 Chitosan fibrids dyed with fluorescent red

CONCLUSION

Chitosan was characterized with FTIR, conductometric titration, viscosity average molecular weight and polarized light microscopy. Glycosidic linkages of C-H stretch at 1152 cm^{-1} – 1156 cm^{-1} show its saccharide structure. Dissolved chitosan was known to participate in ionic bonds with small water soluble parts. Chitosan-dye ionic interactions were observed to evaluate the inherent affinity of Acid Red 360 for chitosan for the observation of the crystal structure of the anhydrous form of chitosan which provides knowledge of the molecular and packing structure of the chitosan chains in the crystal.

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DESIGNING OF NEW HOSPITAL BEDSHEETS FOR PRESSURE ULCER

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INTRODUCTION

European Pressure Ulcer Panel Recommendation (EPUAP) pressure ulcers; pressure, friction and shear effects of other factors that occur in the skin and subcutaneous tissues, are defined as a localized tissue damage [1,2,3,4]. Presure ulcers generally happens to long term patients who underlying health condition. Elderly people are particularly vulnerable because of mobility problems and the ageing of the skin. Pressure ulcer to feel patients' pain, increased risk of infection, length of hospital stay and costs lead to an increase in the quality of life is adversely affected [5].

The best way to prevent pressure ulcers is providing convenient conditions which are well balanced body weight, dry outer skin layer, efficient moisture and heat transfer and lower friction between skin and material surface. Efficient moisture and heat transfer can be improved via textile material.
Cotton is the most common fiber used for bedsheets because of many advantages like comfort, moisture and heat transfer capabilities. However new textile materials were developed for better performances. Luxicool yarn is one of them and developed for better thermo-conductivity properties resulting in a quick dissipation of thermal energy and a cooling effect because of molecular composition and structure of the polymer by Luxilon Industries. The yarn is a monofilament and suggested to use with hdyrophilic multifilament yarns such as PA and PET [6].

In this study Luxicool yarns with PA and PET were woven and knitted to produce bedsheets. Those bedsheets were used for long term patients in Pamukkale University hospital to make comparison with the conventional textile materials whether they can improve pressure ulcers. Comparison were made with subjective and objective methods.

MATERIAL AND METHODS

Luxicool yarn properties are given as follows:
Product description: 37/70/N/T32 Luxicool 70 denier
Denier: Avg 380 µm ± 6 den
Tensile strength: Avg 3.1 N ± 0.5 N
Elongation at rupture: Avg 65 ± 20 %
Shrinkage: Avg 3.0 %

Luxicool yarns plied with PA and PET yarns producing PA/Luxicool 166 dtex and PET/Luxicool 166 dtex yarns. These yarns were woven and knitted to produce bedsheets and with a thin layer of spacer fabric confectioned to use for long term patients (Figure 1). Table 1 shows properties of fabrics produced with Luxicool yarns. Conscious patients were asked to fill up a form consisting of 5 questions to compare Luxicool fabric and conventional fabrics. Pressure ulcers were tested on unconscious patients objectively by using Braden scale.Braden, the most widely used in the United States is a pressure ulcer risk assessment scales[7].

Figure 1: PA/Luxicool woven bedsheet for hospital use

Table 1: Properties of fabrics produced with Luxicool yarns.

Fabric No and Abb.	Production Method	Yarn Type
1. PET-W	Woven-130 g/m^2	(150 Denier)%50 Luxicool*(150 Denier) %50 PET
2. PA-W	Woven-130 g/m^2	(150 Denier)%50 Luxicool*(150 Denier) %50 PA
3. PET-K	Knitted-225 g/m^2	(150 Denier) %50 Luxicool*(150 Denier) %50 PET
4. PA-K	Knitted-225 g/m^2	(150 Denier) %50 Luxcicool*(150 Denier) %50 PA

RESULTS AND DISCUSSION

Subjective and objective tests were runned on long term patients in Pamukkale University hospitals. Results showed that Luxicool used bedsheets creates statistically significant comfort over conventional bedsheets subjectively. Randomly 105 patients were chosen to join the subjective tests, 55 men and 50 women. They used one night 100% cotton bedsheets as control group and the other night our product produced with Luxicool yarns as testing group. Then they will asked to fill up questionnaire consisted of 5 evaluations. Figure 2 shows general comfort comparison of the fabrics which is rated between 1 to 7. While 100% cotton bedsheets rated average 4.51, Luxicool yarns used bedsheets rated 5.83. Objective tests were runned on 107 unconscious patients in ICU unit of Pamukkale University, 61 testing group and 46 control group. "Pairwise comparison of mean difference between two sample" testing method showed statistically no significant difference.

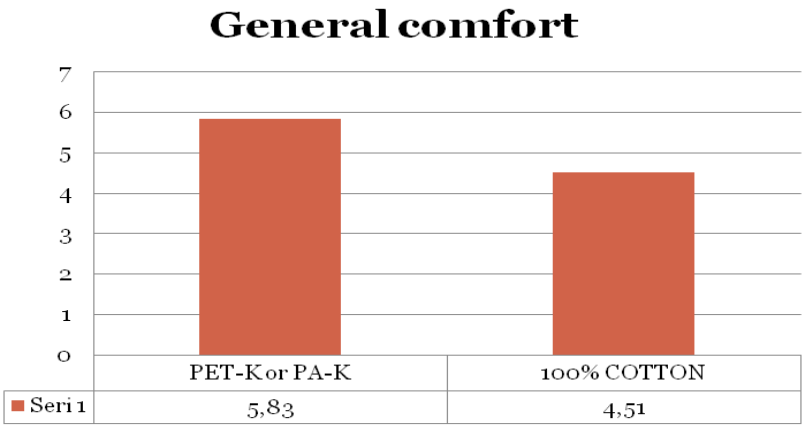

Figure 2: General comfort comparison of bedsheets produced with Luxicool mixed yarns and 100% cotton yarns.

NOTE
This paper partly presented in "Proceedings of JSPS AA Seminar Series 9" in 24-26 November, Hangzhou, China.

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DETECTION OF WARP ELONGATION USING IMAGE PROCESSING IN SATIN FABRIC

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ABSTRACT

In this study, warp elongation of satin fabric were detected using image processing to reduce yarn breakage during weaving. We used a digital CCD camera during analysis at weaving. MATLAB measurement pixels from taken photo and found elongation statistically. Warp elongations of fabric samples were examined and detected on the loom at high sensitivity. Also the elongation for each yarn was measured and different results were taken due to difference in mechanism settings. These differences can make high warp breaking ratio, we can see worst settings with plotted yarns.

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

INTRODUCTION

Competition has reached to an inevitable point in the world. Science and technology are evolving rapidly. Textile industry has an increasing need for faster production, more qualified fabric, and lower cost.Weavingmachine mechanism includesshedding, weft insertion, beat-up, take-up and let-off system. We need clean shedding, precise weft insertion and demanded warp yarns of let-off at the suitable amount and tension for better fabric quality. Using automatic control systems is advantageous to acquire high quality fabric production. Computer systems are used extensively in the process control. The advantages of automatic control systems in textile industry have come to the forefront.

Automated inspection becomes a natural way forward to improve fabric quality and reduce labor costs. However, the task is challenging to say the least. Fabric inspection with computer is therefore beneficial, yet there are challenges: (a) numerous categories of cloths, (b) distinct composition of various wallpaper groups of fabric texture, and (c) similarity in shape between defects and background texture[1]. Automated fabric inspection to operate the systems but they are expensive and are work correctly only for satin fabric that some weft density, which are called the ‘unpatterned’ fabrics. Researcherswere improved several major methods for “unpatterned”fabric[2,3]. There are many companies worldwide working on image processing for fabric control such as Dornier,Uster, Barco Vision, andElebit Vision [4,5].

Because of warp yarns across the width of the weaving machine carry different tensions different elongation in the warp wires are seen. The occurrence of different mechanisms for the warp yarns extensions varies.We researched extensionsin the fabric region.

In this study, the elongation of the warp yarns was measured using image processing onthe fabric. Different warp elongations are found on the fabric. Elongations of the warp yarns onleft, middle and right sides are different on the fabric. Warp elongations of the fabric were photographed for calculation. Images wereanalyzed with MATLAB and then statisticsanalisiswas were taken. Satin fabrics are woven in three different weft densities by keeping all the settingsconstant. In this study, it is obtained that warp elongation values are different by image analysis.

MATERIAL AND METHOD

Material

In this study, a satin cotton fabric is used which has Ne 40/1 warp yarns and Ne 80/2 weft yarns with a density of 50 ends/cm and 28 weft/cm respectively. We analized with images for twoweft densty per canti meter, 20 weft/cm and28 weft/cm.

Modifyinga normal camera body and lens structure, Charge Coupled Device (CCD) is obtained and its electronic film plates are used instead of normal film. $1mm^2$ 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 [6]. 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 [7].

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 ona 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 naturalgraphics 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 the distance between the lines after weaving.
L_f is the mean distance between two dots on fabric.
L_y is lenght warp yarn in the fabric.

C is warp crimp.
C_{online} warp crimp at loom
μisfabric shortening after take a loom.
λis unit converter between pixels and milimeter.
ε is warp elongation in a fabric.

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

$$\Delta L = L_1 - L_0$$

$$L_1 = L_{k1}.(1 + C) \quad (2)$$

$$\Delta L = L_1 - L_0$$

$$\Delta L_ç = L_{k1}.(1 + C) - L_o \quad (3)$$

$$\varepsilon = \frac{L_{k1}.(1+C)-L_o}{L_o} \quad (4)$$

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

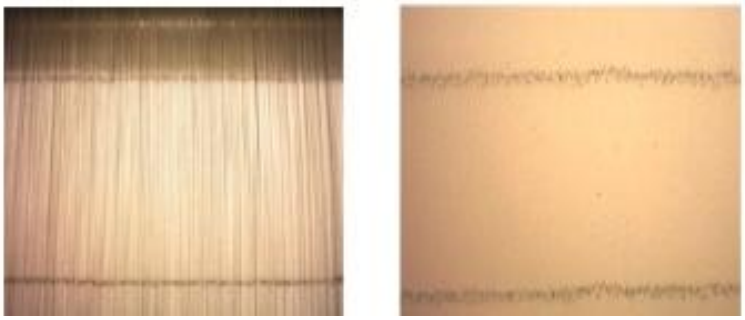

Figure 2. a)Plotted at warp beam. b) Dots at the fabric.

Figure2.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.

RESULTS AND DISCUSSION

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

Table1 Image proccessingsummary

	L_{ft}					L_{yt}		
	Left	Middile	Right	C	C online	Left	Middile	Right
20 weft/cm	100,66	100,9	100,74	0,04	0,04	104,68	104,93	104,77
28 weft/cm	99,7	98,52	99,83	0,03	0,03	104,23	105,61	104,38

L_0 = 102 mm

Table2 Warpelongationaganistweftdensities.

%ε	Left	Middile	Right
20 weft/cm	2,62	2,87	2,72
28 weft/cm	2,19	3,54	2,33

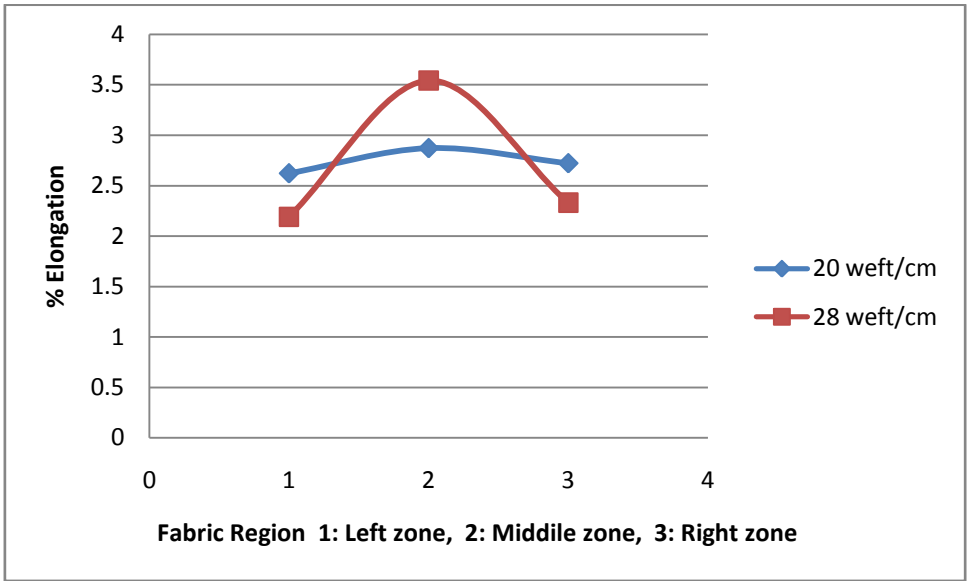

Figure 4.ElongationPercentage of theFabrics on theLoom

Warp elongations calculated in fabric. These elongations changed along the widh of loom. Other researchers founded chanced warps train along widh the loom [8,9]. We can seevary of elongations at Figure 4.

CONCLUSIONS

The distribution of elongation on the fabric during weaving 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.

ACKNOWLEDGEMENT

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CUTTING OF FABRICS FOR UNDERWEAR

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ABSTRACT:

Fabrics used for underwear are spread and cut using different techniques depending of their properties and width. Flat and wide materials can be processed using traditional manual or automated cutting methods, while tubular materials demands special spreading methods and spreading machinery. Automated cutting systems are available for both flat materials, and tubular fabrics. They significantly increase work productivity and quality of cut components. Specific spreading and cutting methods are used working with narrow lace. Manual process ensures reasonable quality of cut components, however the amount of manual work is very large and thus work productivity is low. There are companies which have tried to improve the situation developing specialized line cutting machines to ensure continues cutting of narrow lace.

Key words: spreading machines, cutting machines, spreading machines for tubular fabrics, automated cutting systems, automated cutting systems for tubular fabrics, cutting of lace

INTRODUCTION

Underwear is produced from very wide range of fabrics from different fibers with different properties. Depending on the cutting way these textile materials can be divided in two groups:

- Different width flat or tubular woven, non-woven or knitted fabrics,
- narrow woven, knitted or in some other technique created lace.

When compared with other types of garments, the components of underwear are smaller and their shape is not complex.

CUTTING OF FLAT AND TUBULAR WOVEN, NON-WOVEN AND KNITTED FABRICS

Cutting of wide materials are performed using traditional flat fabric cutting methods and machinery. However, there are several differences in the cutting process because of the specific properties of underwear materials, such as, elasticity, material manufacturing way (flat, tubular fabrics), material storage way (a roll, book folded), comparatively small size of the components, others.

Spreading

Flat materials can be spread manually or using spreading machines. As most part of underwear materials are elastic, special attention have to be put to smooth, even and tension free fabrics laying in the spread.

Performing traditional manual spreading, two workers move the lay of a fabric over the table to the beginning of the spread. During this movement the fabric can be stretched and laid on a spread in uneven way. The spread is longer, the larger possibility to get tensed material in it. This makes limitations to the length of spreads and necessity for workers with certain skills in laying elastic materials.

The best quality manual spreading can be ensured using a special movable spreader for “face to face in both directions” spreading (see Fig 1.).

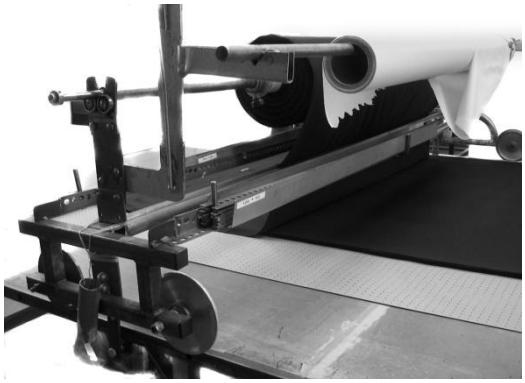

Figure 1. Movable spreader for "face to face in both directions" spreading

In this case whole material roll is moved over the table thus avoiding any fabric stretching during the spreading. Besides, qualitative work process can be performed only by one worker.
Automated spreading of flat and elastic materials have to be performed by universal or specialized cradle feed spreading machines which can ensure adjustable fabric tension according to the fabric elasticity.

Tubular materials also use to be spread manually or automated way. If process is done manually, usually one worker (as tubular fabrics are narrower in a flat folded way) lays the material on a spreading table folding or cutting material at the ends of the spread. "Face to face both directions" spreading mood is used (see Fig.2).

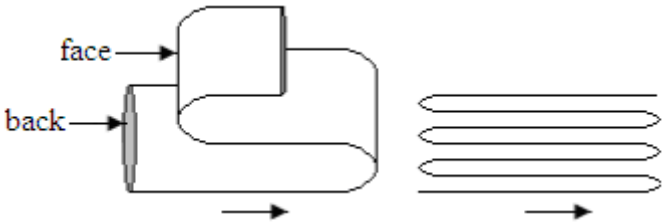

Figure 2. "Face to face both directions" spreading mood for tubular fabrics

If spreading is performed automated way, a special spreading machine for tubular fabrics or a traditional machine with several special devices for tubular fabrics are used. A folded fabric is placed on a tray at the rear of a truck and directed over a special roof above the traditional fabric feeding system (see Fig.3.a). Adjustable stretchers expand the fabric and guide it between two fixed horizontal rolls instead of a cutting device. If the fabric is narrow, two separate spreads can be performed simultaneously (see Fig.3.b).

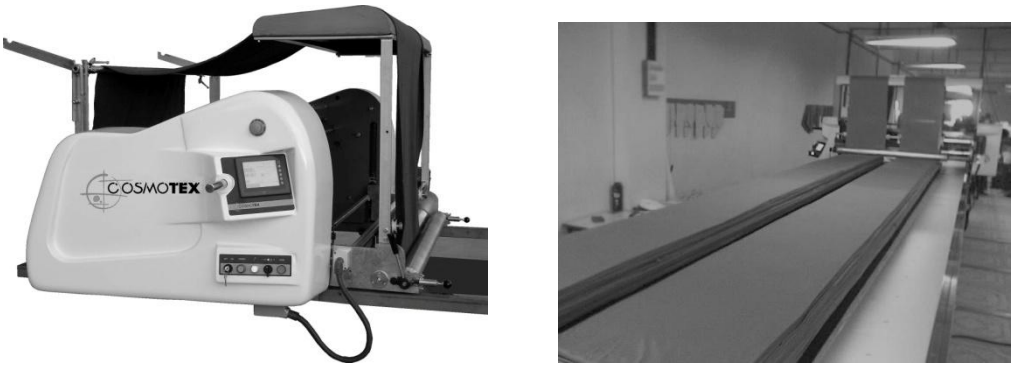

Figure 3. Automated spreading of tubular fabrics: special device for tubular fabrics, spreading of two spreads simultaneously (b)

Spreading of wide textile materials with intricate patterns

Underwear fabrics can have also patterns which have to be coordinated in the ready articles (see Fig. 4.a,b). In this case material is laid in separate sections and pattern coordination can be ensured using laser beams (showing the right direction of the material stripes on the spreading table), special needles (placing them under the first lay of the material to coordinate pattern in the spread in its main points) and specific spreading ways [1].

Figure 4. Coordination of pattern: panties with matched pattern (a), components of pajama with coordinated pattern

Cutting of wide fabrics

Manual cutting process can be performed by all kind of traditional machines. Straight knife machines are used to cut high spreads and large or middle size components. Round knife machines are used for low spreads and cutting of simple shape large or middle size components. The most precise cutting of small components can be performed using a band knife machine.

Automated cutting of flat materials can be ensured by cutting systems used for all kind of materials. The size of the cutting zone – the area in which cutting is done fully not moving surface of the cutting table – is smaller, working with styles with similar, small size components (for example, panties, bras), (see Fig.5).

Figure 5. Automated cutting of small size components

Automated cutting of narrow tubular textile materials

Automated cutting system for tubular fabrics is developed by Italian company Bierrebi [2]. Its first version AC2 and the last, newest variant AC3 can perform up to 5 cutting processes of tubular fabrics simultaneously. Book folded material packages of tubular fabric are passing common material feeding system which ensures tension free feeding by conveyor belt. Fabric is transported to cutting section where on separate 5 cutting tables automated double lay cutting process is performed. Independent from other tables cutting process (cutting of different styles or pattern pieces) can be performed on

every cutting table. The operational space of the cutting system is only 20sq.m. It ensures automated fabric feeding, cutting and also counting and stacking of cut components. The system can be operated only by one worker.

Comparing with traditional cutting process of tubular fabrics, cutting systems AC2 and AC3 significantly increase productivity, cut component quality, reduces fabric consumption and operation space needed to the work process.

Figure 6. Automated cutting system for tubular fabrics AC3 developed by company Bierrebi

CUTTING OF NARROW LACE

Usually the lace has pronounced pattern which has to be an accent or even design center of the style. Therefore the precise, symmetrical coordination of the pattern in the cut components is the main task during the cutting process. The small width of the lace and necessity to ensure pattern coordination make spreading and cutting process very much different, comparing with cutting of traditional wide and flat fabrics.

Figure 6. Matched pattern lace components in panries

The spreading process is influenced by the specific width of the lace and therefore the lace is divided in two groups:

- Lace up to 10 cm wide – narrow lace,
- Lace 10 to 40 cm wide – wide lace.

Placement of the pattern on the components

The pattern pieces for repeated use are made from firm cardboard and markers are created manually directly on a fabric. The contours of the components are shown on the pattern pictures of the lace and

are added to the technical documentation for each style. These pictures determine the precise placement of components on the pattern of the lace. The coordination of the pattern may be realized in two ways: the precise coordination of pattern in all areas of the component or only at its key positions (see Fig. 7.a,b).

Figure 7. Precise placement of a component on a fabric pattern: in all area (a), only in a key point (b)

Pattern pieces may be placed in opposing directions on lace with symmetrical patterns (see Fig.8).

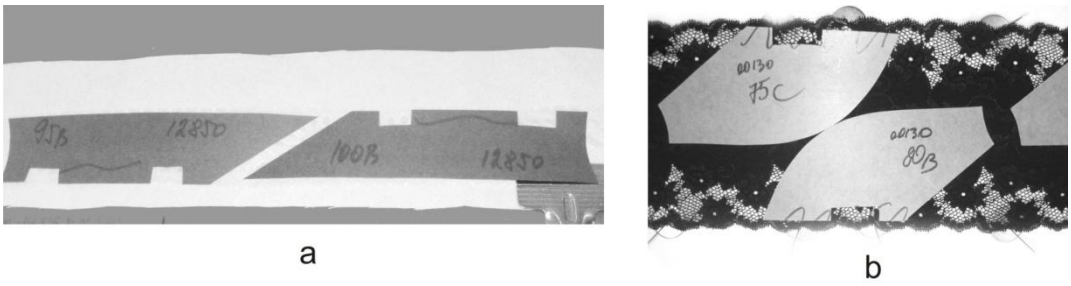

Figure 8. Placement of components in opposing directions

The exact direction of pattern pieces is determined by using lace with asymmetrical patterns.

Manual cutting of lace

Marker making of styles directly on fabric

A marker is made directly onto the fabric at the beginning of the spreading process. It is created on the first lay of lace which is placed on a firm paper layer. The marker is made from only half the full set of pattern pieces (only one of two asymmetrical pattern pieces are placed in the marker) as the narrow lace is spread using the 'face to face' spreading mode (see Fig. 10).

The number of articles placed in the marker is determined by the number of pattern pieces and their size, as well as by the maximum practicable length of the spread (about 3m). During the marker making process, the placement of metal pins, to coordinate the pattern in all the plies of the spread, is also determined.

The marker is not fixed onto the fabric ply and is usually a temporary device to determine the sequence of pattern pieces and the length. The number and size of each pattern piece in the marker is marked on the edges of the first paper ply. This written information is later used by a cutting operator who replaces the pattern pieces back on top of the prepared spread before cutting. When the marker is finished, the pattern pieces are removed from the first fabric ply to start spreading process.

Marker making process can be performed also automated way. The OptiTex [3] company has developed a nesting system 'Match++' for ensuring the marker making process matches the lace pattern.

The spreading process

The 'face to face' spreading mode is used to obtain precisely coordinated patterns on all the symmetrical components. Fabric plies are usually spread onto metal pins to coordinate the pattern precisely. The pins are fixed under the first fabric ply at key points of the pattern (see Fig. 9). Depending on the pattern, they can be used along either one or both sides of the lace. A larger number of pins are needed to coordinate the pattern in larger components. However, they must be placed so that they will not impede the subsequent cutting process.

Figure 9. The pins are fixed at key points of the pattern

In the spreading of narrow lace (up to 10 cm wide), the pattern is only coordinated along its edges. The 'face to face in both directions' (zig-zag) spreading mode may be used, folding the fabric at the end of every ply (see Fig. 10,a).

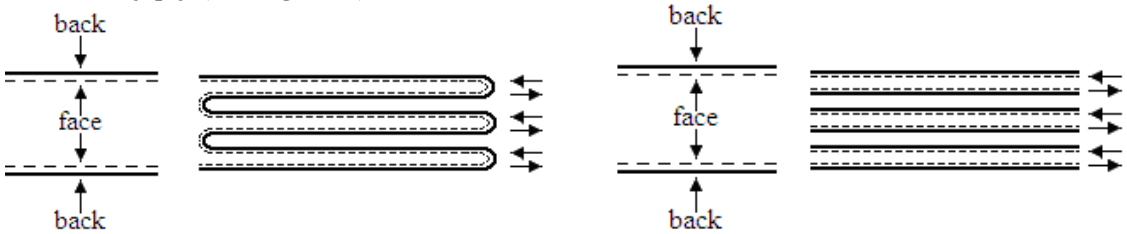

Figure 10. The 'face to face in both directions' (zig-zag) spreading mode: folding fabric (a) and cutting fabric (b)

When spreading wide lace (10 – 40 cm wide), the fabric plies are cut off so the ends of the spread are not thickened (see Fig. 10,b).

If precise coordination of the pattern is required in all areas of the lace and the pattern is positioned in one direction only, the fabric is spread using the 'face to face in one direction' mode (see chapter 4, section 3.5), cutting it off at the end of each ply (see Fig. 11,a).

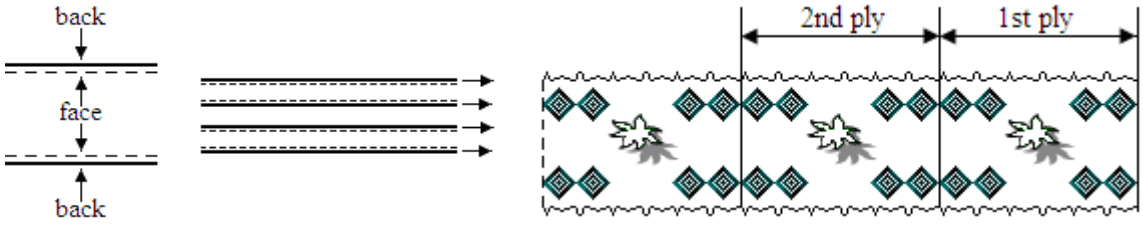

Figure 11. Spreading the lace with matched pattern: 'face to face in one direction'

mode (a), coordination of the pattern in all plies (c)

The end of a ply should ideally finish at the same position in the fabric pattern where the next ply starts (see Fig. 11,b). If the fabric pattern at the end of the ply does not coincide with the starting position of the fabric pattern in the next ply, the length of the marker must be extended. This spare fabric will be cut off during the cutting process.

The cutting process

The pattern pieces are replaced on the top of the spread before cutting. An operator ensures the plies are not displaced and that the placement of specific pattern pieces on the spread corresponds to the directions in the technical documentation. Components are cut using a band knife machine. Special clamps are used to fix the spread and to prevent displacement of the fabric plies. The position of the clamps is changed during the cutting process to prevent them impeding the cutting device.

Automated cutting of lace

Lace, difference in pattern repetition and width can be also cut automated way. Italian company Bierrebi [2] has developed specialized line cutting machine AL017 which can perform single lay continues cutting process of flat lace and also narrow tubular materials (see Fig. 12). An optic grid system enables automatic placement of the fabric lay for pattern matching. Machine eliminates multi-ply spreading, pinning and marker making performed in the manual lace spreading and cutting process. It performs automatic cutting of every lied ply, counting and stacking of cut components. Its memory system can store up to 1000 styles for further imitate use.

Figure 12. Lace cutting machine AL017 by company Bierrebi

Comparing with manual cutting process, automated process significantly increase work productivity, ensure constant and high pattern matching and cutting quality, reduce required floor space to performed spreading and cutting process (no need for spreading tables, a separate cutting machine), besides, automated cutting process can be operated only by one worker.

CONCLUSIONS

Although underwear styles do not have large number of components and their shape is simple, spreading and cutting process is work and time consuming. Material elasticity and small width, small size of components and necessity to perform pattern matching increase scope of work and complicate work process. Traditionally used manual cutting methods can ensure reasonable quality of cut components, however the amount of manual work is high and thus work productivity is low. For low volume production in small enterprises this kind of work management is acceptable. However, demands of middle and large volume production sites need to ensure much higher work intensity and productivity. Cutting solutions of company Bierrebi are the most advanced and acceptable for intensive work process.

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ON-LINE PURCHASE OF FABRICS FOR UNDERWEAR

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ABSTRACT

Fabrics for manufacturing underwear can be purchased on different websites which offer direct sell or contact details of potential fabric sellers. The information giving material characteristic is more or less extended, including or not including samples. The minimal order use to be given in weigth or length of the fabric. The most often the delivery time offered by suppliers is 3 weeks. On-line shopping websites use three main type of payments: T/T, L/C and D/P or their several combinations to secure the purchase process and enable manufacturing of the order. Performing purchase on-line a buyer gets wide choice of products and save his time and finances. However, he also risks being dissatisfied with the properties or quality of bought fabrics, having complications in returning unacceptable products or getting in problems because of not perfectly saved payment methods used.

Key words: on-line shopping, underwear fabric suppliers, payment methods, make to order supply

INTRODUCTION

Online shopping is among the most popular activities of the Internet during the last decades. Individuals and large companies find their business partners using different websites which ensure direct sell or contact info of potential business partners. On-line shopping has several important advantages: their users can get wide choice of desired products and significantly save time to search them [1,2].

WEBSITES TO BUY UNDERWEAR FABRICS AND KEYWORDS TO FIND ON-LINE SELLERS

Fabrics, including materials for manufacturing underwear can be found and purchased on different websites. Based on their main aims and structure, they can be divided in two groups: websites which ensure direct sell of the products and websites giving contact details of companies which are interest to sale.

Websites which ensure direct sell of the products:

- Websites for on-line selling – on-line shops [3,4,5,6],
- Websites of textile companies which are interest to sell their products [7].

Websites giving contact details of companies interest to get new cooperation partners:

- Websites giving general information about different activities, for example, places, traveling, shopping, health, education, also business, manufacturers of certain products. These websites gives contact details of companies which are selling textile materials [8,9],
- Websites of fair centers giving contact info about their customers – companies which regularly take part in their fairs [10],
- Websites joining textile manufactures, exporters and suppliers [11],
- Websites of textile manufactures of one country joined by some organization having a website [12],
- Websites of textile companies [13],

Key words to find underwear fabric sellers on-line are:

- *General use keywords* - underwear fabrics, underwear material/fabric suppliers, underwear manufacturers, knitted fabrics,
- *Keywords including info about material type* – knitted cotton fabric, cotton licra/spandex fabrics, knitted polyester fabric, others;

- *Keywords including info about techniques used to manufacture the fabric* - warp knitted fabrics, weft knitted fabrics, rib fabric, tricot fabrics, lace, others.

INFORMATION ABOUT FABRICS TO PERFORM ON-LINE PURCHASE

Material characteristics

The information giving material characteristic can be more or less extended: photo (can be with possibility to enlarge), composition, manufacturing (knitting) type, weight, width, density, pattern, colours, colour fastness, finishing ways, application, packing way (roll, book folded) weight of one roll.

Samples

Fabric samples to see the material and to estimate its properties and quality can be offered before making the decision to do the purchase. In some cases the samples are free of charge, in some – not. If payment is asked, it has to be performed using *T/T in advance* payment method. Sample delivery is promised during 1-3 days.

Place of origin

Usually the country of origin and the name of the company manufacturing the offered material are also available. The on-line shops use to give also website address and the location address of the company.

MINIMAL ORDER, PRODUCTION CAPABILITY AND SYPPLY TYPE

Minimal oder quantity

The minimal order quantity is the amount of product which can be obtained in one purchase. That is important in cases when the buyer creats business relation with unknown product seller and wants to test the product the first time. The minimal order quantity is also important to small and medium size companies as often there are not able to cooperate with fabric manufacturers which are located far away and, because of transportation terms, can not sell small quantities.

Traditionally knitted underwear fabrics are sold measuring their weight (in kilograms) or length (in yards, meters). The minimal order use to be from 100 kg and up (100kg, 500kg, 800kg).

Production capability

Production capability of the company manufacturing the fabrics is important for large buyers. It shows the maximal quantity of the certain material which can be produced for the buyer in one month.

Supply type

In most cases searching for underwear fabrics the buyer offers *make-to-order* supply type. It means that the company manufacturing the material is ready to fulfil the order after its final confirmation and, most often, after some advanced T/T payment (30% or 50% T/T advance payment).

PAYMENT TERMS

Generally speaking, the payment terms are negotiable. There are a number of different payment methods that can be used for on-line shopping. Three most often used in on/line shopping are: T/T payment, D/P and L/C payment.

T/T payment

T/T (*telegraphic transfer*) is a form of bank transfer when a buyer transfers money to the suppliers' bank account directly. It is one of the simplest forms of international transfers. T/T payments are a cheap and fast way of transferring money overseas through most banks. It takes 3-4 days for us to received the wire transfer made from anywhere in the world. This payment method is not recommended when dealing with an unknown supplier.
T/T payment can be ensured in several ways:

- *100% Upfront TT* **(**T/T payment in advance) - a buyer transfers full amount of money to the suppliers' bank account before the order is received. T/T payment in advance is usually used when the sample and small quantity shipments are transported by air. T/T payment in advance presents risk to the byer if the supplier is not honest.
- *30% Upfront TT* - Since many factories need money in advance to buy raw materials for the order production, 30% upfront TT (deposit payment) is a common payment term for suppliers, especially when dealing with an unknown buyer. The normal payment terms are: 30% deposit and 70% balance (after production). 30% T/T as deposit and 70%T/T against the documents
- *100% Backward TT*- If being paid after pre-shipment inspections. If being paid after receipt of merchandise, it is nearly 100% reliable for buyer cause buyer can cover the whole risk, however, on the opposite, suppliers are not willing to accept this way due to big potential risk of dispute or fraud.

To reduce risk to the buyer, on-line shops use Escrow service - a third party on behalf of the other two parties in a money transaction. Using the Escrow service buyer's payment is placed into an Escrow account and held their. Payment is only released to the supplier when the buyer confirms satisfactory delivery of his order. Escrow service is popular dealing with small amounts.
Advantages and disadvantages of the method: It is low cost payment method and acceptable for all suppliers. However, for a buyer it is deposit payment, there is not payment protection (in case if a seller finally does not send a purchase or there is problems with the purchase) and the buyer has to use his credit card information to perform T/T payment.

L/C- a letter of credit

A Letter of Credit is a payment mechanism in which a bank or more than one bank is involved to ensure higher level of security for a buyer. Letters of credit deal in documents, not goods. Simply, a letter of credit is a letter written by the importer's bank to the exporter. It verifies that the payment will be guaranteed when the bank is presented with the concrete documents. As the bank personnel are not industry experts the buyer and seller have to negotiate carefully which specific documents the latter must provide, before the transaction is made. Most commonly used are:

- Approved Quality Inspection Report/s (to avoid shipment of defective items)
- Approved Laboratory Testing Reports (to avoid shipment of non-compliant items)
- Bill of Lading (issued on or before a certain date, to avoid delays)

Most letters of credit are "irrevocable" once the importer has had them sent. L/C is used for the larger quantity order shipped by sea. The typical L/C scenario takes 14-21 days to complete. A Letter of Credit payment mechanism is highly recommended for transactions that are US $20,000 and above.
Advantages and disadvantages of the method: Using this payment method no deposit payment is required, which reduce the risks on the buyers side. The supplier has a pressure to comply the buyer's requirements. However, complex procedures, high fees and high threshold of registered finance may prevent small and medium size companies from being involved.

D/P - document against payment

The exporter makes shipment and sends the shipping documents to his bank. This bank then sends the shipping documents to the buyer's bank, which informs the buyer. The importer makes payment and only after that he receives the shipping documents with which he can get the goods.

Advantages and disadvantages of the method: Comparing with L/C (a letter of credit payment method) D/P payment way is simpler and cheaper for the buyer. However, there is the risk for the supplier that the buyer will not pay while the shipment is already loaded. *A payment against documents* arrangement involves a high level of trust between the exporter and the importer. Traditionally it is used in long-standing business relationships for the small quantity order.

Combined payment ways

To get more secure cooperation way for the both side – the buyer and the seller – on-line shopping website offer combined payment ways. For example:

- 50% T/T advance payment and 50% made via D/P,
- 30% T/T as deposit and 70% made via D/P.

DELIVERY TIME

Delivery time depends on supply type, ordered quantity, used payment method, location of the buyer and seller, other factors. However, most often delivery time offered by suppler is 3 weeks (variants: 20-25 days, 20-45 days, 10-20, 15-25). Sometimes, the buyer adds the comment, for example, 20-25 days after received payment (cooperating with an unknown buyer), or after paid deposit (using the deposit to purchase the raw material to fulfill the order).

DISADVANTAGES OF ON-LINE FABRIC PURCHASE

Besides the positive sides of the on-line purchase, there are also several disadvantages which make a certain risk in using this kind of business cooperation. The most important disadvantages are following:

No tactile experience

An online buyer can't see, touch or test the fabric and judge its quality before making the final decision to purchase. The buyer relies on the images and description of the product, sample sent by the seller, however this info can not give full idea about real fabric purchased.

Complications in case of quality problems

Inability to see and test the material can lead to dissatisfaction of the buyer with properties and quality of the fabric. Return of the improper purchase is always complicated, time consuming and also costly

Risks performing payment

There is no payment method that is perfectly safe to both the buyer and supplier at the same time. Performing T/T payment buyer has to use his credit card information. In case of D/P payment, the seller is in a risky situation as the buyer can cancel his payment while the shipment is already loaded. L/C payment method is rather complicated and costly therefore not available for smaller buyers and purchases.

CONCLUSIONS

In nowadays when suppliers and consumers are often located far away from each other, and there is not time and possibilities for direct contacts, on-line communication has become important part of the business. In the on-line sell the most important part of the success is the level of trust between the manufacturer of the product and its buyer. If the supplier gives honest information, ensures qualitative product, observes delivery terms and time but the buyer performs payment in required way and time,

the cooperation is successful and makes the base for wider business opportunities in between the same or new partners.

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FUNCTIONAL CLOTHES

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APSTRACT

Since the first days of human existence the clothes has been used for protection, and later it got the elements of social, cultural and economic differentiations. Each differentiation and each human activity gave us new aspects of clothes- Functional clothes are the segment of clothing in which the clothes pass the limits of conventional. The production of this kind of clothes integrates the domains of medicine, biotechnology, nanotechnology, physics and computing in the aim of fulfilling multiple and complex demands of the users. Functional clothes are designed specially to satisfy the needs of the users who will wear it under extreme conditions. Throughout the market we can find different types of these clothes. The most important examples are: sports clothes, protective clothes and medical equipment. New technologies, science and the latest scientific achievements and knowledge have a huge influence on the functional clothes, and they have the aim (task) to provide each generation of these clothes with a better functionality.

Key words: Clothing, Functional clothes, Spandex

INTRODUCTION

Clothes are one of those elements which make the difference between the people and the animals, because the humans are the only beings who creates clothes. The practical function of the clothes is to protect human body from the dangers coming from the environment: weather (intense sun, extreme warmth and coldness), insects, dangerous animals and the nature itself. Clothes can protect us from many things that can injure a naked human body.

Functional clothes represent an evolutionary segment of the technical textile market, i.e. these clothes represent the area in which the clothes pass the conventional limits and integrate with the domains of medicine, biotechnology, nanotechnology, physics and computing (among the others), to satisfy multiple and complex demands of the users who will wear them under extreme conditions. There is an enormous variety of the functional clothing items (products) available in the market, such as protective clothes, medical clothes and sports clothes. (Adanur, S. 1995)

By the universal definition, comfort is "a state of pleasure (satisfaction) which points out the physiological, psychological and physical balance among a human being, his clothes and the environment." It is obvious that comfort is a complex phenomenon which can be considered from the aspects of numerous disciplines. The comfort can be considered as the physiology of a dressed human in a specific climate surrounding, including the physical characteristics (properties) of the clothes.

CLOTHING

Clothes protect the human body from the extreme weather and other environmental influences. They are worn because of the safety, comfort, fashion, but also to emphasize the religiosity, cultural and social character. People are the only creatures that wear the clothes willingly, even if some people put the clothes on their animals. Clothing items include everything that covers or overlays the body and determines an individual or a group of people visually.

Clothing is covering or overlaying the body with clothing items in spite of which the function is in the foreground, and the aesthetic aspect is in the background. Creating of some parts of clothes is not only caused by the protection of the body, but also by some magical influences (the clothes worn during the holding of some religious rituals), aesthetic ones (decoration of the body, for example with the pieces of the fur), and it also depends on the profession (fire suit) or derives out of the feeling of shame. The

way of clothing is influenced by the customs, the level of culture, the technical development and the social position of the people.

Fashion is a term which includes popular styles in various spheres of human activities and thoughts in any time of the history. Styles can change quickly and lately the term fashion marks the latest version of a style in an area. In developed western countries, there is a constant change in fashion, especially in women`s fashion. It didn`t happen in Ancient Greece or Rome or any other great civilization in the world and it started happening several decades ago. Throughout the areas of Iran, Turkey, Japan, China, and many other mostly eastern countries, the same fashion has been worn for decades or centuries. Western countries` fashion is changeable compared to them, and this is dictated by the fashion industry because of the higher profits. In the past, the changes in fashion used to happen during some economic or social changes, for example in ancient Rome, at the fall of the Roman Empire (Barbarian clothes, such as trousers, started to be worn) or during Turkish conquests, but after these important historical events a long period with no big changes came. (leventin, M. 2008)

Fashion plays an important role in functional clothes, too, not only because of its agreement with the civil fashion. The Nazis had a very developed sense for fashion and they entrusted the designing of their uniforms to Hugo Boss, knowing that the visual impressiveness is a part of the attraction and the credibility, so the perfect visual identities of the absolutistic regimes made the acceptance of the insane and monstrous ideas easier.

FUNCTIONAL CLOTHES

Functional clothes represent an evolutionary segment of the technical textile market and they are usually made of the mixture of some innovative materials and the additional functionalities of these clothes, in this case, would mean an additional value or the function we expect these clothes are able to provide. These can be the clothes which protect the individuals exposed to life deprivation or dangerous environment (surrounding) during the work or sports activities, or the clothes which can make the moves easier and enable the body balance to physically handicapped persons, or the kind of clothes which can improve the endurance or decrease the fatigue of the athletes. It can also be the clothes which have a pure aesthetic function, I.e. the clothes which emphasize the body curves. Lately, functional clothes sometimes have some electronic functions, with the use in communications and telemedicine. Spacesuits of the astronauts have integrated microphones and radio devices, and something similar can be found in swimming suits. The design of the functional clothes is ergonomic, so it has a minimum inhibitory effect during the moves and provides the best protection or most freedom and recognizability, depending on the name the above named clothes are used in.

Sports clothes

Sports clothes became an integral part of sport and daily life a long time ago. These clothes not only give an athlete, but also ordinary people the possibility of improving their results and performances, and protect them from possible injuries. Accordingly, sports clothes have the properties such as regulating of the body temperature and moisture, elasticity, and these clothes can endure much wearing out. Sports clothes are the functional clothes, which help the athletes to achieve excellent performances during the competitions.

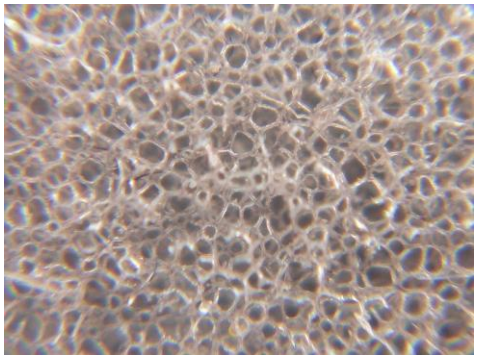
The quality of sports clothes is evaluated according to their thermo-physiological and ergonomic comfort. Sports clothes are made of different kinds of materials which can look the same visually, but when it is about their mechanic properties which are highly related to fitting and the deformation of the clothes during their use, there may be an important difference among them. Now, sports clothes are much more qualitative thanks to modern technologies and new materials. These clothes enable a higher level of protection during the use in different sports activities and give the comfort and help in achieving better sports results.

The clothes create a special microclimate between the body and its surrounding. (Grujic, D.etc, 2012) They act like a barrier to the transfer of the warmth, and to the passing of the moisture between the skin and its surrounding. At the climate conditions when the air temperatures are high and the influence of the wind is minimal, the thermoregulation of the body is done by the process of excretion of the sweat that evaporates from the surface of the skin and, in that way the clothes take the excessive warmth from the skin. Evaporated sweat is brought from the surface of the skin out in the environment, so absorptive properties of the materials the clothes are made of have a very important role in providing the necessary comfort.

The producers constantly find new synthetic materials for the making of sports clothes, as well as the clothes for common activities, The moisture which can be absorbed by a material can`t be higher than 1% of the total weight of that material. Practically, this means that these materials dry very fast. The materials for sports clothes are made of the fibers of great fineness, which are very enduring at the same time.

Most often used material for making sports clothes is "spandex" which is polyurethane in its chemical composition. There aren`t many clothing materials that are so prominent in the design of sports clothes like spandex or lycra. Globally, sport needed elastic materials for clothes adjusted to the athletes to be created. Elastic materials are the important means for achieving comfort, the freedom of moves for the athletes to whom this freedom is essentially important. Now, elastic suits and sports clothes are predominantly used in athletics and they can improve the performances of the athletes in cycling, swimming, etc., in other words, everywhere where it is necessary to overcome the resistance of the air.(Gavin,T.P.,2007)

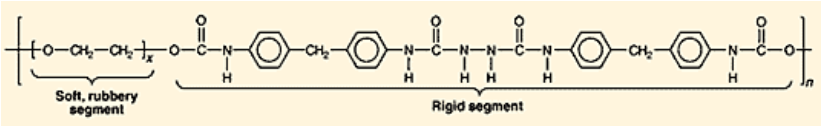
Spandex appeared in the US company "Dupont" in 1959, after a decade of scientific research of Joseph Shivers. It was branded under the name LYCRA, that became the synonym for spandex worldwide. According to its chemical composition spandex is a polymer, and it belongs to polyurethanes (artificial rubber). It doesn`t absorb water and is resistant to the body oils. Spandex has an extreme elasticity – after stretching to 60%, it returns in the initial position with no damages.



Picture 1. Material structure

Spandex achieved its enormous popularity soon after its appearing, especially in the industry of women`s laundry (underwear), but it soon became a part of the swimming suits, male as well as female ones. It was used in the sports equipment of the French Olympic ski team in 1968, and in 1970s the cyclists changed their woolen suits with aerodynamic spandex, and later it was used for the dancing suits, tights, socks and flexible jeans. It achieved its greatest popularity in 1980s, when its use was spread to different sports, professional as well as the amateur ones, and it was the material which was used in making the underwear as well as the outer layers of clothes. In pop culture, different rock bands, whose members wore spandex tights during their concerts had a huge influence on the use of spandex.

Spandex, combined with some light, non-absorbing fibers, such as nylon or polyester, is an ideal material for the use in, so called, compressive clothes which demand elasticity and fitting to the body because of the comfort during the moves, giving the support to the muscles, and besides that, these clothes don`t absorb the sweat and bring it out in the atmosphere or the outer layers of the equipment, keeping the skin dry and protecting the body from the overheating, enabling better blood supply. Compressive clothes also prevent overcooling of the skin and enable the skin to breathe undisturbed. It was also noticed that the use of compressive clothes with spandex decreases the fatigue of the muscles and increases the efficiency of the athlete, and when these clothes are worn after an intensive training, they speed the recovery of the damaged muscle tissue. Because of the above named properties many experts consider compressive clothes and all the clothes made of spandex a healthier alternative to the conventional ones.



Picture 2.. Spandex formula

Spandex is a stretching synthetic fiber alike rubber which, combined with other textile fibers, creates the materials of high elasticity. Because of the possibility of spandex to return in the initial position, it found its use as an inevitable component in the production of the skintight clothes, such as underwear, sports equipment, medical equipment, etc.

The name spandex itself is the anagram of the English term "expands" and it represents an unprotected generic name. The name spandex is typical for the US market, but in the textile industry of European countries the terms ELASTAN, ELASTHAN, ELASTANO, etc. are used. In Serbia, we use the term "Elastin", but in the speech of ordinary people the term lycra is more common. Lycra is a protected (authorized) name and one of the most famous brands of spandex, and it is owned by the US company "Invista". Other famous brands of spandex are: Elospan (Invista(, Acepora (Tackwang), Creora (Hyosung), ROICA, Dorlastan (Asahi Kasei). Linel (Fillattice), and ESPA (Toyobo).

Spandex is almost never used independently and it is combined with the other natural or artificial materials such as cotton, wool, linen, nylon, polyester, etc., mainly with the share of less than 20% . The material which spandex is added to, it gives elasticity and additional softness. When it is combined with light, non-absorbing fibers such as nylon and polyester it makes an ideal material for the use in, so called, compressive clothes which demand elasticity and fitting to the body because of the comfort during the moves, giving the support to the muscles, and besides these, it doesn`t absorb the sweat and carries it out in the atmosphere or upper (outer) layers of the equipment, keeping the skin dry, and protecting the body from overheating in the aim of better blood supply and cooling of the body. At the same time spandex enables the skin to breathe freely. It was also noticed that the use of compressive clothes with spandex decrease the muscle fatigue and improve the efficiency of the athlete, and when these are worn after an intensive training, they speed the recovery of the damaged muscle tissue. Because of the above named properties, many experts consider compressive clothes, and all the clothes made of spandex, a healthier alternative to the conventional ones.

Clothes with spandex mean an additional protection of the body from the influences of the Sun low and high temperatures, and since they are worn completely skinsuited, they take the role of "another skin" and don`t limit making even the most complicated moves. The mixture of nylon and spandex has the property of fast drying, so it has found its use in diving and water sports.

As a material, spandex is inevitable in most of the sports, such as: cycling, athletics, gymnastics, swimming, wrestling, etc. and water sports that are played by the ball, where it is used more and more often in the form of compressive clothes and equipment that are more practical alternatives to the traditional underwear, and its popularity increases. It is used byy the athletes of all levels, the

professional ones as well as the amateur sports people, not only because of its practicality and comfort, but also because of the improvement of the appearance, considering the fact that the equipment with spandex is often very brightly coloured and designed in the way of emphasizing the natural curves of human body.

It can be noticed that the used increases at the rate of 30-40% a year worldwide, and Asian countries have the share of almost 60% of the world consumption of spandex and that makes 25% of the world growth in demand for spandex annually.

Compressive clothes are the narrow underwear items made of the elastic synthetic materials and they are used during various sports activities. The main characteristics are quick drying and skintightness, i.e. gentle or strong compression of the muscles. (Yarbourgh, P.etc,2005) Unlike the traditional cotton underwear which absorbs the water, dries slowly and isn`t skintightned so it cools the overheated body suddenly at the points of contacts, the compressive one suits the body like another skin, so it absorbs the moisture and carries it out in the atmosphere or outer layers of the clothes and the skin remains dry. Besides that, synthetic materials are good thermo-insulators, so they help the organism to keep its body temperature constant, with no sudden changes.

Another, equally important characteristic of compressive clothes is their high elasticity, i.e. their property to return in the initial position after the stretching and to support the muscles. In this way they keep the constant shape, decrease the vibrations of the muscles and improve the results. They also improve the blood supply of the limbs and decrease the producing of the lactic acid and, as a result of that, they decrease the fatigue, the friction between the parts of the body that touch each other. The researches show that the compressive clothes decrease the need for the oxygen during the sub-maximum practicing, and they are considered as the consequence of the decreased muscle vibrations and they enable a more economical use of the energy. The main component of the material the compressive clothes are made of is the synthetic fiber alike nylon or polyester, which a certain percent of is added to because of the elasticity. The mixture of these materials is soft and very smooth. For its production two kinds of materials are used, a thinner, single-layer for the summer clothes. And the ticker one, which has a special layer alike plush inside, and it is an excellent thermo-insulator, but it doesn`t cancel the other functions of the clothes.

Compressive clothes can be made one-piece, or can consist of the compressive shorts and the compressive t-shirt, tights, compressive socks, etc. They are used in many sports such as: athletics, football, basketball, rugby, cycling (with the additional insert), mountain climbing, running, etc. as well as in medicine during the treating of some illnesses such as varicose veins. These clothes have a special role in dressing up in layers, as the basic layer, that protects the skin from the sudden temperature changes and keeps the skin dry by carrying out the moisture through the upper layers into the atmosphere.

The feeling of thermal comfort or discomfort, caused by the integration of the subcutaneous and inert thermal receptors, maintains the overall state of human thermoregulatory system. For the certain speeds of the metabolism, the other physiological parameters of the human organism and the climate conditions of the environment, the thermal neural zone or the zone of thermal comfort will lie in the interval of the ambient temperature in which no special activities of the human thermoregulatory system are necessary. The clothes are in the constant contact and interaction with the human body during performing their function, especially with the surface layer of the body (skin), and the clothes protect the body from the extreme outside influences. The clothes have the role of the barrier to the free exchange of the energy and the mass of a person with his or her surrounding, o the properties of the clothes are an important parameter of the human thermo-physiological comfort.

PROTECTIVE CLOTHES

Protective clothes are the biggest segment of the functional clothes. The functionality of the clothes, in this case, can make the difference between the user`s life and death, at least they can enable the people to work in an unfriendly surrounding, to improve the quality of life and prevent or decrease the injuries. The genesis of the protective clothes during the centuries, the changes of the materials, fabrics and forms from the beginning of the civilization until these days, are very important in the process of creating the protective clothes.

The functionality of the protective clothes can be determined on the basis of the nature of the threat, which the body requires the protection from. Technical demands in each case are quite specific and special. The natures of the threats in the case of life threat are some extreme ecological conditions (natural or artificial), such as the extreme warmth, coldness, fire, rain, snow, dust, wind or radiation. There is also the protection in the cases of ingestion, spouts, or radioactive particles. There is the protection from the cuts and ballistic or blunt impacts (thumps), too.

CONCLUSION

Clothes have had the protective role since the appearing, and it later it started to get the elements of sociological, cultural and economic differentiations. Each differentiation (for example, a new religion) caused the new types of clothes, and each human activity (professional sport, computing, etc.) also brought the new aspects of clothes.

Functional clothes have the role to satisfy the demands of the users who will wear them in extreme conditions. In the aim of fulfilling this condition, the achievements from different areas of science are used. There is a great variety of functional clothing products which are available in the market: the protective clothes, the medical clothes or sports clothes, the clothes worn by the professionals, soldiers, firefighters, miners, etc.

The youth mainly choose the clothes which differ them from the others (in style, colour, designing), the clothes which beautify the body and hide the irregularities. The functional clothes seem to be immune to the fashion and represent the point of connecting important usefulness, but that`s not true. Fashion certainly influences the functional clothes, especially sports and military ones. It should be emphasized that this is a bilateral relationship and that it goes vice versa, because there is an important influence of the sports and military clothes on the civil fashion.

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THE INFLUENCE OF ASIAN CULTURE ON EUROPEAN COSTUME AND CONTEMPORARY FASHION

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ABSTRACT

Considering the fact that boundaries of the East and the West world are not geographical, but rather cultural, you can realize that differences between them must be apparent in social, philosophical and art life. When you consider their social and cultural development throughout the history you can clearly see this dichotomy. It is not about religion or nation, because both sides have a wide spectrum of different nationalities and religions, it is about a different kind of philosophy of life, on one side -one that is rational, and opened up to material world and fast technical growth on West and on the other side -philosophy that is characterized by religious sensibilities, familial social orders, and ageless traditions on East. This can be seen in every aspect of culture, especially when it comes to aesthetic and visual ones; fine arts and design being one of them. Every side for itself brought accomplishments in this filed, but when it comes to costume and fashion, magic starts to happen when mutual interaction starts to influence the products of their design. Eastern costume has been influencing fashion since it has been introduced to the West world. Japanese art and costume in particular, set the tone for contemporary fashion and the way of thinking in experimental and avant-garde fashion of the 20th century.

Key words: *East, West, costume, fashion*

INTRODUCTION

Everyone who works in the field of fashion, today, knows how modern clothing developed from historical, national and ethnic costumes. You can't do a research of history of contemporary fashion and ignore the influences from all over the world, regarding headdress, shoes, silhouettes of the dress, even a way of putting clothes on, ceremonial jewelry, make up- that effected European costume to become modern, simplified, comfortable, ready for a fast way of life that 20th century gave birth to. From that point on, European modern fashion spread all over the world and became just one contemporary fashion, regardless of what cultural part of the world it was. East and West, both, embraced fashion as a new way of life, constantly changing and adapting to new social circumstances. Nevertheless, one can't deny the influence that culture of the East had on Western, European, uncomfortable costume to change into a form of art that we call fashion.

HISTORICAL OVERVIEW OF COSTUMES OF THE EAST AND WEST

Ancient Times

Cultural seclusion of the World on East and West started in ancient times. Greek scholars created Western civilization, with the help of new rational-thinking philosophy that is considered to be the pillar of Western civilization. In that time Ancient Egypt and Ancient Greece, started differentiate themselves from the populations on the East, in the most obvious way; with the help of fashion. Egyptians started wearing linen pieces of translucent cloth that was tight around their body, but never in color; only plain whites were used, so they could distinguish themselves from the ordinary, as they considered, barbaric cultures on the East that wore dresses in rich color and robes, with fantastic detailing in painted and woven ornaments. Ancient Greeks did the similar thing in one point of their civilization, the Classical era (400 -500 BC), they abandoned every ornamentations and decorations in their costume, so they would represent themselves as higher, above all Eastern civilizations.
Different philosophies developed probably in that part of history. Western philosophy; always in pursuit of the accurate answer involving nature, and its elements, that later developed into science, covering all aspects of life. That kind of philosophy always tends to find problems that may come, and search for the best practical solutions for them, thus developing Western civilization that we know today; modern, industrialized, accustomed to discussing rules and laws by reasoning. For that reason

in costume they strive for celebrating the aesthetic of the human body - as the most important objective of every garment. In ancient times with Greek costume, body was indicated under soft draped wool robes, and with Egyptian it was the linen translucent cloth-like pieces of garments that gained form only when swaying from a human body.

On the other cultural part of the world Eastern philosophy was already developed. It did not search for the answers for the problems of the nature and life surrounding them, as the main objective. It was concentrated on acknowledging the problem and understanding it, being in the present moment and appreciating it, and most importantly - developing the Self - not being concentrated on the material world, but rather the inner being of self and others. In costume East has developed most beautiful silhouettes and decorative elements of all civilizations. India and Middle East with their decorative elements, China that gave birth to the most luxury textile material - silk; with incredible assets of treads that are soft and strong at the same time and Japan - creating most incredible form of costume that combined influences from neighboring countries, traditional techniques in making all garments, but also in time discarding all excess decorations in the shape of the costume, thus contributing with futuristic assets to their national costume.

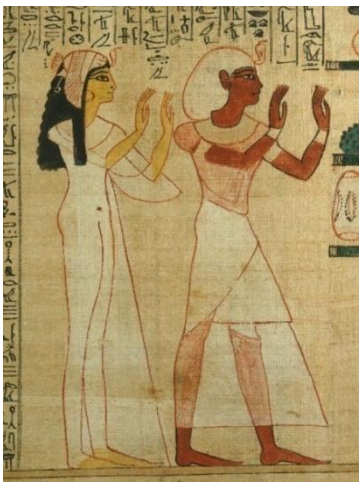

Figure 1: Costume of Ancient Egypt (Detail from the Book of the Dead of Nodjmet)

Figure 2: Shang dynasty (1600-1046 BC), costume, China

Figure 3: Ancient Greece, woman wearing chiton dress, sculpture

Figure 4: High-ranking, court dress of the Heian period (794-1185 AD), Japan

From that moment on, two cultural sides developed their costumes following two different paths that were guided by the religious, philosophical an social rules that were alternating in time.

Through centuries West costume changed shapes and silhouette with the help of developed tailoring techniques that were based on their philosophy - that always sought for new solutions, but the color remained unchanged for centuries. Color palette of the West is always comfortable, using unmistakable combinations of colors, easy to clean and easy to match with the rest of the wardrobe.

Meanwhile, on the East with the help of their point of view of life they quickly found unusual solution regarding the shape that was mainly planar, made out of basic geometrical shapes triangle, square and rectangle, that gave freedom to the body to move lightly and to create spaces between the body and garment- and that remains the main objective of fashion philosophy of Eastern designers, even today. Considering those gaps between the fabric and skin and with those empty spaces, they are telling the story of the body that lies hidden from the eyes of the observer, in more mystical and exotic way than that of Western, tailored and fitted dresses that emphasized every attribute of the human body.

Silk roads

Silk fabric was first developed in Ancient China and played an important role in their culture and economy thousands of years. Silk fiber is thin but strong, produced by the silkworms in process of making their cocoons. It can be woven into a very soft and smooth fabric.

Legend gives credit for developing silk into a Chinese empress, Leizu (Hsi-Ling-Shih, Lei-Tzu), wife of the Yellow Emperor, around the year 2696 BC. Legend says that the idea for producing silk into fabric came to Leizu while she was having tea in the imperial garden. A cocoon fell into her tea and unraveled. She noticed that cocoon was actually made from a long thread that was strong and soft at the same time. It is said that she discovered how to combine silk fibers into a thread that can be woven into fabric. It is also given credit to her for inventing the loom that combined the threads into a cloth.
Textile made out of silk fibers was originally reserved for the Emperors of China and as their gift to others, as a sign of great appreciation. Because of the qualities it had, it spread gradually through Chinese culture then to rest of the regions of Asia and ultimately spread first to the many areas accessible to Chinese merchants and then soon to the rest of the World. It was in great demand, and became a staple of pre-industrial international trade. First evidence of the silk trade is the findings of silk in the hair of an Egyptian mummy of the 21st dynasty (around 1070 BC). The silk trade reached as far as the Indian subcontinent, the Middle East, Europe and North Africa. This trade was so extensive that the major set of trade routes between Europe and Asia came to be known as the Silk Road.

Silk Road is a network of trade and cultural transmission routes, interaction connecting the east and West by merchants, pilgrims, monks, nomads, soldiers and urban dwellers from China and India to the Mediterranean Sea during long period of time. The name for this route started to become in use during the Han dynasty (206 BC-220 AD). Sections of that route were expanded in time, and Chinese even expanded the Great Wall of China to ensure the protection of the trade route. Trade on the Silk Roads was a significant factor in the development of both civilizations, East and West, opening long-distance, political and economic relations between them. Though silk was certainly the major trade item from china, many other goods were traded; religions, philosophies, technologies and arts, thus carrying out cultural trade among civilizations along its network.
The Emperors of China wanted to keep knowledge of sericulture a secret so China would maintain monopoly over this luxury fabric. But the obsession for this textile, that reached people all around the world, soon uncovered the process of producing silk fibers.

Eastern influence on European costume

Voyages, early discoveries and trades through the Silk Roads, gave Europe a view of a secular heaven-on-Earth, a land never to inhabit, a perfect "other", land vested with exotic mystery - Orient (lands that Europeans call "East": Asia, Middle East and by some opinions even North Africa. Also these lands are called Orient). The allure and inscrutability attributed to the East is, in fact, West`s failure to achieve full comprehension. Eastern philosophy and culture always challenges the Western mind, and makes Western feel their culture is incomplete. Therefore, West will always seek for that missing part and see it as exotic and far, thus creating a void and missing a realistic view of the Eastern culture.
This need for decorative and exotic things is first evident in costume and textiles. In the seventeenth and eighteenth centuries, the Western wardrobe was vastly enriched with textiles from the East that brought new pattern and possibility to Western dress.

Figure 5, 6, 7: Materials and exotic floral patterns that show European costume of the 18th century, influenced by Eastern ornaments and fabrics

In the nineteenth century, the era of industrial revolution, World Exibition and colonial exchange brought object categories to the West, such as - silk from China, -Shawls from India and after 1854. - Kimonos from Japan, because in 1854. Japan opened the gates to the rest of the World, after being closed and hidden for centuries.

At the turn of the millenium

At the end of the nineteenth century great discoveries and technological revolution gave the world something to think about. With the invention of photography that was able to capture a moment of reality on two-dimensional surface, artists could1t compette anymore. They started asking questions about the significance of their filed of work. Was art becoming obsolete? What are we suppose to do? Is the main objective of art to immitate reality? Meanwhile things happend that helped them unravel that questions without an answer. With much more increased travelling accros the Globe, and colonial exchange Europe, or the Western civilization came accross with secret Eastern world that was hidden, or forgotten.

The Great Exhibition ("Great Exhibitions of the works of industry of all nations"), or sometimes referred to as the Crystal Palace Exhibition, because of the temporary structure in which it was held in Hyde park in London in 1851. It was the firs in a series of World`s Fair exhibitions of culture and industry that were to become popular in 19th-century. It was a window to the world, some might say that was the beggining of globalisation. Everything in one place, so people can observe and compare other cultures through their art and accoplishments.
Artist, influenced by the different aspects of art that far away countries represented, found a solution to this dead end they seemed to ended up in. Art was not just a reflection of reality, particulary eastern artefact represented some other way of second nature, displaying emotion, and attitudes with showing

distorted reality with illustrated portrails of nature. Exotic cultures had a great impact on moder painters. Very often you colud hear Pablo piccaso himself say that African art influenced his mature works.

This was felt in all aspects of art, where design soon gane the position it desirves as an art form. Costume of Western civilization came through greatest revolutions that ever happened until than. Tailored dresses and thight corsets will soon be forgotten and nothing will ever be the same in costume desig, because it will be introduced to draped and loose wardrobe of the east, that gave the body all freedome it needed and all the beauty it deserved.

Figure 8,9: Changes that happened from 1900.(on the right) till 1920. (on the left) in fashion is evident in comparison

As seen on the photographs from 1900's and 1920's show, changes that costume went in just 20 years is exceptional. From tight corsets - that threatened the health of many women, some even resulted in death, and tailored tightly around the body, to the loose dresses that fit all, that are comfortable and movement-free. For that to happen, whole Western costume designs had to be inspired with something great - and it was! Among other things, the influence from the Eastern costume opened doors for modern-wear, loose dresses, comfortable, but at the same time very sensual and exotic wear-all a modern woman could ask for.

From that moment, fashion was born. Trends were changing, and because the industrialization was growing so fast, fashion was able to meet every challenge along the way in the 20th-century.

CONTEMPORARY FASHION AND INFLUENCES FROM THE EAST

Eastern designers setting the tone for Avant-garde movement in fashion

Fashion became more and more important in 20th-century, especially with the rise of Cinema, through means of which actresses promoted new fashion looks and new life styles. Haute couture became necessary part of their high life, and a thing that ordinary woman can only dream of.

Fast growth of industrialization made possible for women all over the world to wear fashionable clothes with changing trends from season to season for an affordable price. This had it's up and down sides; while fashion trends were more accessible to everyone, the quality couldn't compare to the wardrobe of haute couture from the first half of 20th-century. Fashion lost the art form that it once had, and fast way of life was partially a reason for that. But on the other hand it seemed that what West needed once again was the touch of a hand from East in making art out of clothes.

Japanese designers started engaging in fashion, with Kenzo Takada and Issey Miyake being the first two out of a few that changed the course of fashion. Once again winds from the East brought new ideas and new philosophy when it came to creating clothes, finding their meaning and try purpose. Rei Kawakubo, the woman behind the *Comme des Garçons label, followed his path, coming in Paris in 1981. In the same year Yohji Yamamoto presented his first show, also held in Paris. Their design combined the simple traditional form of the kimono cut of their homeland elements that were ever present in their ideas, but also for some of them unconventional colors and prints that blinded the public (Kenzo) and on the other hand disturbing, philosophical fashion which deliberately confronts and questions Western ideas of a perfect body (Yamamoto and Kawakubo).*

They showed to the world that dark side of fashion that became so essential for the people of West world. It gave the individual the needed androgynous, intellectual look that tells a story about inner improvement; in place of a tight, tailored exterior that only speaks about material world.



Figure 10, 11, 12: Japanese designers: Yohji Yamamoto, Rei Kawakubo for the label Comme des Garcons and Issey Miyake

Their design opened Western minds regarding the Dress, and what fashion really means. It is not just a series of trends that alternate every decade, years or season. Fashion is a form of art that people get so infatuated by that it has to become accessible to all, even in lower quality and price.

Eastern garments in everyday fashion

Eastern way of thinking, aesthetic and technology in decorating garments implemented itself unnoticed into every-day life and wardrobe. Without even realizing it, today we wear so called "flip-flops" that originated from Japanese traditional -Zori and -Geta shoes, bathrobes in form of a -Kimono, shirts that have Cheongsam-like collar, a garment originally from China, or one-sleeve dress that looks a lot like Indian-Sari.

CONCLUSION

It is apparent that costume and fashion had their course in western civilization, constantly changing form of the clothes, and trying to find the perfect one by improving tailoring techniques over the years. One important thing comes to mind when thinking about the constant change in Western costume-the color never changed, it was always comfortable and overall you can just see it as grey. On the other hand Eastern costume had established the form long ago, that was unchanged for centuries when it comes to cut and form, but when it was placed on a human body -limitless possibilities of form emerged. It is exactly that same principal that modern Eastern designers represent in their work, even today with a variety of Chinese designers setting trends all over the world. In conclusion, East has been a great influence on every revolution West population had regarding costume, tailoring and fashion trends. West has always needed that Eastern influence. Being so much different, only when

cooperating with each other - miracles are possible, and the ones that contemporary fashion achieved with Western tailoring techniques and technology and Eastern way of thinking prove that.

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STUDENTS PAPERS

PATTERN MAKING OF ONESIE UNISEX JUMPSUIT

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ABSTRACT

"Onesie" is a word that is used for comfortable working clothes for adults. This article of clothing belongs to the category of clothing intended for rest and sleep, so it is most commonly made of comfortable cotton knitted fabrics. This work refers to "TuTa" by Ernest Michahelles - garment whose concept is based on the principle of geometric tailoring, and whose form is irresistibly reminiscent of the onesie. The idea is to innovate and redesign Michahelles "TuTa" which becomes a unisex one-piece jumpsuit. This paper focuses on the pattern alterations that need to be made before the garment production in order to fulfill functionality and consumer satisfaction of a newly designed onesie unisex jumpsuit.

Key words: basic pattern block, pattern alteration, onesie, one-piece pyjama, garment sampling

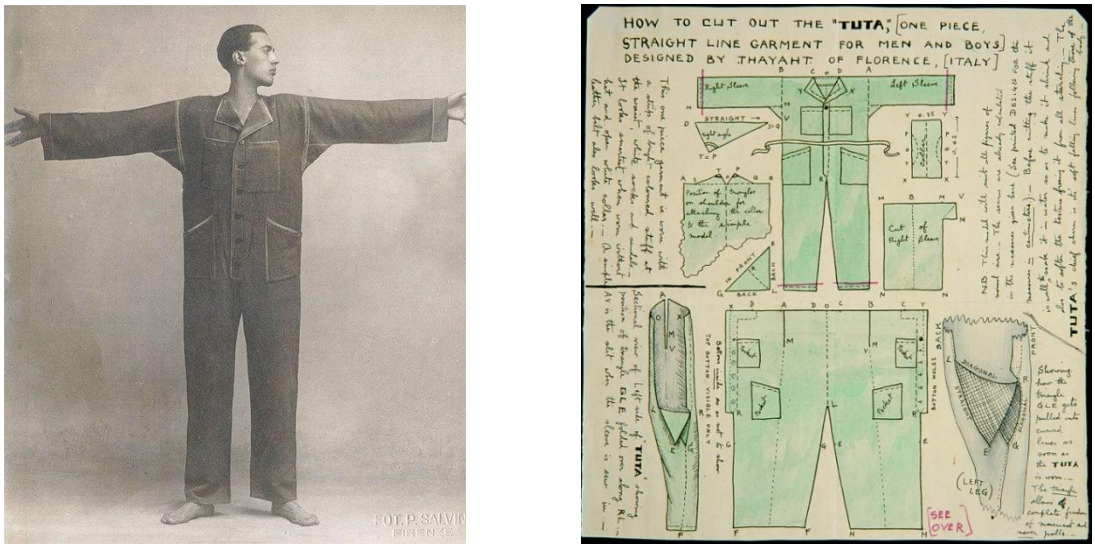
INTRODUCTION

Pattern making is the process that involves the design and development of two-dimensional templates used for garment production. The literature provides a number of published pattern making methods (Kwong, 2004, Wisegeek, 2014, Ashdown, 2011, Musilova, and Nemčekova, 2014, Ujević et al., 2000, Jansen, and Rüdiger, 1990).
According to the Oxford Dictionary, the term Onesie is the most commonly used word for one piece leasurewear first designed for infants, but to date used also by adults. The word probably derives from "onesies", a brand that designs and produces clothing for infants. The basic stylistic feature of this clothing is that is made from cotton knitted fabric, which is often used in the design and production of casual clothing and sportswear. Onesie is primarily intended as sleepwear or as leisurewear, but has also gained significant popularity as part of street fashion. Nowadays, the apparel Onesie is worn by men and women of all ages as a comfortable and affordable clothing. It is also worn by celebrities, sending a message of a brave and bold fashion expression deviously influenced by comfort (Oxforddictionaries, 2014, Richard, 1998, Steele, 2005, Lupano, Vaccari, 2009, Dailymail, 2014, Thefashionpolice, 2014, Onesiewarehouse, 2014, Wikipedia, 2014).

Figure 1: The designed Onesie Unisex Jumpsuit (student drawing)

Flexibility, personality and professionalism are new market demands (Richard, 1998, Steele, 2005, Lupano, Vaccari, 2009).The realization of the Onesie was accessed through one of the basic principles of design this was the representative appearance of the garment. But beside aesthetics, the focus was given on the apparel functionality.

The idea was to revitalize the apparel known as *„TuTa“* first designed by Ernesto Michahelles. Michahelles worked under the pseudonym Thayaht, a concept taken over from Giacomo Balla. The concept is based on the tailoring of objects made by geometric principles. He tried to innovate and create unisex clothing that is based on the principle that the shape and volume are following inherent structural principles. *"Tuta"* from the year 1918 is designed as a cheap and uniformed clothing – one-piece suit that for basic block simplicity can be tailored at home (Richard, 1998, Steele, 2005, Lupano, Vaccari, 2009, Boccioni, and Brik, 2014).



a) b)

*Figure 2: „TuTa“ designed by Ernest Michahelles: a) Thayaht with the „TuTa“, b) Explanatory drawing (*Boccioni, and Brik, 2014)

The aim was to provide clothing that maximizes the freedom of body movement, and an active lifestyle as well as physical ideal.

EXPERIMENTAL

This work shows pattern alterations that that are performed before the garment production in order to fulfill functionality and consumer satisfaction of a newly designed onesie unisex jumpsuit. The first step was to investigate the procedure of traditional methods and select the appropriate basic flat-block pattern. In the second step, the basic fabric properties for the designed garment had been selected. After that, primary linear body measurements have been taken over the body surface that can fit male and female with similar body dimensions and auxiliary measurements have also been calculated. Linear distances and curves were used to draft the basic pattern block based on mathematical foundation and approximation, Figures 3 and 4 (Kwong, 2004, Ujević et al., 2000, Jansen and Rüdiger, 1990).

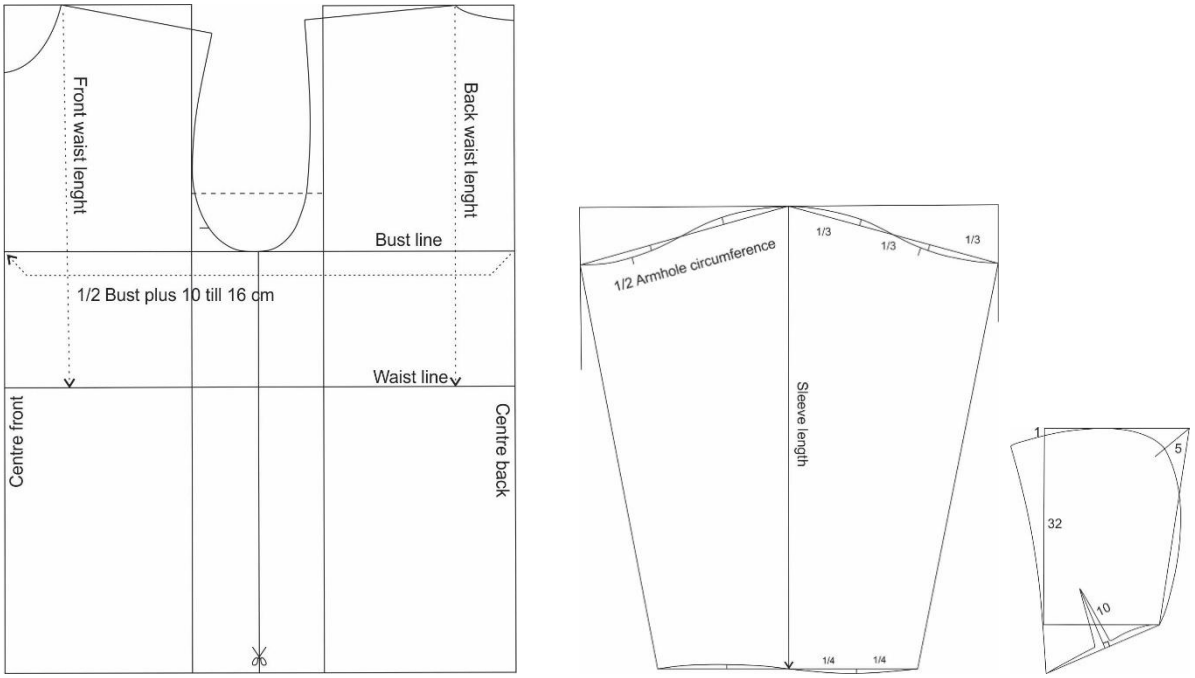


Figure 3: Basic block pattern of men's shirt: front and back part, sleeve and hood (Ujević et al., 2000, Jansen and Rüdiger, 1990)

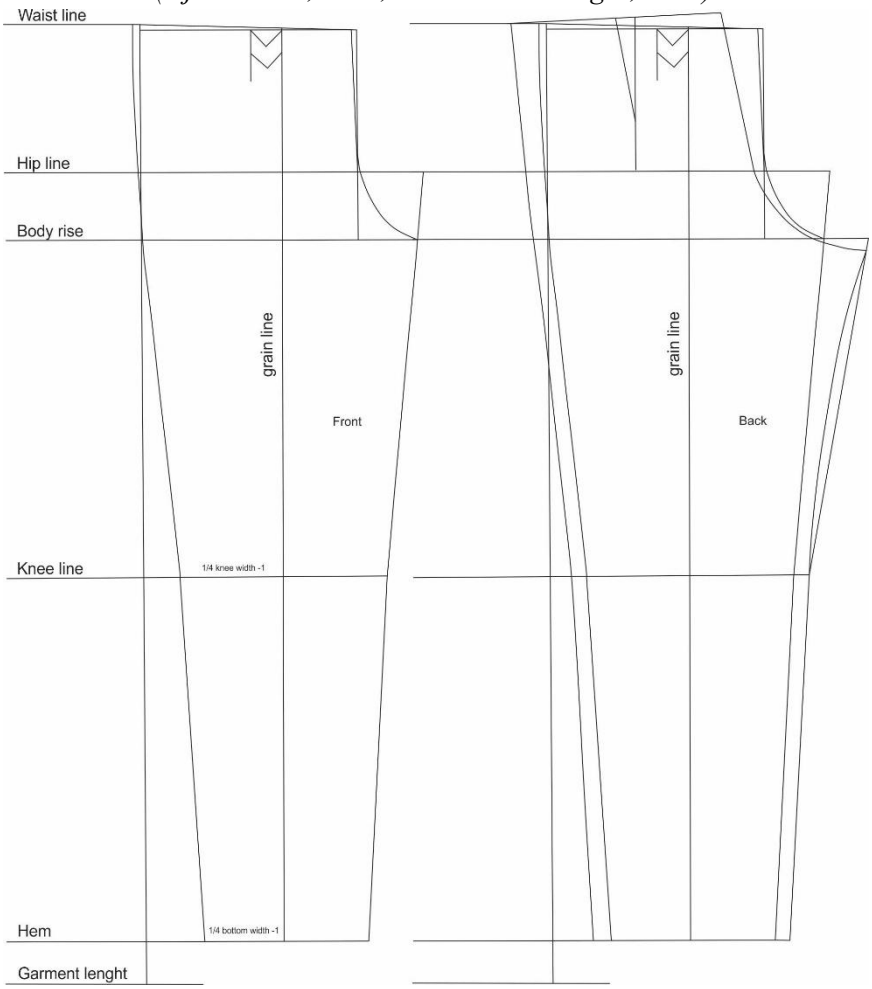


Figure 4: Basic block pattern of men's trousers: front and back part (Ujević et al., 2000, Jansen and Rüdiger, 1990)

PATTERN ALTERATIONS

The garment alterations (Figure 5) have been made from the basic pattern block presented in Figure 3 and 4.

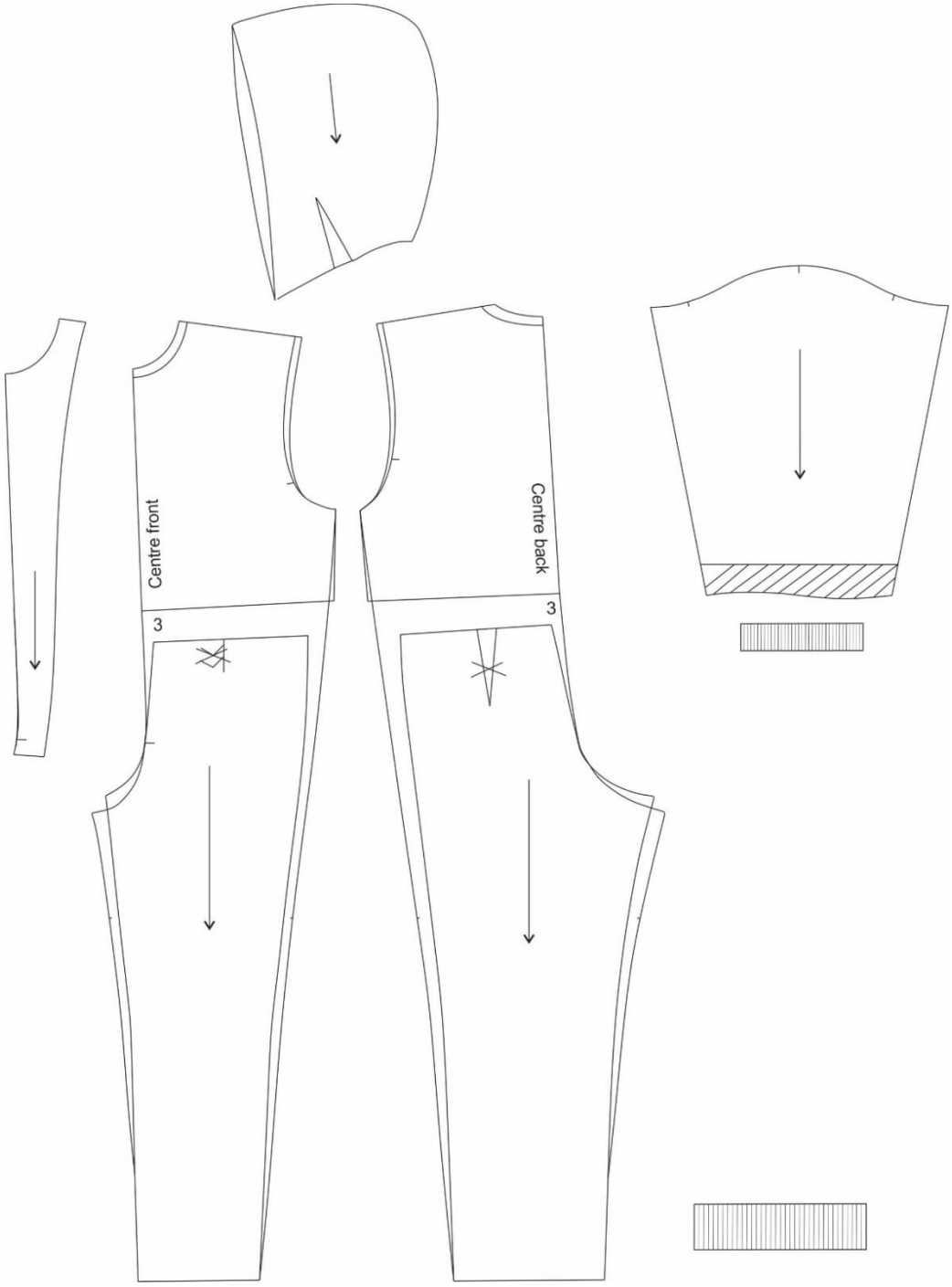


Figure 5: Pattern alterations from the basic pattern block shown in Figure 3 and 4. Additionaly, all pattern pieces needed for garment production are presented: front and back part, extended front facing for zip fastening, sleeve, hood, cuff and ankle ribs
Ujević et al., 2000, Jansen and Rüdiger, 1990)

FITTING TEST RESULT

After finishing pattern alterations, on all manually drafted patterns seam allowances have been added before tailoring. The Onesie was made using weft knitted rib fabric. Garment sampling has been performed in order to test comfort and functionality of the drafted unisex onesie jumpsuit.

CONCLUSION

The study has considered pattern alterations of a unisex onesie jumpsuit based on the selected traditional basic pattern block. After the pattern altering, a garment prototype has been made to check and refine the garment pattern. The garment sampling confirmed that the drafted pattern provided the desired comfort and functionality to the selected male and female individuals of similar body forms.

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JAPANESE HISTORICAL AND MODERN STREET WEAR AS AN INSPIRATION FOR FASHION COLLECTION

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ABSTRACT

The world of fashion has a long and varied artistic history. Trends change on a seasonal basis and often reflect the overall sentiment of culture at any given time. For example, in times of war or turmoil, feminine designs tend to become more popular to counterbalance all the preceived negativity. When there's international financial trouble, designes tend to be less over-the-top and many designers focus on more realistic designes. By contrast,in economic ''boom" times,designs tend to be very avant-garde and are more art pieces then functional clothing. Taking inspiration from both modern and historical fashion can be a great way to infuse something new and fresh in your designs.

This study shows the connection between traditional and modern Japanese clothing combined for creating fashion collection.

Key words: *Fashion,collection,inspiration,designe,tradicional,modern,japanese clothing*

INTRODUCTION

Designers find inspiration in everything they see. Looking true designers eyes world looks more complex and interesting.Taking inspiration from both modern and historical fashion can be a great way to infuse something new and fresh into your design. It is very hard to make clothing that is only inspired with certian period or modern wear and not copy it. To achieve it, designers carefully look at the overall scale of an outift, deeply observing and analyzing shapes and structure, fabrics and details used. When historical period is the inspiration it is possible to detect very interesting forms, glamorous costumes and some period trademarks, which reflect their origin and represent a concept of their own style.

When using street, underground and urban fashion as inspiration designer has a lot of freedom in expressing their own mind and creativity.

HISTORICAL PERIOD AS INSPIRATION

History and fashion have a lot in common. Historical inspiration is not just found in costumes but also in arhitecture, art, music, old tails and stories etc. Costume shapes can be bold and mind-blowingly wild, or clean and minimalistic like Japanese traditional cloting. Over the past 30 years, fashion designers have considered hisotorical period as guide line in designing textiles and clothing, embracing new forms and materials based on historical resarches.
A good designer must be a constant observer, a creative thinker and a good listener to understand the style, composition, balance, aesthetics and human emotions and to understand the psychology of vision and perception.

Designers can also combine two periods in one inspiration. For this collection, I used two historical periods Japanese ''kimono*"(Image 1,2)* and Roman „toga''*(image 5).*

Image 1:Japanese kimono for men

Image 2:Japanese furisode kimono for women

On image 1 Japanese kimono for men is shown. Kimonos are T-shaped, straight-lined robes worn so that the hem falls to the ankle, with attached collars and long, wide sleeves. Kimonos are wrapped around the body, always with the left side over the right (except when dressing the dead for burial) and secured by a sash called an *obi*, which is tied at the back. Kimonos are generally worn with traditional footwear (especially *zōri* or *geta*) and split-toe socks (*tabi*). Kimonos are traditionally made from a single bolt of fabric called a *tan*. *Tan* come in standard dimensions,about 36 centimetres wide and 11.5 metres long and the entire bolt is used to make one kimono. The finished kimono consists of four main strips of fabric two panels covering the body, and two panels forming the sleeves with additional smaller strips, forming the narrow front panels and collar.Men's kimonos are usually one basic shape and are mainly worn in subdued colors. Formality is also determined by the type and color of accessories, the fabric, and the number or absence of *kamon* (family crests), with five crests signifying extreme formality. Silk is the most desirable, and most formal fabric. Kimonos made of fabrics such as cotton and polyester generally reflect a more casual style.

On image 2 you can see Japanese kimono for woman called furisode.The typical woman's kimono outfit consists of twelve or more separate pieces that are worn, matched, and secured in prescribed ways, and the assistance of licensed professional kimono dressers may be required. Called upon mostly for special occasions, kimono dressers both work out of hair salons and make house calls. Choosing an appropriate type of kimono requires knowledge of the garment's symbolism and subtle social messages, reflecting the woman's age, marital status, and the level of formality of the occasion.
A furisode (振袖, lit. swinging sleeves) is a style of kimono distinguishable by its long sleeves, which range in length from 85 centimeters for a kofurisode (小振袖), to 114 centimeters for anōfurisode (大振袖). The sleeves are attached to the body of the kimono only for a short distance; the inner edge is open for the rest of its length, allowing the lining to show on the inner edge (or both, if the sleeve is left open on the outer edge as well). Furisode are the most formal style of kimono worn by unmarried women in Japan. The furisode is made of very fine, brightly colored silk, and is commonly rented or bought by parents for their daughters to wear when celebrating the year they turn 20. By wearing a furisode, a young woman signifies that she is both single and a legal adult, and thus available for marriage. In this sense, a furisode might be likened to the formal gowns worn by debutantes in the West.

Image 3:Japanese kimono inspired men fashion by Louis Vuitton

Image 4: Japanese kimono belts inspired fashion by Zac Posen

In image 3 and 4 it is showed how kimono can inspire different designers.

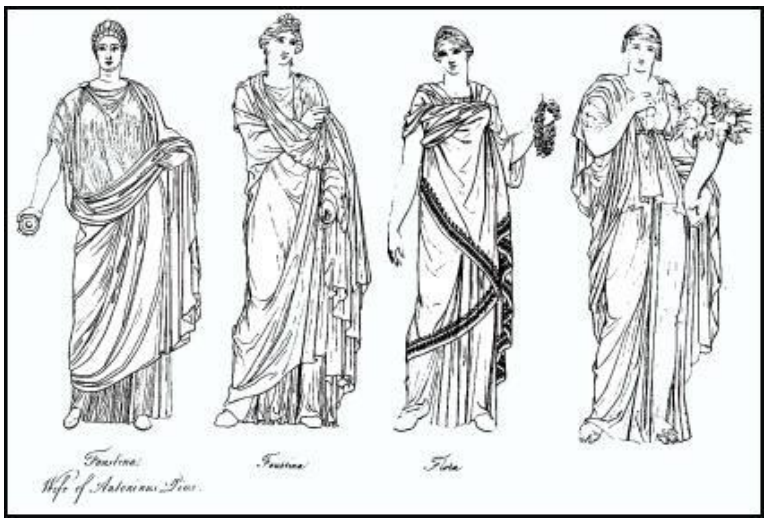

Image 5: Different types of Roman toga

The toga, a distinctive garment of Ancient Rome, was a cloth of perhaps 20 ft (6 m) in length which was wrapped around the body and was generally worn over a tunic. The toga was made of wool, and the tunic under it often was made of linen. After the 2nd century BC, the toga was a garment worn exclusively by men, and only Roman citizens were allowed to wear it.

The toga was based on a dress robe used by Rome's northern neighbours, the Etruscans. The toga was the dress clothing of the Romans, a thick woolen cloak worn over a loincloth or apron. It is believed to have been established around the time of Numa Pompilius, the second King of Rome. It was taken off indoors, or when hard at work in the fields, but it was considered the only decent attire out of doors. Free citizens were required to wear togas because slaves would wear tunics. They wore them because the tunic was a sign of poverty and would let them work with ease.

Image 6 : Toga inspired dresses

INSPIRATION FOR THE COLLECTION

For inspiration for this collection are used diversity of many elements. Next to kimono and toga Japanese street style specificly Harajuku fashion is used.

Harajuku is part around Harajuku station in Shibuya Japan, where Harajuku street fashion was born in early 90's. This style is part of Japanese street fashion and it is mostly popular with teenagers and young people. It includes variety of different styles like: Lolita, Visual kei, Ganguro, Gyaru, Decora, Kawaii, etc.There are many designer that made inpact on this style (Vivianne Westwood, Jean Poul Goultier), but before everything creativity and attitude of individual person. Because of this is it also known as fashion of young. Harajuku fashion started as a way to rebel against fashion and „mold'' that was presented to the wide masses. But afterall it become part of fashion, but free fashion.

For this collection focus is more on „rock'' and „cold'' part of this style and not so avant-garde. It is interesting how there is noticeable conection between tradicional and modern japanese fashion (images 7, 8, 9 and 10).

Image 7: Harajuku Tokyo street fashion

Image 8: Harajuku Tokyo street fashion

Image 9:Harajuku Tokyo street fashion

Image 10: Harajuku Tokyo street fashion

Every good and complex inspiration should have few basic elements: shape, fabrics that will be used, color palet, structure, etc. All this elements can be found in one object or making inspiration from many different parts of few objects (mood board).

MODEL DESCRIPTION

Analyzing the inspiration-In this colection shape is combined with two very diferent but also very similar shapes, Japanese and Roman tradicional wear. Japanese kimono for men (look image 1 page 2), that has very clean and straight lines and it is layered, Japanese kimono furisode for women (look image 2 page 2) where for this collection focus is only on sleeves since they are long and mysterious and Roman toga that represents draping, but the figure is very similar to kimono. Materials that are used are heavy and modern with warm colors and animal print.

Image 12 kint material

Image 13 Black leather material

Image 14 Showes animal

Image 15 Fur material

Model sketches

CONCLUSION

In this paper the relationship between historical epoch and costume with fashion design is described. From the work, we can conclude that costume and fashion are very closely related and that many famous designers were inspired by the historical epoches. By using Japanese tradicional clothing, Roman toga and Japanese Harajuku fashion, the collection was resuleted as undergraound, street, modern style. The clothing from the collection, presented in the paper are for everyday, casual wear and are bold and chic.

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SHIBORI – OVERVIEW OF TRADITIONAL JAPANESE FABRIC DYEING METHOD

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ABSTRACT

In this article the author presents traditional Japanese textile material dyeing technique. Shibori is the oldest dyeing technique used for different textile materials to produce clothing and interior articles. The history of the technique, materials used to dye, the influence of colour on the design, tools to perform dying and several types of the dyeing method are described in this article.

Key words: shibori, dyeing, textile material, design of textile materials

INTRODUCTION

Different textile material dyeing methods are known. *Shibori* is the one of them. This is Japanese traditional textile material dyeing method and the oldest clothes died using this method are dated by 8th century. From the early beginning the materials dyed using *shibori* method were used differently – for clothes of royal family, belts, kimonos, tunics, scarves and others. *Shibori* method uses tying, twisting, sewing, and compressing of the textile material to perform resist dyeing process. Endless number of *shibori* techniques exists to create unique designs on the material. In this article some of the techniques, tools and dyeing process will be described.

HISTORY

Dyeing is the one of the oldest methods to decorate textile materials used in many parts of the world: Southern America, Africa, Close East, China, India, Indonesia and also in Japan. As it is known, textile materials were died in Japan already 1000 years ago and great methods were created to obtain fabrics with marvelous designs.

Various forms of resist-dyeing techniques have been used all over the world for centuries, but no culture has perfected it quite like the Japanese. In Japan, the earliest known example of cloth dyed with a *shibori* technique dates from the 8th century. It is among the goods donated by the Emperor Shomu to the Todai-ji in Nara. Natural indigo dye was primarily used on cotton and hemp fabrics.
Japanese *Shibori* has a lot of different techniques and there were developed from generation to generation. After Kamakura period, various *shibori* dyeings were used for clothes of Samurai. '*Tsujiga-hana'* which was popular in the last years of the Muromachi period was worn by ladies and children from Samurai society, young men and military commanders.
In Edo period, there were high-class *shibori* on silk fabric in Kyoto, and ordinary-class *shibori* on linen and cotton fabric with indigo in Arimatsu, Narumi, Bungo, and Takase. Kosode dress with '*Kanoko-Shibori'* of Kyoto was worn by women and high placed Samurai. After the middle of the Edo period, many new advanced techniques were developed, and especially a technique called '*Honza-Kanoko'* which ties a fabric without drawing a design and a *kanoko* needle and with only the sensations of the fingertips required elaborate and high skills.

TOOLS TO PERFORM SHIBORI DYEING

Shibori is usually the combination of different dyeing techniques, therefore work process can be more or less complicated. Several simple tools are needed to perform tying and stitching of textile material. Cotton thread, wire is also good for tying, elastic bands can be used and a long fine needle is the best

for stitching. Wooden tools in a shape of squares and three-angles are also needed to compress the textile material. Wooden blocks can have different shapes, size, thickness and depends on the pattern which has to be created. Different kind of poles is used in pole winding and wrapping techniques. The poles can be longer and shorter, different size and thickness, made from metal, plastic and wood. Drain pipes and a wooden broom handle can be used as poles, too.

Other materials needed to perform dying process are: different size sponges, brushes, newspapers, a steam iron, a piece of cloth to clean the work surface, a waterproof marker, vellum to copy designs, a ruler, a pen, an eraser. Compasses, rulers, oval bowls can be used to created circles for *karamatsu shibori*. Scissors are needed to cut fabric and templates. The author S. Mandy says in her book: "protective clothes – a plastic apron, rubber gloves, a protective mask is necessary as work process is performed using different chemicals and dyes" [2].

Dyes and auxiliary materials

It is very important to choose the right dye for the dyeing process. Cellulose fibers, such as, cotton, flax and artificial silk can be dyed with reactive dyes, while protein fibers – silk and wool have to be dyed with acid dyes. Reactive dyes can be used also for silk, however, the colour will not be enough resistance.
A liquid detergent is very good to wash the fabric before and after dyeing, also performing multi-step dyeing. The detergent have be used in small portions as it is very concentrated [2].

Psychology of colour and combinations of colours

Colour is phenomena which is very important in the human life. The colour was object of interest already from antique times [4]. Colour creates certain effects - psychological and physiological. Numerous scientific researches have showed that every colour has its psychological significance and character. Endless number of colours exists. Also it is known that colour can affect us to react positively or negatively. The colour can be the reason why we choose certain article. Warm and cold colours exist. The warm colours are: yellow, red, orange and cold colours are: blue, violet, green. The white and black colours are neutral.

In Asia the dyeing with natural pigments are traditional already many centuries. Specialists think that dyeing with natural pigments still has great potential and sometimes artificial dyes can be successfully replaced with natural dyes [5].

To perform dyeing process certain knowledge about dyes, the use of dyes, derivation of dyes, dye mixing and combination of dyes are needed. Many people use different cards with great number of colour nuances to calculate amount of the dye and additional substances used. Violet can be mixed with cold colours, such as, magenta and ultramarine blue, while warm colour orange can be mixed and combined with turquoise till yellow. Grey and black can be mixed with dark blue and chestnut brown. The samples of colours are seen in figure 1.

Figure 1. Sample of colours [2]

As on the paper, also on the textile material, every tone of the colour can be changed to get stronger or lighter tone, also dyeing textile material tone of colours can be obtained. On the figure 2 the fabric in blue colour tones got dyeing wrapped on the pipe is showed.

Figure 2. Colour effects [2]

Harmonic colours are, for example, blue/ tirkize, gree or magenta/ violet/ blue. An-traditional effects can be obtained mixing opposite colours. Violet and gold colours are combined on the figure 3.

Figure 3. Colour effects [2]

TYPES OF SHIBORI DYEING

Endless number of tying, compressing, refracting and bending of fabric exist to perform *shibori* dyeing method. Every kind of mechanical impact to fabric gives different pattern and it is also

dependent on the type of the material used. The technique used is dependent on desired pattern and properties of the fabric.

Tying or *kumo shibori*

Tying or *kumo shobori* is one of the simplest and oldest methods to decorate fabric. Using this technique the time can be saved as material is folded two or more times and then tied [2].

Some authors accent that the shape of pattern is dependent on the shape of the fabric, tension of the thread, while setting, distance and quantity of the thread influence penetration of the dye. Tying principle limits the shapes of pattern obtained – from circles to squares with rounded corners [1].

On the bases of it we can make the conclusion that *kumo shibori* is the technique in which the thread or rubber string by which the fabric is tied influence penetration of the dye. Strong thread, wire or raffia instead of elastic band can be used.

The sample of work process using beans, small rubber strings and the ready dyed fabric can be seen on the figure 4. The beans are placed on the fabric and tied with the rubber, after the fabric is dyed. After the drying the fabric, the rubbers and beans are taken off. The places on the fabric where rubbers were fixed stay undyed.

Figure 4. Tying for kumo shibori [2]

All design possibilities increasing or decreasing tying units are used in Japan. Large motives of circles were used on kimonos.

Stitching

Stitching is one of the *shibori* methods and the name already says that the fabric is stitched and then dyed. This kind of *shibori* was mostly used in Japan, however, also in other places it was popular, too[1]. The main stitch used in shibori is the simple running stitch. After the stitching of a fabric is completed, the cloth is drawn into tight gathers along the stitched thread(s) and secured by knot. It is then dyed. The cloth within the gathers is protected from the dye.

The shape which is pressed together and creased can be wrapped with a plastic bag which will not allow the dye to penetrate the fabric. The plastic bag has to be tied with thread. This way is obtained undyed motive. The best motives are those which have simple shapes. The motives are created firstly drawing them on the fabric in needed places. After that the stitching is performed along the lines. To create larger motives corks can be used which are fixed on the fabric and the thread is uptight around them. When the stitching is finished, the plastic bag is wrapped around the cork hidden in the fabric. The plastic is fixed tying with tread. The work steps are showed in the figure 5. After dyeing, the parts of the material covered with the plastic are un-dyed or weakly dyed. The sample of the ready dyed fabrics is seen on the figure 6.

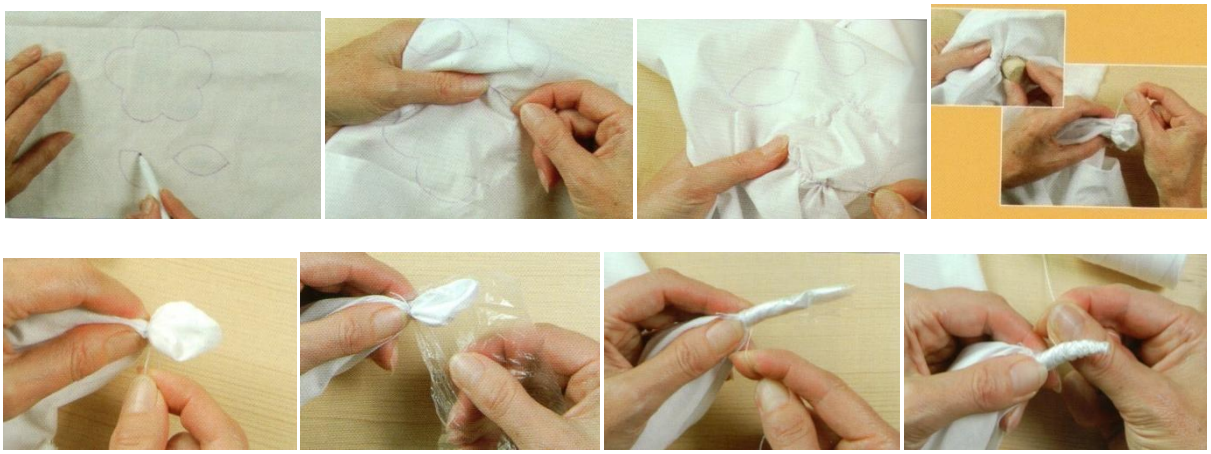

Figure 5. Work phases [2]

Figure 6. Complete dyed fabric [2]

Karamatsu

Using *karmatsu* tecnique circles and radial lines are created on the fabric. Half circles are drawn on the fabric, the number and size of the circles depend on the design. The design can be created only from two circles or more circles. The number of smaller circles can be placed in the one large circle. The number of inside circles and distance between them also depend on the pattern. Work process of making circles with equel distance between them is showed on the figure 7. The ready dyed fabric is seen on figure 8. Graphical way the work principles *karamatsu shibori* are showed on figure 9.

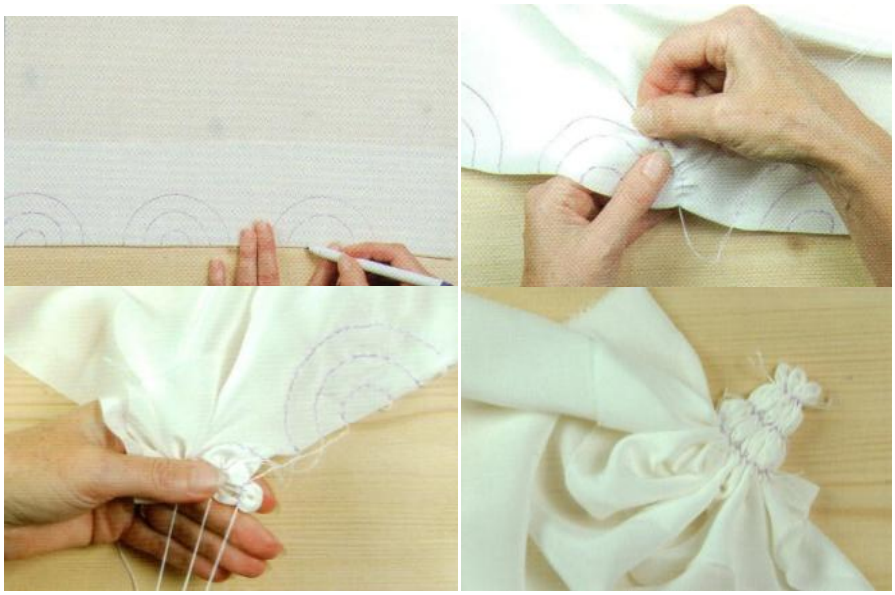

Figure 7. Work steps [2]

Figure 8. Dyed material

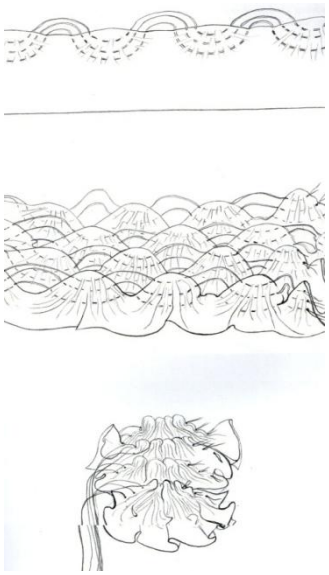

Figure 9. Work princips showd Graphical way

Wrapping on the pole

Wrapping the fabric around the pole is simple method and the best results are obtained working with silk fabrics. The fabrics of different size can be dyed, however, S. Mandy in her book says that the ideal dimensions of the fabric is 40cm X 152cm [2].

The material is warpped on the pole or any other pipe. After it the pipe with the fabric on it is put in the dye. To get special creased structure, the material has to be dryed keeping it on the pipe. On the figure 10 material is half un-warpped from the pole. This fabric had been dyed by several dyes.

Figure 10. The fabric warpped on the pole [2]

Arashi shibori

Arashi (storm) is the name given by the Japanese to resist-dye patterns created using an ingenious process of wrapping cloth around a pole, compressing it into folds, and dyeing it. Many of the resulting diagonal patterns suggest rain driven by a strong wind [7].

Figure 11. Arashi [6]

There are two types of *arashi shibori* dyeing method. In the first method the fabric is wrapped around a pipe at a diagonal. Once the fabric is wrapped, it is tied with twine at the base of the pole (figure 12).

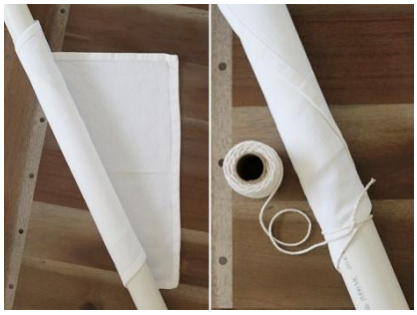

Figure 12. Wrappind of the material [8]

After it twine is wrapped around the fabric and after 6-7 wraps around the pole, the fabric is scrunched down. It is very important to tight the twine and the end. Wrapping is continued, scrunching and tightening until all the fabric is compacted. The knot is tied at the end above the fabric (figure 13).

Figure 13. The fabric before dyeing [8]

After the fabric is prepared, the dyeing and drying process is performed. Ready dyed fabric and its pattern is seen on the figure 14.

Figure 14. The fabric after dyeing [8]

5. WELL - KNOWN DESIGNERS WHO HAS USED SHIBORI DYED FABRIC

Many well-known fashion designers have used fabrics dyed with *shibory* method in their collections. A dress by Dior, and Tory Burch, as well as, a blouse by Cavalli, seen in the figure 15, has *shibori* patterns.

Figure. 15. a)Dior and his modern dress colored by shibori technique
b)Tory Burch showed a more ethnic take on the technique.
c) Just Cavalli mixed traditional Shibori with contemporary patching.

CONCLUSION

From ancient times people liked to decorated their clothes. The Japanese decorate clothes using *shibori* method from 8. century. The *shibori* is Japanese traditional fabric dyeing method. The name *shibori* has many meanings and covers different dyeing techniques. This dyeing method can be very complicated, depending on pattern created. It is used to decorate scarfs, scarves, kimono, tunics, belts, ties, pilowcases and different garments. Combining different colours difftent patterns can be created. Enfless number of *shibori* tying, pressing and stitching ways exist to dye the material and obtain different patterns. The dyeing can be performed with different dyes and it is very important to use the right dye fo every kind of fabric.

With the development of mechnical dyeing ways the hadmade dyeing is used less and less. Because of the specific of *shibori* method, it is still well known in the world. Today computer programs can be used to create designs similar to *shibori* motives, however they do not have the same value as handmade ones. Only handmade *shibori* can make unprognozable patterns and that is the real value of this old dyeing method.

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ANALYSING SPORTS BRA FEATURES TO DESIGN THE MOST SUPPORTIVE SPORTS BRA

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ABSTRACT

This essay identifies the crucial design features of commercial sports bras by evaluating the reduction of breast displacement during activities. Four women, with different breast and body types representative for aged24–40 years were studied while they performed activities either braless or wearing one of seven different sports bras. Three-dimensional movement of the breasts was derived by videoing the motion of breast markers attached at six different breast positions using a Vicon 3D motion analysis system. The breast displacement relative to the thorax was measured using a validated local ''thorax–breast 3D coordinate system''. The results showed that reduction in breast displacement was positively related to the gore height, shoulder strap width, neckline height and side seam depth. The study concluded that the most effective bras had the following features: compression type, short vest style, high neckline, slings, cross back, bound neckline, no centre gore, no wire, no cradle, no pad and a non-adjustable wide strap. Designers can use this study to develop more effective bras for physical active women.

Key words: sports bra, comfort, design

HISTORICAL OVERVIEW

There are different reasons why women and girls choose to wear a bra. Part of the reason is cultural. In oursociety, girls are taught they should wear a bra. Part of the reason, is that some women feel more comfortable wearing a bra. Another reason is because some women think they look better while wearing a bra. A push-up bra is an extreme example of a bra that supposedly forces the breasts to what is considered a more attractive shape. However, another common reasonfor wearing a bra is to minimize bounce. This is especially true for sports bras. In a questionnaire issued by the university 46% of a 2000 young girls said their breasts were a barrier to participating in sport[1].

In the 19th Century, women wore corsets to try to force the body into what was considered an attractive shape. In 1875, manufacturers George Frost and George Phelps patented the "Union Under-Flannel" a no bones, no eyelets, no laces or pulleys undergarment. In 1893, a woman named Marie Tucek patented the "breast supporter", the device included separate pockets for the breasts and straps that went over the shoulderwhich were fastened by hook-and-eye closures[1].

In 1913, the first modern brassiere to be awarded a patented was invented by a New York socialite named Mary Phelps Jacob. Mary had just purchased a sheer evening gown for one of her social events. At that time, the accepted undergarments were corsets, stiffened with whaleback bones and steel rods. Mary found that the whalebones poked out visibly around the plunging neckline and under the sheer fabric, so with two silk handkerchiefs and some pink ribbon, the first bra was invented.On November 3, 1914, she was awarded a patent for the "Backless Brassiere". Caresse Crosby was the business name Jacob used for her brassiere production. However, Jacob did not enjoy the business, so she sold the brassiere patent to the Warner Brothers Corset Company in Bridgeport, Connecticut for $1,500. The Warner Brothers Corset Company made $15 million dollars from the bra over the next 30 years. The undergarment name "brassier" was derived from the old French word for "upper arm". Her patent was for a device that was lightweight, soft and separated the breasts naturally. It should be noted that Jacob's brassiere design was intended to flatten the breasts and not enhance them. Her invention didn't even have cups. Without publicity, her brassiere business was doomed to sag and Mary sold her company to Warner Brothers Corset Company for just $1,500[2].

Ida and William Rosenthal went into business as the Maidenform Company in the 1920's as a protest against the notorious flat-chested flapper girls of the Roaring 20's. Ida was the actual inventor of brassiere cups and designed bras for every female figure from budding teens to the mature matron.In the 1920's, Ida Rosenthal was noticed that a bra that fit one woman did not another woman of the samebra size. This is because women have different sizes of breasts. Then she invented cup size which we had completed meanwhile and we still use today[1].

In the other side, sports bras were invented in 1977 by Hinda Miller and Lisa Lindhal, two Vermont joggers who were tired of their breasts bouncing witheach step. One evening in Lindhal's home, a male friend pulled a jock strap out of a laundry basket and held it to his chest, saying, "Look, a jock bra." They made the first sports bra by sewing two jock straps together[2].

For many women, both young and old alike, the bouncing that occurs during physical activity can cause discomfort, this in turn can reduce the desire to exercise. Fortunately there is a simple solution… invest in a quality sports bra. The only challenge is to find one that works for your young athlete. The snug fit of a sports bra relieves the strain on ligaments and eliminates excessive motion by compressing the breasts. Excessive bounce can be very uncomfortable. Another reason some women or girls are concerned about bounce is because it can cause unwanted attention from men or boys. This is especially a concern for girls at the junior high school and high school level who have co-ed PE classes[2].

However, surprisingly, currently there is no established method for measuring either how much a given bra minimizes bounce, or how much a given woman's breasts bounce. Today, bras are only labelled according to bra size and cup size, neither of which give any indication of how much the bra minimizes bounce. The only way a woman or girl can find out how much a given bra minimizes bounce is to purchase the bra, wear it while playing sports, and then see how much it minimizes bounce. They are often disappointed. We have a situation similar to that which existed before the invention of cup size, in which women had no way of knowing ahead of time if a bra fit. A major problem is that there are many bras on the market that look like sports bras, and are sold as sports bras, but don't do very much to minimize bounce. Also, many women have need for a bra that minimizes bounce even if they don't plan on playing sports-this could be the secretary who has to run up stairs, or person who has to run to get somewhere on time. It would greatly benefit women and girls if bras could be labelled according to how much they minimize bounce[3].

Nowadays, sports bar are made of high tech fabrics, because they work better than cotton. There are usually two types of sports bra on the market:

Compression Bra

They compress the breasts against the chest and typically look like crop tops. They are designed to support breasts and minimise bounce during exercise, and are considered perhaps more suitable for females with smaller or medium bust size.

Encapsulation/Harness Bras

Each breast is supported in a separate cup like a traditional bra. These can also look like a crop top on the outside whilst inside maintaining the features of a supportive bra. Due to their sturdier construction they are considered to be more suitable for females with larger bra size.

The compressionbra is designed to restrict breast movement by flatteningthe breasts against the chest wall, while the encapsulationbra contains two moulded cups which supporttwo separated breasts.The compression bras havegenerally been thought to be more effective forwomen with smaller breasts (cup sizes A or B), whilethe encapsulation bras were considered to be moreeffective for women with cup size C or above.

IDENTYFING MORE SUPPORTIVE SPORTS BRA DESIGN RESEARCHES

Previous research has shown that sports bras are effectivein controlling breast movement during running activities. Inappropriately designed and/or ill-fittingbras with insufficient breast support can lead to musculoskeletalpain, upper limb neural symptoms, deep bra furrows and discomfort. Sports bra designersinvariably use stiff fabric around the breasts togetherwith tight shoulder straps to minimize excessive breastmovement. However, there is little published informationon the critical featuresand the interaction of thecomponents within a sports bra and how to improvethe design of sports bras to control breast movement.Also, previousstudieshave investigated the effectiveness of brasmade from different materials with different styles[4].

This essay, tell us about research which usesa standard and valid breast local coordinatesystem for measuring the 3D breast movementrelative to the thorax is required to enable comparativeevaluations to be made. The aim of the research which I am writing about was to determinethe functional design features of more supportivesports bras. A 3D motion study using a 3D local coordinate system was carriedout to investigate systematically the bra factors thataffect breast movement during activities. The objectiveswere to investigate the 3D breast movement under different support forces that provided 10 specific bra componentsduring various activities and toevaluate the effectiveness of different bra features onthe reduction in breast movement.Most studies have focused only on the vertical movement of the breast,because it has beenreported to be greater than the horizontal one, but the breast isa visco-elastic deformable body whose movement in 3Dspace is complex, the motion of breast in only the vertical direction is probably insufficient to describethe whole breast movement[4].

In this study-I write about, measuredbreast movement, relative to the thorax was in *vivo*by using a newly developed breast coordinate system (BCS). The system was used todefine the 3D displacement of six markers on differentbreast quadrants of four woman subjects wearing differentsports bras or no bra while they performed three different activities: walking, running and stepping. The results were analysed statistically to determinethe effectiveness of bras in reducing breastdisplacement. In this particular experiment subjects were four healthy female casual runners aged from 24 to 40 years.The procedures to be employed were carefully explained to the subjects before they signed the informed consents to participate.The inclusion criteria were healthy and premenopausalwomen. To avoid the influence of abnormal hormonalconditions on the connective breast tissues, there were subjects who were excluded if they were breast feeding or pregnant, or if they have had a history of previous breast surgery or any musculoskeletal disorder or pain. Also the subjects were selected because they had the most prevalent breast sizes 75B, 75 C, 80B and 80 C.

Two compression types and five encapsulation types were tested in the study. The bras were selected as beingrepresentative of the different features of sports bras currently commercially available. Very important fact is that the subjects' breastsizes were measured by a bra fitter who had beentrained for 14 weeks in a bra fitting course in theUniversity. The most appropriate bra size was providedor the subject to try on, according to her breast sizebased on the Metric Bra Sizing System,which isdetermined by the full bust girth and underbustgirth (cm).The fitting procedure follows a standard process.Firstly, the correct tensions of the underband and theshoulder straps were ensured. Secondly, the subjectleaned forward so that her breasts completely filledthe cup, to ensure that there was no gap, bulging, wrinkle, digging or sliding. Lastly, she raised her hands tocheck that the bra stayed in place. The bra fit was then assessed and ensured. This study focused on the evaluation of the functionalperformance of the bras in terms of the reductionof breast displacement during activities[5].

A total ofseven styles of running sports bras with different fibrecontents and design features were selected for 3D motion analysis. The various featuresof the selected bra samples are shown in *table 1*.

Table 1. *Detailed description of sports bra samples:*

Bra sample number		1	2	3	4	5	6	7
Product sketches	Front							
	Back							
Design features	Cup layers	2	2	1	1	2	1	1
	Front cup	Full cup	Short vest	Short vest	Full cup	Short vest	Full cup	Full cup
	Cup seam elongation (%)	30	40	5	Mould	30	8	Mould
	Inner lining	Mould	Mould	No	No	Mould	No	No
	Sling	Yes	No	Yes	Yes	No	Yes	Yes
	Neckline elongation (%)	35	34	14	14	5	20	30
	Gore	Yes	No	No	No	No	Yes	Yes
	Wire	No	No	No	Yes	No	No	Yes
	Cradle	Yes	No	No	Yes	No	Yes	Yes
	Back design	Racer-back	Racer-back	Racer-back	Racer-back	Racer-back	U-back	Cross-over
	Closure	Side	Back	Side	Front	Side	Back	Side
	Shoulder strap elongation (%)	35	50	28	35	30	10	10
Fibre contents	Polyamide (%)	42	55		18	67	5	56
	Polyester (%)	53	16	91	72	28	85	27
	Elastane (%)	5		9	10	10	10	15
	Cotton (%)		29			5		2
Design types		Encapsulation	Compression	Compression	Encapsulation	Compression	Encapsulation	Encapsulation

The aim of this study was to identify the bra(s) thatgave the best support to the wearer during the physicalactivities and from this determine the bra features thatare critical. The support functionality of a bra embracesboth the design/style of the bra and the material fromwhich it is constructed, and there is a clear interdependencybetween them[5].

The breast motion analysis was carried out in a Human Locomotion Laboratory under a controlled temperatureof 23±0.5 °C and relative humidity of 65±3%.The experiment for each subject was completed in a single day within seven days after her menses flow. The experiment wasconducted in the autumn season and the controlledexperimental condition eliminated the variation ofsweating that might slightly affect the friction of thebra material. While the subject waswalking, running or stepping, the 3D coordinates of the markers were recorded at a 120 Hz sampling frequencyusing a Vicon motion analysis system (Vicon 612,Oxford Metrics, Oxford, UK). The system comprisedsix infrared cameras mounted on a 2.8m high ceiling ina 102m2 room, and it was statically and dynamicallycalibrated before the experiments. In this study, passivemarkers were selected because these wireless markerswere preferred to avoid breast deformation under thebra. As the breast movement was non-linear in nature, the nipple movement may nothave represented the entire breast motion. Therefore, five more points on the breasts were used to describethe complex pattern of breast movements[7].

Four breast boundary markers were used to definethe BCS and six experimental markers were chosen to attachonto the left breast, the first marker was placed on the nipple. The other markers were 40mm apartfrom the nipple in the horizontal and vertical directions, and the sixth at the top part of the breast, because the vertical breast displacement wasknown to be larger than the horizontal one.The subjects performed three different activities –walking at 3 km/h and running at 7 km/h on a treadmill,and stepping up and down on a platform 240mmhigh for one minute[1].

The breast displacement in every movement cycle is defined by the peak-to-peakamplitude of displacement (i.e. positive peak displacementminus negative peak displacement). The averagebreast displacement in every single experiment wasdetermined by taking the average values of breast

displacementobtained in 10 successive movement cycles.The breast displacements obtained from the different markers were compared with nipple marker. To measure how well a bra reduced the breast displacement, a unique performance indicator, ‘‘Reducedpercentage of Breast Displacement’’ (RBD), wasdevised. It is defined as the percentage change of displacement(i.e. breast displacement (braless) minusbreast displacement wearing a bra, divided by breastdisplacement (braless)×100). It means that thelarger the RBD is, the better is support ofsports bra.

In 11 out of 15 cases, the displacements at the fiveadditional markers were different from those of nipple marker at a significance level of 95%. Top breast marker had the largest and most significant mean difference in breast displacement. The results imply that measuring only the nipple displacement was insufficient for a scientific analysis. Also, it was found that all the bras generally exhibited the strongest reduction in breast displacement in the medial–lateral direction. In contrast,and the smallest in the anterior–posterior direction.The bra samples were most effective in controlling the breast movement in the medial–lateral direction,but less effective in the anterior–posterior direction,so it is evident that more attention should be given tothe design and construction of the centre front, theplasticity of the cup fabric and the location of the cupseam and neckline to address this. For some bra styles,the poor control at the top part of the breast was attributedto a gap between the bra and the breast inside thetop cup during activity, so it should be ensured that theneckline height fits the upper breast boundary, not just while standing, but also during exercise.

The averageRBDs (Reductions in breast displacement) of seven different bras averaged across four subjects and six markers types in the three directionsduring the three different activities. Looking at the ranges of RBD, it can be seen that the smallest ranges were during running in the superior-inferior direction(range=16%) and during walking in the medial-lateral direction.(range=19%). This implies similar performances for the different bras in reducing the verticalbreast displacement during running, and reducing themedial–lateral breast displacement during walking.Consequently, the design features of the bras are lesscritical in terms of reducing movement in these directions,so more attention should be paid to the anterior-posterior (x) breast displacement.RBDs for the seven differentbra styles in the three different displacementdirections for the four subjects, six markers and threeactivities. It shows that the bras with different designfeatures exhibited different levels of control. It is that Style 3 (according to Table 1.) was, overall,the most effective in reducing breast displacement in all directions, followed by Style 2. Referring to Table 1,the common design features of the effective bra samplesof Styles 2 and 3 can be listed as follows:
1. compression type-to limit breast movement in alldirections;
2. short vest style with high neckline to maximize thecoverage;
3. rigid cup seam to fit the breasts and preventmovement;
4. side slings to restrict the medial–lateral breast
5. race-back panel to distribute the tension to the back;
6.slightly elastic bound neckline to fit the upper breastboundary for stabilization;
7.no centre gore, no cradle, no wire, no pad;
8.wide strap with good recovery, but with noadjustment.

In the end, the least what every women can do for herself is to find sports bra that works for her, and there are some tips to finding the right one:
Compare the two types of sports bra – Compression bra and encapsulation bra
1. Consider fit, not bra size – Breast size can change with weight loss or gain, menstrual cycleor medication.
2. Make sure the clasps or straps don’t dig into your skin.
3. Choose a bra that has good ventilation – this will ensure sweat doesn’t get trapped, which increase friction and chaffing
4. Encourage your child to mimic the activity they will be doing whilst trying the bra on beforepurchase
5. Replace the bra every 6 months to a year - bras over time lose their elasticity and thereforetheir support

6. Consider design – a Y back ensures the shoulder straps don't slip. A back panel providesextra support and improves posture.
7. Once you have found the right sports bra, buy two, so that your child always has one forexercising.
8. Increasing the cup size, while decreasing the rib size gives a similarly sized bra and vice versa,so if for example a 34D is a little big, a 36C may be a better fit than a 34C.

CONCLUSION:

Indisputably, women who are physically active should wear sports bras. A sports bra is not only a piece of clothing andwhen we talk about sports bra, every designfeature is „the most important". Of course women are different, but most of all need well fitting bra. A bra that fits properly, can improve posture, prevent back pain and injury, relieve muscle tension, and enhance overall look.The more effective bras shared common features such as compression type, short vest style, high neckline, side slings, cross-back panel, bound neckline with a slight elasticity, no centre gore, no cradle, no wire, no pad and a non-adjustable wide strap. The most effective bra had a unique inverted-U shape bounded seam over the upper and side boundaries of the cups with a wide cross-back design. The inelastic top front panel was so high that the cups fully encaged the whole breasts. The cup panel used a narrow-width fabric panel with a straight grainline passing through the nipple to guarantee rigidity from the inner bottom breast to the outer top breast areas. Therefore, the breast movements in all directions were much reduced.

Although sports bras can typically cost more than a normal use bra, it should be seen asa very important part of your child's sports wear and should be seen as an investment, rather than acostly addition to their sports participation.

There is still no international standard for the evaluation of sports bras in reducing breast movement. This essay provides a basic insight into the requirements for such a standard a guideline for consumers to select the most suitable running sports bra with appropriate features.

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FABRIC WRINKLE RESISTANCE, TESTING OF WRINKLE RECOVERY ANGLE OF DIFFERENT TEXTILE MATERIALS

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ABSTRACT

Fabric wrinkle resistance and fabric wrinkle recovery angle is discussed in this article. Test methods, equipment and number of specimens needed to perform the tests are described. The results of the wrinkle recovery angle test to improve linen fabric properties are also given in the article. The research of the new testing method to measure wrinkle recovery angle and the results testing different textile materials are showed.

Key words: textile material, wrinkle recovery angle, fabric wrinkling, fabric wrinkling recovery

INTRODUCTION

It is known that there is different kind of textile materials. Every textile material has different structure and its reaction to pressure force is different. Stiff textile materials tend to wrinkle, while materials which are not stiff - contrary. The behavior of the fabric to impact of load and flexion is dependent on initial properties of the fibres and many other constructive characteristics of the fabric[1]. When pressure force affects the fabric, wrinkles can appear on the material surface. The assessment of rigidity as the property which negatively reflects on processing of fibers and yarn, textile material and ready garments giving them stiff touch, poor drapability and appearance, is purpose of different tests. The result of poor resistance to bending is tendency to wrinkle – one more negative property of textile materials which influence esthetical value of the garment and its wear comfort. Different ways can be used to raise fabric resistance to wrinkling. The fabric wrinkling can be contributed by its fibers, yarn and fabric finishing ways. Factors that affect wrinkle development include fibre type and its bending performance, fibre diameter, yarn twist, weft-warp density, fabric construction and thickness [2]. It means that textile materials should not be stiff, they should be elastic enough to return to their original shape after deformations. Wool because of the structure of its fibers has good elasticity and after deformations easy returns to the initial shape. Cellulose fibers are not elastic and tend to wrinkle. Resistance to wrinkling of textile materials reduces in the following sequence: synthetic fibers, wool, silk, acetate cellulose, viscose rayon, cotton, flax [3]. Many cotton fabrics are specially treated with chemicals to reduce their creasing. Wrinkle free finishing is also known by consumers as ‘Easy Care’ and ‘Wrinkle-resistant’[2]. In the article will be described different methods to test wrinkle resistance and fabric wrinkle recovery angle.

FABRIC WRINKLE RECOVERY

Creasing of textile materials is a complex phenomenon which involves tensile, bending compression and torsional stresses[3]. When mentioned stresses are working on the fabric, its outside is stretching, but internal side - wrinkles. R. Čunka emphasizes that the material wrinkling is the result of many factors and it depends on elasticity and other characteristics of the material [1]. The same time, fabric wrinkle recovery is dependent on share and level of elastic deformations, to wit, total deformations created by the load.

To test the wrinkle recovery the fabric has to be bended compressing during certain period of time and after it the fabric wrinkle recovery angle has to be measured.

Fabric wrinkle recovery angle

Wrinkle recovery is fabric property to return to its initial shape after bending deformations [2]. The larger is ability of the material to absorb the water and the more water is absorbed by the fabric, the larger is its wrinkling. Because of this reason fabric tests have to be performed in strongly climatized conditions in balance with standard atmosphere. Because of the same reasons, any additional physical contact with the fabric has to be eliminated during the test. Even increased stream of air can affect fabric wrinkle recovery angle[1].

Several different methods are used to test fabric wrinkle recovery angle. As with the time new technologies are developed, new ways to test fabric wrinkle recovery angle appear, too. Some of them will be described in the following text.

During the test a fabric is flexed – creased under 180° angle and compressed. The test is standardized (JUS F.S2.018, DIN 53890, DIN 53891) and to perform the test 10 fabric specimens with dimensions 5x2cm in direction of weft and warp are needed. The fabric is bended – creased under 180° angle in certain distance from its edge in longitudinal direction. After that the sample is covered with a glass sheet and 1kg weight is put on the top. Loading time is 60 minutes. After it, the fabric is released, left to relax some period of time and wrinkle recovery angle is measured.

The crease recovery of fabrics depends on the time of creasing, the time of recovery and the extent of crease curvature. R. Čunka emphasizes that two ways to measure wrinkle recovery angle exist after fabric is relaxed - using JUS and DIN [1]. Using JUS wrinkle recovery angle is measured in 5 and 60 minutes after fabric relaxing to get angles α_5 and α_{60}. While, using DIN standard, wrinkle recovery angle is measured in 30 minutes after fabric relaxed to get angle α_{30}. From the measured values α_5 and α_{60}, α_{30} a rebound angle α_o can be calculated. The angle α_o is a measure of fabric recovery in certain moment after it is released. It can be expressed by α_5 i α_{60} :

$$\log \alpha_o = \log \alpha_{60} - 3{,}5 \log \frac{\alpha_{60}}{\alpha_5}$$

Similar, if recovery is measured after 30 minutes, α_o is calculated following way:

$$\log \alpha_o = \log \alpha_{30} - 4{,}74 \log \frac{\alpha_{30}}{\alpha_5}$$ [1].

There is also developed fabric wrinkle recovery angle test by use of special equipment to affect the fabric and after – to measure, R. Čunka [1]. To perform the test 10 fabric specimens with dimensions 3 x 1,5 cm cut in direction of weft and warp are used. The fabric is also bended under 180^o by help of special gadget. Load is kept 5 minutes, after the fabric is taken from the press to the holder of the protractor. After 5 minutes the wrinkle recovery angle is measured.

NEWEST METHODS TO MEASURE WRINKLE RECOVERY ANGLE

Baumert and Crews in 1996 were researching how rinse and drying cycles influence wrinkle recovery of 100% cotton and cotton/polyester fabrics. The authors used the wrinkle recovery angle method and found out that the rinse cycle using fabric softeners improves wrinkle recovery angle for most part of tested materials [4]. Also the author says that the dryer provides better strength retention, improves wrinkle recovery and whiteness.

At Ghent University were performed a research to improve the wrinkle recovery of easy creasing linen fabrics. New kind of hybrid yarns (HF1-HF3) was developed. They consist of SMA (Shape Memory Alloy) wires (Ni-Ti legura) as the core with a textile shield around it. Hybrid fabrics (HF1 - HF3) were

developed by embedding the hybrid yarns in both the warp and weft directions of a fabric, to bring about all-direction recovery from creasing. 10 specimens were used to test the material. The wrinkle recovery angles (WRAs) of the hybrid fabrics were assessed in both dry (RH 65%) and wet (RH 90%) conditions. 5 minutes after taking off the weight, the wrinkle recovery angle was measured. It was established that during the first seconds the most part of fabric specimens returned to their initial shape because of the super elastic wires which immediately regained their shape. The results of the research are seen at the figure 1. Significant wrinkle recovery angle differences of fabrics HF2 and HF3 in dry conditions and significant wrinkle recovery angle differences of fabric HF2 in wet conditions are showed in a diagram. It is considered that this kind of results are obtained because of the fact that yarn HF2 consists of 5 cotton yarns wrapped around the core, and because of it, it absorbs more moisture then other yarns. It is also assumed that built-in yarn hybrids with SMA core will not diminish mechanical properties of the flax. This kind of fabrics can be used to manufacture goods where recovering to initial shape is important, for example, tents, curtains, bags and others.

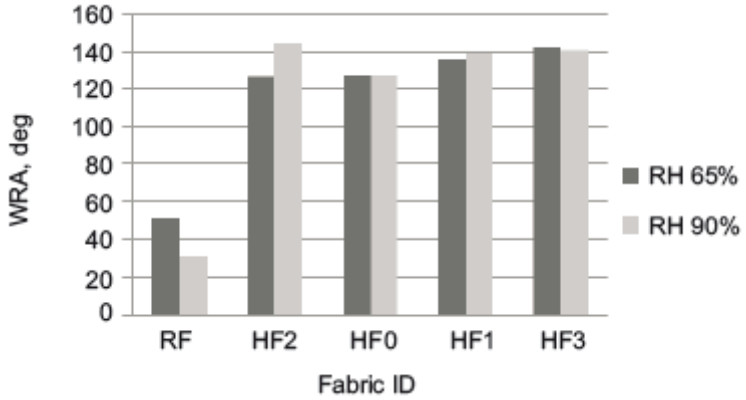


Figure 1. Measuring results of hybrid fabrics in different moisture conditions [2]

As wrinkle recovery is one of the most important factors influencing fabric usability, the authors in their researches have discussed also other assessment ways [5]. They have compared new and old research methods. The first access, called smoothness appearance, is used in two test methods: American Association of textile Chemists and Colorsts (AATCCC) 124-2010 and AATCC 128-2010. In these methods fabric samples are home laundered or treated by standard equipment for creasing. After it, they are visually valuated comparing with standard replicas which present different wrinkling levels. The other method based on creasing under the fabric recovery angle is standardized in AATCC 66-2008 u ISO 2313:1972. It specifies the compression force and time to create a folded wrinkle and the suspension condition to observe the change in the folding angle, respectively [5].

A novel method to carry out automatic wrinkle creation, sample handling and recovery angle tracking for performing wrinkle recovery evaluation is proposed. Firstly, a specimen is pressed for 5 minutes by a specially designed pneumatic compressor to create a wrinkle. Secondly, the acquisition of a video sequence is initiated as soon as the briquetting is released after 5 minutes pressing time to record the moving wind of the wrinkled specimen. Finally, a series of image processing operations, including holding, thinning and Hough transform, are applied to process each video frame to calculate the recovery angle of the specimen.

The entire test is automatic. 8 types of fabrics were selected to conduct a contrastive test between the standard method and the proposed method.

Compared with the existing fabric wrinkle recovery measurement devices, such as the SDL-M003 wrinkle recovery tester, the developed measurement system has made three important contributions:

1. the whole test procedure is automated eliminating human interference,
2. wrinkle recovery angle is recorded to perform dynamical analyze of the recovery,
3. video records are used to calculate wrinkle recovery angle and ensure more precise and effective measuring [5].

VIDEO ACQUISITION SYSTEM

New equipment is showed by its authors on the figure 2[5]. The equipment automates most part of operations of the AATCC 66-2008. The tester consists of two major components, a pneumatic presser and a video sequence acquisition system. The pressing duration of each specimen can be adjusted through the control of a time relay.

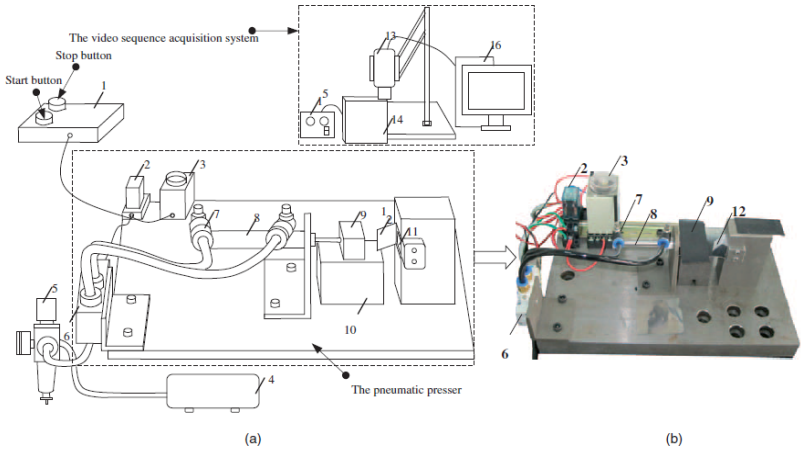


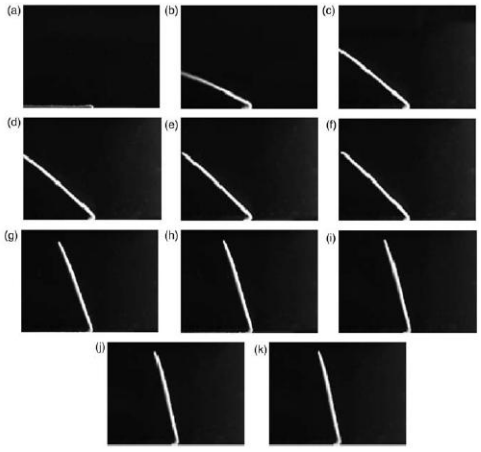
Figure 2. New designed machine for measurement angle receovery [5].

The components on the figure 2(a) are: 1 – control box, 2 - OMRON MY2NJ intermediate relay, 3 - FATO CFJS (A-B) time relay, 4 - OLF55 AF F oil-free air compressor, 5 - AW2000-02D reducing valve, 6 - SI5120-5LZ-01 solenoid, 7 – series ARJ1020F miniature regulators, 8 - DJ2B10-25-A cylinder, 9 – briquetting, 10 – briquetting platform, 11 – metal foil, 12 – specimen, 13 – charge-couple device, 14 – light source, 15 – light controller, 16 – computer [5].

Figure 2(b) shows the real image of the pneumatic presser. The video sequence acquisition system comprises a Basler industrial CCD camera (scA1600-14fc), an OPT-FL130130 light source, a light controller, a computer and the National Instruments Vision Assistant 8.0 software. The light illuminates the specimen from the horizontal direction. The 2-megapixel Basler camera, equipped with a 25-mm Pentax lens, is mounted above the specimen vertically to target the moving wing of the specimen, and its actions are controlled by the computer via the IEEE 1394 interface [5].

Video frame processing

In the video sequence shown in Figure 2, the dangling wing of the folded specimen is a bright stripe on a dark background. The other wing is clamped horizontally and does not appear in the image frames.



Slika 3. Video sekvence [5].

For the experiment eigth diffrent textile materilas were taken which are showed in the table in the figure 4.

			Yarn count (Tex)		Density (yarns per 10 cm)	
Sample	Materials	Weave	Warp	Weft	Warp	Weft
#1	100% cotton	Plain	14.6	14.6	196	210
#2		2/1 ↖ twill	11.7	9.7	732	382
#3		5/3 satin	18.2	36.4	683	324
#4	100% wool	Plain	8.1 × 2	8.1 × 2	269	241
#5		2/2 ↗ twill	8.3 × 2	8.3 × 2	368	313
#6	70% wool/30% polyester	5/2 satin	7.3 × 2	9.7	520	442
#7	65% polyester/35% cotton	2/1 ↖ twill	18.2	18.2	480	240
#8	100% viscose rayon	Plain	19.4	19.4	205	205

Figure 4. Fabrics which were used for the test and their structute [5]

Results of wrinkle recovery angles by American Association of Textile Chemists and Colorists (AATCC) 66-2008 and video sequence method

Measurement results of both methods are showed at the figure 5. The method AATCC 66-2008 is marked as a method I (Method I), but the automated method is marked as the method II (Method II).

Sample		Angles of face-to-face warp folded (°)		Angles of back-to-back warp folded (°)		Angles of face-to-face filling folded (°)		Angles of back-to-back filling folded (°)	
		I	II	I	II	I	II	I	II
#1	1	67.0	66.8	66.5	68.2	75.3	76.0	75.3	76.0
	2	67.9	68.2	68.2	68.2	77.0	76.1	76.8	77.6
	3	68.4	68.2	69.9	68.3	77.1	76.3	78.5	77.8
	Average	**67.8**	**67.7**	**68.2**	**68.2**	**76.5**	**76.1**	**76.9**	**77.1**
#2	1	88.4	90.2	84.1	85.6	87.0	88.0	88.9	88.9
	2	88.9	90.3	84.2	85.7	88.3	89.1	88.6	89.4
	3	90.6	91.2	86.1	85.7	90.5	89.3	91.2	90.0
	Average	**89.3**	**90.6**	**84.8**	**85.7**	**88.6**	**88.8**	**89.6**	**89.4**
#3	1	84.2	84.4	109.2	111.8	133.9	135.0	108.9	111.8
	2	84.2	85.6	112.3	111.8	135.8	135.0	109.9	111.8
	3	87.7	85.8	113.9	112.0	136.5	135.0	114.2	111.8
	Average	**85.4**	**85.3**	**111.8**	**111.9**	**135.4**	**135.0**	**111.0**	**111.8**
#4	1	163.1	163.3	163.4	163.2	169.0	168.7	167.2	167.0
	2	163.3	163.3	164.9	163.5	170.2	168.7	169.0	167.9
	3	163.9	163.8	166.2	165.2	171.3	169.2	169.0	168.7
	Average	**163.4**	**163.5**	**164.8**	**164.0**	**170.2**	**168.9**	**168.4**	**167.9**
#5	1	152.4	153.4	165.0	165.5	157.5	158.2	162.8	163.3
	2	153.4	153.4	166.7	165.6	157.9	158.2	163.8	163.3
	3	154.6	153.4	167.0	166.4	160.2	159.5	163.8	163.3
	Average	**153.5**	**153.4**	**166.2**	**165.8**	**158.5**	**158.6**	**163.5**	**163.3**
#6	1	156.2	157.4	166.7	165.7	143.5	145.8	133.8	134.6
	2	157.9	158.2	166.7	166.2	144.8	146.3	135.2	135.0
	3	159.3	158.2	169.1	167.0	148.5	146.3	135.8	135.0
	Average	**157.8**	**157.9**	**167.5**	**166.3**	**145.6**	**146.1**	**134.9**	**134.9**
#7	1	118.4	119.0	106.8	108.2	130.1	132.7	118.4	120.9
	2	118.8	119.8	108.7	108.3	132.8	133.3	119.3	122.4
	3	120.5	120.0	109.5	110.3	132.8	133.5	123.8	123.5
	Average	**119.2**	**119.6**	**108.3**	**108.9**	**131.9**	**133.2**	**120.5**	**122.3**
#8	1	87.8	88.7	86.9	88.3	104.2	105.4	105.4	106.3
	2	87.8	89.6	88.2	88.8	104.8	106.2	106.5	106.8
	3	90.1	89.8	88.7	89.3	107.4	106.8	106.5	106.9
	Average	**88.6**	**89.4**	**87.9**	**88.8**	**105.5**	**106.1**	**106.1**	**106.7**

Figure 5. Research results American Association of Textile Chemists and Colorists (AATCC) 66-2008 and video sequence method

From the results od the test we can see that wrinkle recovery angles are diffrent and diffrent are results for spacemen which are tested face-to-face and bask-to-back. We can also seen that the wrinkle recovery angles are diffrent for diffrent spacemens. The reason is diffrent composition of the materials. For sample #1, the wrinkle recovery angles of the face-to-face specimens are slightly different to those of the back-to-back, whether they are warp folded or filling folded. In sample #2, sample #3 and sample #7 the angles of the face-to-face are remarkably different from those of the back-to-back. Wrinkle recovery angles of sample #1, sample #4 and sample #8 have the same behavior. There is no certain trend for sample #5 and sample #6. Wrinkle recovery angle for cotton fabrics are smaller then the angles of woolen fabrics. It can be seen that the wrinkle recovery angles of the plain fabrics are smaller than those of the twill and satin fabrics. It is also found that the wrinkle recovery angles of cotton fabrics are smaller than those of fabrics containing wool. The rebound velocity of cotton fabrics is slower than that of wool fabrics.

CONCLUSION

Every material depending on it structure and composition have different wrinkle recovery properties and wrinkle recovery velocity. The valuation of fabric stiffness is the purpose of different tests. It is property which mainly negatively influence production fibres and yarn and tekstile material and also ready garments, giving them stiff touch, poor drapability, bad esthetical appearance. The factors which influence fabric creasing are: type of fibres and their bending, fibre diameter, density of weft and warp, construction of the fabric and its thickness. Several testing methods can be used and mainly 10

spacemen are needed to test the wrinkling recovery angle. As linen materials are easy creasing, its testing is performed to improve wrinkling recovery properties and to make hybrid flax. Test results show that the spacemen HF2 (RH 90%) has significantly diffrent properties comparing with other spacemens tested in wet conditions. It is considered that this kind of results are obtained because of the use of special HF2 yarn which consists on 5 cotton yarns wrapped around the core and absorbs more moisture then other specimens. It is also considered that built-in yarns with SMA core will not diminish the mechanical properties of linen fabric. Comparing method AATCC and method using video acquisition system, the results show that video acquisition system is very precise, effective and automated.

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COMFORT OF APPAREL DESIGNED FOR BICYCLING

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ABSTRACT:

Comfort of apparel is an important quality criterion. It affects not only the well-being of the wearer but also their performance and efficiency. If an active sportsperson, like a cyclist, wears a clothing system with only poor breathability, the heart rate and body temperatures will increase much more rapidly then while wearing breathable sportswear. As a consequence, the wearer of the breathable apparel outperforms the other, as it is possible to withstand high activity levels for a longer period of time. In this paper a study was concluded to show which materials and which properties are of most importance to achieve the highest level of comfort as to provide durable protection of the user against all external, mechanical and atmospheric effects, as well as great aesthetic appeal and a high constancy as possible throughout the whole period of use of the apparel for cyclists.

Key words: comfort, thermal comfort, apparel, sportswear, mechanical properties, protection properties, water vapor, durability, elasticity, resistance.

INTRODUCTION

Materials designed for the manufacture of sports clothing must meet many different requirements regarding barrier characteristics, comfort of use and service life.
Textiles designed for sports clothing should perform several very different, and even mutually excluding, functions. On the one hand, they must protect their users against heat loss, overheating or soaking, and on the other hand they must meet high requirements in respect of product durability, as well as many other properties contributing to the comfort of use [2]. First of all, such characteristics include:
-Protective properties against variable atmospheric conditions existing during the clothes' use, as well as protection against physical damage,
-A high resistance to external influences, including tear strength, resistance to abrasion, shape stability, color fastness, making-up quality, constancy of protective functions, and other features contributing to the service life of such materials,
-Comfort-providing properties, generally described as wellness, including first of all physiological comfort [1].

This includes protection against over-warming or -cooling, owing to high water vapor permeability, i.e. carrying off perspiration, good warmth retention and adequate air permeability. Moreover, the user's feelings are positively affected by soft handle and good shape assumption by the fabric and clothes cut that does not limit the user's ease of movement, as well as the cloth's aesthetic appeal and practical constancy of protective and aesthetic functions throughout the period of use.

It is rather difficult to make all the mentioned features compatible, and optimized solutions can be found only by using composite materials, i.e. multi-layer systems with appropriately selected types and characteristics of the component materials used to manufacture clothing of that type.

DEFINITION OF COMFORT

The human body is an active system that responds to changes in the environment in a way that relates to the level of physical factors. The physiological comfort is closely related to thermal comfort, which

is considered as a state of satisfaction by the thermal environmental conditions [1]. Comfort is defined as a state that expresses a sense of comfort, or lack of discomfort. It is about achieving a neutral state. Thermal comfort is a condition in which a person expresses satisfaction with their thermal environment. Thermal comfort occurs when there is thermal stability between the human body and the environment in which it is located.

COMFORT EVALUATION PARAMETERS

Comfort is a sensation a person feels when wearing clothes and it is a subjective reaction. It is the consequence of various causes. Clothing must provide some thermal isolation, high permeability of moisture and good ventilation in order to maintain optimal thermoregulation of the human body. The result of balanced interaction in the system "man - climate - clothing" is expressed in the human comfort when wearing clothes. Comfort is not an authentic feature, but the result of the decisions of the man himself. [6] There are the following parameters for the assessment of comfort:
- Air permeability - is defined as the rate of air flow passing vertically through a defined surface, at a given pressure difference between the two surfaces of materials [8]
- Thermal Conductivity - As all textile fibers other than glass, thermal permeability is better than air permeability, thermal isolation does not only depend on the specific thermal conductivity of the material used, but also on the volume of air contained in the material, ie. the structure and thickness of the material [6].
- Thermal resistance - Heat resistance of a thermal isolation fabric and inversely is proportional to the thermal conductivity
- Heat absorption - is an objective measurement of hot - cold sensation of fabric and it is a characteristic that depends on the surface.

Comfort, which is felt or not when the clothing is worn, is a subjective reaction and a consequence of (figure A):
- Microclimate inside the clothing (temperature, humidity and air between skin and clothing),
- Pressure of garments (pressure of the garment on the human body) and
- Feeling of a touch (touch of clothing on the skin of human).

Clothing must allow a certain thermal insulation, high permeability and good ventilation. Moving steam with human skin through layers of textile materials into the environment occurs through capillary transport, adsorption on the surface of the fiber, absorption and desorption and diffusion of air through the pores of the material (Figure). At the same time, it has a significant role on hydrophilicity or hydrophobicity knitwear. (1)

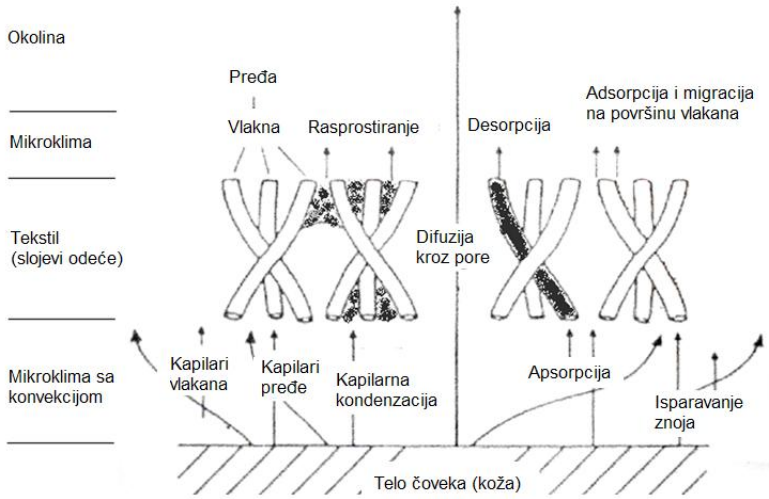

Figure 1. Mechanisms of water vapor through the textile material

THE BASIC CHARACTERISTIC OF CLOTHING FOR CYCLISTS

The basic characteristics to be taken into account in the design of clothing for cyclists are:

· Material properties, which are used for making clothes,
· Thermal regulation and moisture leaks,
· Quick drying,
· Inserts for impact protection.

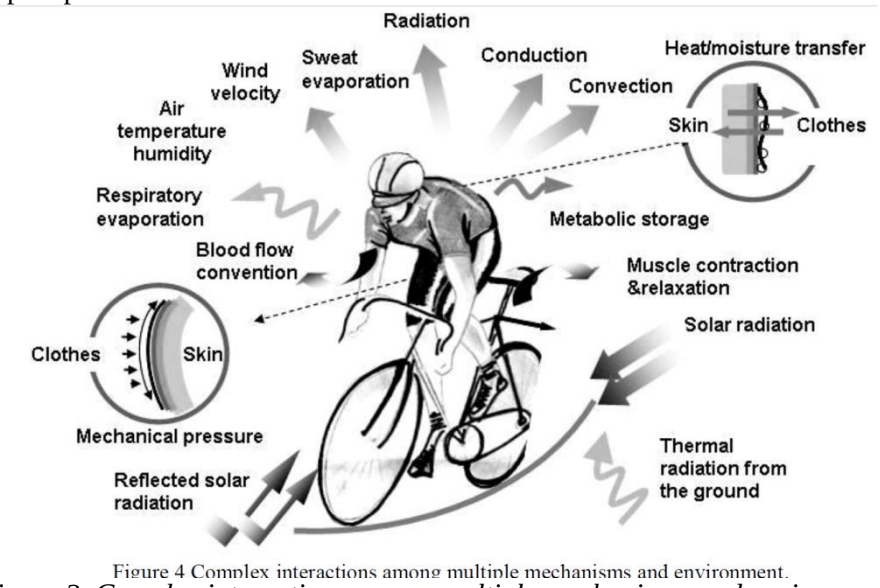

Figure 4 Complex interactions among multiple mechanisms and environment.

Figure 2. Complex interactions among multiple mechanisam and environment

Clothing creates a microclimate between the body and the environment. Clothing acts as a barrier to heat transfer passage of moisture between the skin and the environment. The base layer of clothing for cycling is in direct contact with the skin. When riding a bike it is normal to expect that there will be a lot of alternating sweating and cooling, so it is important that this layer of clothing does not retain moisture, but that it takes away from the skin. In climates where air temperatures are high and the wind effect is minimal, thermoregulation of the body is carried out by the process of the secretion of sweat, which evaporates from the surface of the skin, and thus the skin has the excess heat taken away from it. The sweat is evaporated in the form of water vapor from the skin through clothing, discharged into the environment, and therefore a very important role in ensuring the necessary comfort have sorption properties of the material from which the clothing is manufactured.

Materials for sports clothes are made from fiber of very high fineness, which are at the same time very durable. The insulating layer of clothing for cyclists is the second layer of clothes, who dresses over the base layer, in a period when temperatures are lower. Its purpose is to retain body heat, and the best way to do that is to create a layer of air around the body. This layer of air reduces the heat exchange between the body and the environment. The insulation layer is mainly composed of polyester, which is processed in such a way that the air is retained between its fibers. This layer of air forms a protective layer, which provides excellent isolation. These materials are fast drying and an excellent transport of perspiration to the outside environment. The materials of which the clothing for cyclists is made off are very elastic, which also affects the comfort of clothing, as well as the structure of clothes itself which devotes more attention. In a further effort to increase comfort, the inserts are made of impact protection, where there is always room for innovative technologies and are manufactured from bioactive, antibacterial insoles with anatomical structure.

Comfort parameters shown in the case of multilayer materials intended for clothing for cyclists

Specification for materials, raw material composition, weave, and the area weight of the material is shown in Table 1. The first two materials are single-twists while other materials are made from several layers of which there are:an external or top layer, a middle layer that functions as a barrier, and a back layer - usually described as the lining. These layers are joined together, either by the technique of point laminating or while making up the clothing, to form a specific multi-layer composite material.

The **top layer** must show good physical and mechanical properties to provide durable protection of the user against all external, mechanical and atmospheric effects, as well as great aesthetic appeal and as high a constancy as possible throughout the whole period of use. This layer, depending on its structure and raw materials, can also fulfill barrier functions, including resistance to wetting and water penetration inside the composite material, as well as windproof capability. A typical example of such a material may be woven fabric made from multi-filament polyester yarns, principally micro-fibers, with a high structure cover factor and high strength, sometimes with an additional waterproof finish or soil-release finish.

The **middle layer**, with barrier properties, can be of two basic types:
a water- and windproof layer consisting usually of polymeric membranes or coats on a carrier such as polyester knitted fabric, with high water vapor permeability and low air permeability. Mostly, these are water and windproof and simultaneously 'breathing' micro-porous hydrophobic polyurethane coats/membranes with a high water vapor permeability or hydrophilic coats/membranes with a compact structure and a generally lower water vapor permeability, but higher water-tightness. Both types of materials are made by the technique of reversible coating and transferred onto light, usually knitted textile carriers.

These parameters should be at the following levels:
for micro porous hydrophobic coats/membranes, the water-tightness should be at a level of 200-250 cm (measured by the hydrostatic method - water head); water vapor permeability of about 2000 g/m2.24 h (measured by the gravimetric method under static conditions) and resistance to water vapor below 10 m2 Pa/W (measured by the method of sweating a heat-insulated plate under dynamic conditions); for hydrophilic compact coats/membranes, water-tightness up to 1000 cm, water vapor permeability of 1200 g.m2.24 h and resistance of water vapor below 20 m2.Pa/W.

Athermo-insulating layer with a high warmth retention, used in sports clothing to be used under lower temperature conditions (e.g. in the spring/autumn or winter periods). This layer mostly consists of fluffy polyester non-woven fabric or raised knitted fabric of the Polar type. These knitted fabrics have single-sided or two-sided developed piles, usually from polyester micro-fibers [3]. Their fluffiness provides particularly high warmth retention.

The back layer of the system, fulfilling the role of lining, may for example be a thin polyamide woven/knitted fabric, but Polar knitted fabric or fur fabric is also possible.

Table 1. *Characteristics of exemplary textile and textile-polymeric materials as individual layers of model composite systems.*

Kind of layer	Type of fabric	Raw material	Basic weight, g/m²	Thickness, mm
External layer	Woven fabric	Polyester fibre	110	0.24
	Woven fabric/ hydrophobic micro-porous coat	Polyester fibre/ polyurethane coat	150	0.32
Intermediate, watertight layer	Hydrophobic micro-porous membrane/knitted fabric	Coat/polyurethane membrane/polyester fibre	108	0.31
	Hydrophilic membrane/ knitted fabric	Coat/polyurethane membrane/polyester fibre	126	0.35
Intermediate, heat-insulating layer	Non-woven fabric	Polyester fibre	65	7.3
	Polar knitted fabric	Polyester fibre	200	3.5
Back layer	Woven fabric	Polyamide fibre	55	0.11

Table 2. *Basic properties of the example component textile and textile-polymeric materials for particular layers of model composite systems.*

Kind of layer	Type of fabric	Resistance of water vapour R_{et}, m²Pa/W	Thermal resistance R_{ct}, m²K/W	Water vapour permeability, g/m²24h	Air permeability, mm/s	Water-tightness, cm	Oleophobicity, degree	Spry-test, degree
External layer	PES woven fabric	4.38	-	1781	62.8	-	5	5
	PES woven fabric/hydrophobic micro-porous coat	5.28	-	1814	0	223	5	5
Intermediate, watertight layer	Hydrophobic membrane/micro-porous PES knitted fabric	7.51	-	1851	0	240		
	Hydrophilic membrane/PES knitted fabric	15.94	-	1585	0	100		
Intermediate, thermo-insulating layer	Non-woven fabric	26.00	0.180	2087	2491	-		
	Polar knitted fabric	22.90	0.092	1846	874	-		
Back layer	Polyamide woven fabric	3.35	-	1864	415	-		

Based on the results that are shown in the tables we can conclude that clothing made from multi-layer composite materials containing a hydrophobic polyurethane coat applied on woven fabric or microporous membrane bonded with (or applied on) knitted fabric, shows good water-tightness and a low water vapor resistance or very good water vapor permeability through the composite system, and consequently particularly beneficial hygienic properties and high comfort of use.

Clothing made from multi-layer composite materials containing hydrophilic membranes with compact structures is characterized by high water-tightness and high water vapor permeability at the same time.

The resistance of water vapor flow through the heat-insulating components is relatively high, being of importance for the total resistance of the whole system. The value of Ret depends on the thickness of these components (the amount of air present in the insulating layer). The greater the thickness of component/air layer, the higher the resistance of water vapor, or the lower its permeability is.

The thermal resistance of multi-layer systems depends mainly on the thermal resistance of the heat-insulating layer. The latter depends, in turn, on the layer thickness. The thicker the layer, the better is the warmth retention.

The warmth retention of multi-layer composite material is increased by its polymeric coats/membranes. A relatively higher thermal resistance is shown by the systems containing a compact hydrophilic membrane than those with a hydrophobic microporous coat/membrane.

CONCLUSION

Based on the study of literature that deals with the issue of sportswear comfort, testing of mechanical and thermal properties of knitwear and the final testing by wearing implemented models of female cycling trousers it can be concluded that, in addition to the construction of clothing, a great influence on the ergonomic comfort of clothing have mechanical characteristics of the knitwear and the elasticity of the material. It is proven that clothing made from multi-layer composite materials containing hydrophilic membranes with compact structures is has high water-tightness and high water vapor permeability at the same time. It is of importance that there is a great thickness of the component/air layer so it can provide a higher resistance of water vapor. Also if the layer is thicker, warmth retention is better. The warmth retention of multi-layer composite material is increased by its polymeric coats/membranes.

Because the clothes create a special microclimate between the body and the environment it is of high importance that the sportswear for cyclists gives the wearer complete comfort, good physical and mechanical properties as to provide durable protection of the user against all external, mechanical and atmospheric effects, as well as great aesthetic appeal and as high a constancy as possible throughout the whole period of use.

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THERMAL COMFORT PROPERTIES ON EXAMPLE OF KEVLAR AND KEWLAR WOOL FABRICS

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ABSTRACT

The author has conducted research on thermal comfort between the fabric of Kevlar and Kevlar fabrics mixed with wool. Through research and comparison, we determined that Kevlar fabrics mixed with wool have better thermal comfort then Kevlar fabric.

Key words: Thermal comfort, Kevlar, Wool, thermal conductivity, heat absorption.

INTRODUCTION

The comfort we feel when wearing garments is a subjective reaction that is attributed to various factors. Clothing must allow certain thermal insulation, high moisture permeability and good ventilation to maintain optimal thermal regulation of the human body.

The result of balanced interaction in the system "man-climate-clothing" is expressed in human comfort when wearing clothes. Comfort is not an authentic feature, but the result of a decision of the man himself.

THERMAL COMFORT

Thermal comfort is a condition in which a person expresses his satisfaction with the thermal environment. By thermal comfort comes heat balance between the human body and the environment in which it is located. Thermal comfort depends on many factors. Thermal insulation of clothing is a very important factor, because it creates a boundary between the human body and the environment. The impact of clothing on the comfort of man depends on the material and structure of the garment. The structure of clothing means the size; fit of the human body, cutting, number of layers and the like. Type of material used in the individual layers includes not only knitwear, fabric or non-woven fabric but also their structure: the thickness, strength, and porosity. Also, thermal resistance, water vapor and air permeability are considered key features associated with comfort[1].

WOOL

The name describes the soft fur coat of certain mammals, especially sheep (sheep's wool). Wool, along with silk and casein belongs to a group of protein fibers, but differs from other animal hair because of its high percentage of sulfur content (3-4%), which stems from its high content of double amino acid cysteine. Wool is one of the renewable raw materials[1].

Wool has the natural characteristic of so-called regulation of temperature. The interior of the wool fiber can take steam, while the external surface repels water. Fiber can hold up to 33% water in relation to its dry weight without having the feel that it is damp. It are dries much more quickly than, for example, cotton. A product of wool contains, from its total volume, up to 85% of the air. This feature allows it to heat very well. Wool is not greased and not jam-packed, because the fiber is elastic. Also, once colored, it does not discolor and is not flammable. It does not burn, but immediately turns into charcoal, and unlike synthetic fiber, it hardly absorbs sweat. Without special treatment, it

can cause a sense of unpleasant "scratching" on the skin. There is no scratchy feeling with fine merino wool.

Kevlar

Kevlar is the commercial name for poly (imino-1,4-fenileniminoteraftaloil), a polymer from the group of aromatic polyamides obtained from low-temperature polycondensation starting from chlorides of terephthalic acid and a phenylene diamine. Kevlar was obtained in 1965 in the Du Pont laboratories. [1] [2] [3] At the time, nylon (aliphatic polyamide) represented the crowning achievement in the development of polymer fibers, but it was necessary to develop a synthetic fiber that would have drastically higher tensile strength (resistance to tearing) of nylon[2].

Kevlar fibers have a tensile strength significantly higher than steel and other engineering polymer materials. This enabled some quite new aspects of the application of synthetic macromolecules. So today, Kevlar can be found in bulletproof vests, helmets and items for daily use.

HEAT RESISTANCE

Thermal resistance (Rct) is a thermal insulation material and inversely proportional to thermal conductivity, as shown by the formula[3].

$$Rct = \frac{\boldsymbol{h}}{\lambda}\left(\frac{m^2K}{W}\right)$$

In the dry materials or in materials that contain a very small amount of water, it directly depends on the material thickness (h) and the conductivity of the fiber (λ).

THERMAL CONDUCTIVITY

Thermal conductivity is the basis for determining the heat transfer through the textile material. As all textile fibers other than glass, conduct heat better than air, thermal insulation does not depend only on the specific thermal conductivity of the material, but also on the volume of air that is in the material-the structure and the thickness of the material thickness.

With the increase in thermal conductivity thermal resistance decreases and heat absorption capacity increases and it can be expressed by the following formula:

$$\lambda_T = \frac{\boldsymbol{h}_T}{R_{abs} + R_{sep}}$$

Legend:
λ_T - overall thermal conductivity
$\boldsymbol{h}_T$ - overall thickness
R_{abs} - thermal resistance of the absorbing layer
R_{sep} - thermal resistance of the separation layer

HEAT ABSORPTION

The heat absorption is an objective measurement of a warm - cold sensation of the material and it is a characteristic that depends on the surface. If the absorption of heat is high, it provides a feeling of cold at first contact with skin. The characteristics of surface materials have a large impact on this phenomenon.
Absorption of heat can be calculated by the formula:

$$b = (\lambda pc)^{1}/_{2}$$

Legend:
λ - thermal conductivity (W/m K)
p - the ability to spread water (kg)
c - the specific heat of the fabric (J/kg K)

7. Table ofmedium ± standard deviation

Table 1: Fabrics physical properties (medium ± standard deviation) [4]

Fabric	KA	KV
Structure and source	Regularly weft (Comercialy)	Regularly weft (RMIT)
Calculated yarn (tex)	95	Kevlar 95 Wool 35
Selected turbo (cm)	II	II
Ends (cm)	II	II
Regained moisture (%)	3.2	5.9
Thickness of fabric (mm)	0.32 ± 0.01	0.51± 0.01
Mass per unit area	210 ± 1	299 ± 2
Optical porosity	2.5±0.7	6.1 ± 0.8
Air permeability	6.5±1.4	30.6 ±4.2

Results of the Table 1

In Table 1 results show that air permeability of KV (30.6mm / s) is greater than the air permeability of KA (6.5 mm / s). Also the porosity of the optical KV (6.1%) is greater than the porosity of the optical KA (2.5%). Regarding the physical properties of fabric we can see that KV has the same number of vertices ending per cm as KA but total yarn count for KV because it was different because of the wool component (27% of the total). How KV and KA contain the same amount of Kevlar yarns per unit of fabric, weight and thickness of the KV was increased due the woolen yarn. Regained moisture of the fabric KA was 3.2% while the fabric KV it was 5.9%, meaning that KV fabric has a higher re-obtained humidity of wool components, which may absorb moisture more than Kevlar[4].

CONCLUSION

Features relating to thermal comfort of KA and KV fabric through research include heat resistance and water vapor permeability and moisture management fabric. The test results of water vapor resistance reveals that KV fabric can transmit water vapor in the atmosphere much easier than KA. Also, thermal resistance indicates that the thermal resistance of fabrics KV is greater than the KA of the fabric. However, when we look at the weight and thickness of the fabric, thermal resistance of KV fabric can be less than or equal to KA fabric. Comparing KV with KA fabric, KV fabric has the ability to manage transfer of moisture because water moistens the KV fabric and passes through the fabric, while KA has very little ability to manage the moisture. KV fabric has a higher air permeability and porosity of the optical KA fabrics, which indicates that the KV fabric is breathable and good. In addition, the wool component contributed marginally larger snapping force of the KV fabric as opposed to the KA fabric[4].

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