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INTRODUCTION

It is our pleasure that today, department for textile and clothing science and design of Technical faculty "Mihajlo Pupin", University of Novi Sad, are organizing a jubilary fifth time international scientific proffesional conference Textile Science and economy with partners **Kyiv National University of Technologies and Design, (Ukraine), and Faculty of Mechanical Engineering, Univeristy of Maribor, (Slovenia)**. It is necessary and justified, nowadays, more than ever, to assemble the scientists and entrepreneurs in the field of textile and clothing industry. The Scientific-professional Conference "Textile Science and Economy V" (TNP’2013) is organized with the goal to promote connection between Serbian entrepreneurs and scientists and experts to jointly contribute the development based on knowledge and innovations. We are aware that by establishing these development research institutions and institutions of academic education, very active participants in this process must be included.

It is necessary to keep connections and cooperation based on knowledge and experience because that leads us to sustainability and development of our textile and fashion industry. Therefore, this conference TNP'2013 meets the Strategy of Scientific and Technological Development of Serbia for the period from 2010 to 2015. Through the papers of the Conference TNP'2013 participants current situation in the textile and fashion industry is to be analyzed, as well as the vision of this industry in Europe up to 2020 from the standpoint of the European Technology Platform (ETP). The European Union has entered the new millennium, setting the strategic goal of achieving extremely competitive and dynamic economic development based on the innovations and technological development. Therefore, this Conference TNP'2013 wants to contribute to the development strategy of the Serbian textile and fashion industry in the direction of the dynamic cooperation of science and economy.

The aim of this Conference TNP'2013 is to foster the regional cooperation with the scientists, experts, businessmen from the neighboring countries as well as from the other countries, what gives this event international significance and its scientific and professional level. Therefore, it is a great pleasure that such a remarkable number of the scientists and businessmen, mainly from the region and the other countries, responded to our invitation.

The submitted papers of our colleagues were published in The Conference Proceedings. Because of economic focus of this event, the business and professional papers and the papers of our graduates, now employed in many companies, have found their place in The Conference Proceedings.

At the plenary lecture we have tried to show you possibilities of involving in the European projects, experiences related to technology transfer from the University to Economy. In the part of inviting lectures, we have tried to assemble the leading scientists, experts and professionals from the industry whose working experiences can contribute to the Strategy of Scientific and Technological Development of the Republic of Serbia.

In the poster section we wanted to present scientific and professional work at our Faculty.

Technical Faculty "Mihajlo Pupin" is the only scientific institution in Vojvodina in the field of textiles and clothing. The intention of this Conference TNP'2013 is to present to the entrepreneurs the Faculty’s previous experiences and competences in the field of education and science. During the Conference TNP2011 and after, the Technical Faculty will promote its openness and acceptance of new ideas of improving cooperation with entrepreneurs and solving their everyday technological issues as well as those in the field of research - development projects.

On this jubilary fifth meeting we can proudly say that the previous meetings gave a good results, which are reflected in growing number of entrepreneurs from apparel and textile industries, who address to our Faculty for recommended students in accordance with their need for new employes.

Therefore, this meeting will continue in the future to be a place where entrepreneurs requests for needed profile personnel, will be listen with care. Those requests will be implemented in structure of our study program with one aim, to build highly educational creative personel who will offer soulutions and new ideas for development a new technology and products available to cope with strong competition on the global market

The Chairman of the Organizing Committee:

Vasilije Petrovic, PhD, Professor

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WORD OF THANKS

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- **Kyiv National University of Technologies and Design, (Ukraine),**
- **Faculty of Mechanical Engineering, Univeristy of Maribor, (Slovenia).**

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- **Provincial Secretariat of Science and Technological Development, AP Vojvodina**
- **MMS Fashion, Ivanjica**

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METHODOLOGY OF THE MANAGEMENT OF SCIENTIFIC PROJECTS WITH SPECIAL REFERENCE TO FP7 - MAPICC 3D PROJECTS

D. Ujević, B. Brlobašić Šajatović
Faculty of Textile Technology University of Zagreb, Croatia

Abstract: *Scientific research is usually divided into fundamental and applicative or applied researches. In the framework of the research project fundamental researches are aimed at researchers having a specific goal. The specific area of research within the MAPICC 3D project is clearly defined: scientific research orientation among many project members and clearly pre-determined, and areas of work among the members (partners) are precisely defined and specified in Consortium Agreements. They include methodological research, development s and the specific implementation.*
All researches among the FP7 members MAPICC 3D project have a team oriented as well as individual research characteristic in order to monitor the contribution of each researcher in a particular subject area very precisely. These researches are sometimes referred to as strategic researches directed towards the desired goal or project outcome. MAPICC 3D as FP7 project with its 19 members is one of the major scientific research projects funded by the EU.
Faculty of Textile Technology of the University of Zagreb plays a respectable role as one member of the project. This work contributes to the explanation of the methodology of compound technological projects, in this case great FP7 project MAPICC 3D.

Key words*: project management, scientific research work, partner collaboration*

1. INTRODUCTION

Scientific and scientific research activities include diverse scientific and developmental researches, publishing the results of scientific and developmental researches, application of research results, scientific training and improvement, and maintenance and development of scientific research infrastructure. Scientific activity is of fundamental importance for the overall development of each country. Among other things, scientific activity is also based on the relationship among various research institutes, University, faculties, Academy of Sciences and Arts, institutions and bodies., which is in the concrete example of this paper described on the basis of the Consortium Agreement among the FP7 members of MAPICC 3D project [1]. According to the concept of the European Union towards the end of the 50s of last century the process of design standardization was initiated, ISO standards and norms that are aimed at improving and settling all normative acts and procedures of the Member States and beyond. Only later incentives and development of various scientific research projects aimed at improving and developing scientific research potentials began [2]. Consequently, scientific research activity is planned which affects scientific research, development and culture of the population, and economic progress. An increase in the total volume and quality of scientific activities, ongoing scientific training of researchers, technical staff and laboratory technicians as well as especially university teachers, assistants and young researchers is particularly emphasized. A special part of education is focused on best specialization especially in natural sciences. The publication of scientific achievements and implementation, particularly with the use of the results of scientific research papers is very important [3,4].

In this case, scientific research activities, planning, research and application of the achievements within FP7 of project MAPICC 3D are published by scientific research project members within the consortium agreement, according to the regular schedule and the obligations of the project members [1].

2. SCIENTIFIC RESEARCH WORK ON FP7 MAPICC 3D PROJECT

Scientific research work is a systematic creative activity which provides acquiring new scientific research knowledge or applicative benefits, using existing and new scientific research work for new applications on the basis of using scientific methods. The goal of researchers within FP7 MAPICC 3D project is to develop new industrial automated and cost-effective integrated processes for manufacturing high-quality and high performance products for multi purpose thermoplastic composites [5]. The meaning and value of the results of scientific research is determined by the contribution of these results to the development of science itself, as well as the by objective possibilities of their application in the development of economic and social systems. The results of scientific research are public welfare and they are available to the public. Availability and the publicity of the results of scientific research are ensured, as a rule, if they are published.

In modern science it is not possible to accomplish complex and demanding tasks, scientific or scientific research activities without modern scientific infrastructure. The most important prerequisite for the conduct of scientific research, besides an adequate number of quality scientists and researchers, is scientific research infrastructure. It includes: scientific research laboratories, scientific libraries, scientific information and documentation services, systems of scientific and technical information, computer networks, scientific publicist writing, collection and processing of scientific documents in the archives. In addition to this scientific and research infrastructure, test equipment, devices and systems as well as the total technical basis that organizations use to implement scientific research tasks provide support data and material basis for scientific research work. Laboratory testing equipment and semi-industrial pilot plants for research and testing of new technological solutions are considered equipment for performing research activities.

Today, modern methodology and technology of performing scientific and professional work or scientific research work in its broadest sense is unthinkable without the optimal functioning of various information systems.

Essential prerequisites for organizing, planning and optimal functioning of information systems in scientific research, scientific educational organizations, institutions and scientific libraries are appropriate hardware and software. It is beyond dispute that the hardware and software are the most necessary scientific research structure.

2.1 Interaction and mutual cooperation between partner industries

Within the scope of a demanding project like FP7 MAPICC 3D project it is necessary to establish such a relationship to scientific research work and to other associates on the basis of which the effect of the project team members will be as great as possible, and costs as low as possible. This is achieved by building good relationships among the prject members , by developing personal social life, and by introducing material and moral simulation results of the project members for the results of work and research. Interpersonal relationships within the MAPICC 3D project of particular importance for successful work and successful job performance. The relationship among the project members, researchers and must be based on cooperative, specific and planned interactive collaboration, and it must be also based on group and individually and mutually synchronized processes. The principle of teamwork should be used for individuals and workinggroups, for managers and associates of working groups. The target-orientated guidance of business strategy is the process by which the leadership in a team environment sets common goals. It is relevant to note that associates should know which goals they pursue. The basic criteria for evaluating the abilities of associates are work results which have been achieved in relation to the set goals. The success of target-orientated guidance can be seen in the increase of efficiency and in faster growth and prosperity. The effect of target-orientated guidance is also reflected in a better work ethic, better interpersonal relationships, and proper demarcation of responsibilities and overall higher efficiency of the entire business. In the system of target guidance each project member has pre-set goals defined in the consortium agreement. Calculating income and expenses of a manufacturing plant is also important for further setting and implementation of goals. Evaluation of the performance of an individual, group, as well as focusing on work results can solve many issues for the entire duration of the MAPICC 3D project.

The term research in the etymological sense of the word means the search for new facts, methods, studies of the acquisition and discovery of new knowledge, theories, laws and principles. This basically means that research means systematically searching for new facts from which scientific principles, laws, and regularities are obtained. This means that scientific research is a specific intellectual activity whose primary purpose is to detect and prove scientific truth by using scientific methods. Results of scientific research must be scientifically based; they should represent something new or innovative, i.e. they should increase the global treasure of knowledge. Unlike scientific research, research itself generally includes all ways of solving theoretical and practical problems. Routine activities have nothing to do with scientific research. Scientific research is performed by trained, qualified and experienced intellectuals, specialists, experts in specific scientific fields, branches of science or scientists, researchers, teachers and associates, experts in specific scientific disciplines. Between the terms research and study there is no significant difference, because study includes: observation, acquisition of thorough knowledge, testing and research.

When research is discussed, the term test is often used which has an ambiguous meaning, and it usually means a set of written or spoken questions used for finding out how much someone knows about a subject.

3. PROJECTION AND GOALS OF FP7 MAPICC 3D PROJECTS

The goal of MAPICC 3D project is to develop new industrial automated and cost-efficient integrated high-performance and high-quality manufacturing processes for manufacturing lightweight thermoplastic textile composite structures. New processes are based on new technologies of upgrading 3D textiles produced on a plant using hybrid thermoplastic fibers from various fibers (glass, polymeric fiber reinforcement) to be used in the automobile, railway and aircraft industry as well as in civil engineering.
The innovative concept of MAPICC 3D is based on:

- development of hybrid thermoplastic fibers
- development of modeling tools
- development and demonstration of the equipment for manufacturing 3D panels
- demonstration of the real use of lightweight composite materials for the production of metal constructions to be replaced in the automobile and railway industry.

It is expected that MAPICC 3D project enhances the productivity up to 30% in relation to the present methodology, improvement of mechanical properties of panels which can replace metal structures, substantial decrease of wastes with rational use of raw materials.

The project includes 20 partners from 10 countries, including seven industries, six small-sized and medium-sized companies, six universities and one association.

4. CONCLUSION

Scientific research work is a systematic creative activity which provides acquiring new scientific research knowledge or applicative benefits, using existing and new scientific research work for new applications on the basis of using scientific methods. Today, modern methodology and technology of performing scientific and professional work or scientific research work in its broadest sense is unthinkable without the optimal functioning of various information systems.

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STRETCH CHARACTERISTICS OF FILLET WARP KNIT WITH ELASTOMERIC IN-LAYED YARN

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Abstract: *This paper presents results of an investigation on the stretch characteristics (full strain and its parts) of fillet warp knitted fabric with elastomeric yarn longwise inlaying. In order to undertake the study of the influence of in-layed yarn positioning and of fillet interloping repeat different types of fillet warp knit fabrics with in-lay yarn were produced. The array of data for the various design options provide analytical tool for making comparisons about the mechanical properties of the warp knit fillet structures with elastomeric inlayed yarn. It is observed that the repeat of fillet interloping and the position of in-laying yarn have some effect on stretch characteristics of warp knit structures. It is a consequence of a different relaxation of inlayed yarn in structure. Elastic strain is the largest part of the full strain of warp knit fabric and the part of residual strain does not exceed 0.11.*

Key words*: fillet structure, in-laying, elastomeric yarn, full strain, residual strain*

1. INTRODUCTION

The elastomeric yarns are used in the knitting industry as reinforced monofilaments and as multi plied yarn with elastomeric component. The using of elastomeric yarn allows creating new types of textile materials and it is a major force to achieve their functional properties. The structure of elastic knitted fabric with an elastomeric yarn should provide the maximum use of their specific properties: the ability to more than 100% stretch and almost completely relaxation the length after stretching.

It is well known that, there are the difficulties of elastomeric yarn feeding at knitting zone of the warp knitting machines and an elastomeric is usually use as filling yarn. It significantly changes the structure parameters and the properties of the ground interlooping. The filling yarn, which are positioning between the ground loops and junctures, greatly reduces shrinkage of knitted fabric. It changes an unroving of knit and an inclination of ground loops. The elongation and the durability of knit fabric change depending on the direction of elastomeric yarn position in the knit structure. (Shalov I. et all, 1986).

The using of elastomeric yarn as a longitudinal inlaid yarn in the warp knit structure does not only change a stretch of fabric in the direction of in-laying, but it also changes the shape and the size of the unit cell of fillet interlooping. As a result, net fabric with a hexagonal cell gets an unusual ability to become wider at a stretching. (Ugbolue S. et all, 2010 and 2012).

The study of structure parameters and mechanical properties of filling-fillet warp knit, which is made by alternation of tricot and atlas courses at repeat with different variants of elastomeric yarns position in the structure, showed that the variant of in-laying influences as to its breaking characteristics (Kyzymchuk O., Ugbolue S., 2012), as to the full deformation of warp knit fabric and to its components (Kyzymchuk O. et all, 2011). The value of the full deformation decreases with increasing amount of contacts between the ground yarn and inlaid yarn. Residual deformation of such warp knitted fabric is from 2 to 6% and it is independent of the variant of inlaid yarn position.

At the same time, the influence of the repeat of fillet interloping only at the structure parameters and at Poisson's ratio of auxetic warp knitted fabrics have been investigated (Ugbolue S. et all, 2011; Kyzymchuk O., Nedogibchenko O. 2011; Kyzymchuk O. 2012).

The main field of using of the warp knitted fabric with longwise inlaid elastomeric yarn is the products for medical and rehabilitation purpose which during operation have strain significantly less than breaking loads. Small in size, alternating with the unloading and rest, it affects the structure of knitted fabrics and leads to its deformation, changes its size and shape. For that reason, it is important to study the deformation characteristics at the cycle "load-unload-rest".
The work purpose is a research the deformation characteristics of fillet warp knit fabric with inlaid elastomeric yarn and an establishment of its dependences on a repeat of a fillet interlooping and a variant of in-laying.

2. EXPERIMENTAL SAMPLES

In order to undertake the study of the influence of in-lay yarn positioning, eight types of fillet warp knit fabrics with in-lay yarn were produced. The guide bars with in-lay yarn are placed behind the guide bars with the ground yarn. In order to undertake the detailed study of the influence of a repeat of fillet interlooping nine variants of fillet warp knit fabrics each position of in-lay yarn were produced. Amount of tricot courses n_t at a repeat are 3, 5 or 7 and amount of chain courses n_c are 1, 2 or 3. These fabrics were made on a 10 gauge crochet knitting machine with one needle bed.

The warp knit fabrics were made from 250 denier polyester yarn as ground. The linear density of the polyester yarn is 250 den x 2. It is manufactured by Du Pont and its tenacity is 1.454 gf/den based on a test gauge length of 25.4 cm (10in), and a crosshead speed of 10.16 cm/min (4in/min). The 150 denier (96 filaments) polyester sheath serving as the cover yarn for polyurethane core yarn provided a high elastic in-lay component. The yarn is supplied by Unifi Inc. and the linear density of polyurethane core yarn is 70 deniers.

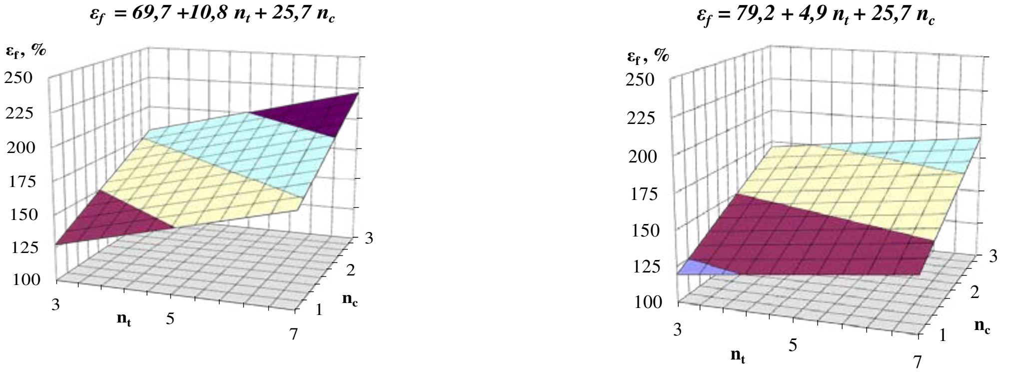
3. METHODS

The research of the deformation characteristics of warp knit fabric at stretching with constant load have been carried out according to GOST at relaxometer. Clamping length was 100 mm. Measurements the length of the specimen was made before loading, after 1, 5, 15, 30, 60 min of the loading, after the unloading and after 60 min of rest. The load of the knitted fabric specimen was determined depending on the elastomeric yarn diameter and the number of elastomeric yarns in the specimen according to GOST 16218.9-89. 3 parallel specimens have been used on tests for each variant of warp knit. The convergence of results defines their adequacy and reliability.

4. RESULTS AND DISCUSSION

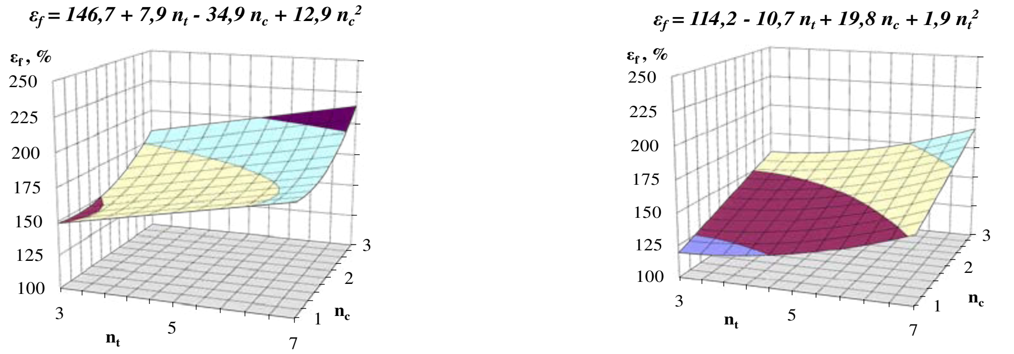
Full strain and its components are characteristics that are most often used for an estimation of mechanical properties of textile materials when tested on a cycle "load-unload-rest". Full strain is the strain of the sample at the end of the first part of the cycle (loading). It is calculated as the percentage difference between the lengths of the sample before and after loading for 60 minutes. The results of research of full strain of fillet warp knit fabric with different position of in-layed yarn are presented on Fig. 1-4. The diagrams show that the full strain of warp knitted fabric depends on the repeat of fillet interlooping. Its value increases with quantity increase as the tricot courses and as the chain courses in the repeat for all variants of the inlaying. It is a consequence of a different relaxation of inlayed yarn in structure. In all variants of warp knitted fabrics the inlayed yarn is fixed in the structure in the vertical ribs of the cell, which is formed by tricot loops, and then stretches inside the cell freely. If the repeat of fillet interlooping has increased, a length of elastomeric inlayed yarn, which is capable to full recovery length after unloading, increases too. As a result tensile strain increases.
It is obvious, that full strain of fillet warp knitted fabric in which structure elastomeric inlayed yarn is fixed at two courses of the repeat (fig. 1.б, 2.б, 3.б and 4.б) is less full strain of fillet warp knitted fabric in which structure elastomeric inlayed yarn is fixed at one course of the repeat (fig. 1.a, 2.a, 3.a and 4.a). This statement is true for all variants of inlaying position in the fillet structure and it is connected with a different relaxation of elastomeric yarn in the structure. For warp knitted fabric in which structure an inlayed yarn is fixed at two courses, elastomeric yarn has more contacts with the

ground yarns. The elastomeric yarn at such structure is slightly stretched consequently the friction forces arising that leads to a decrease in tensile strain.



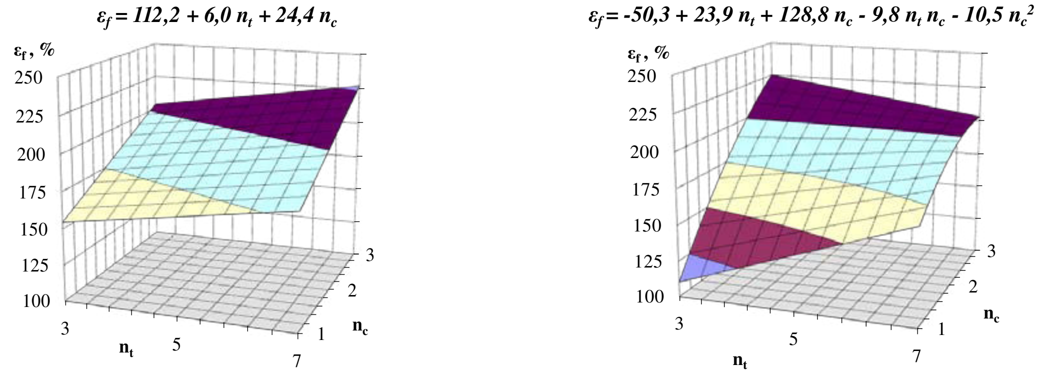
a) at one course of repeat *b) at two courses of repeat*

Figure 1: Full strain of warp knit fabric in which in-laying yarn turns from the back to the front side



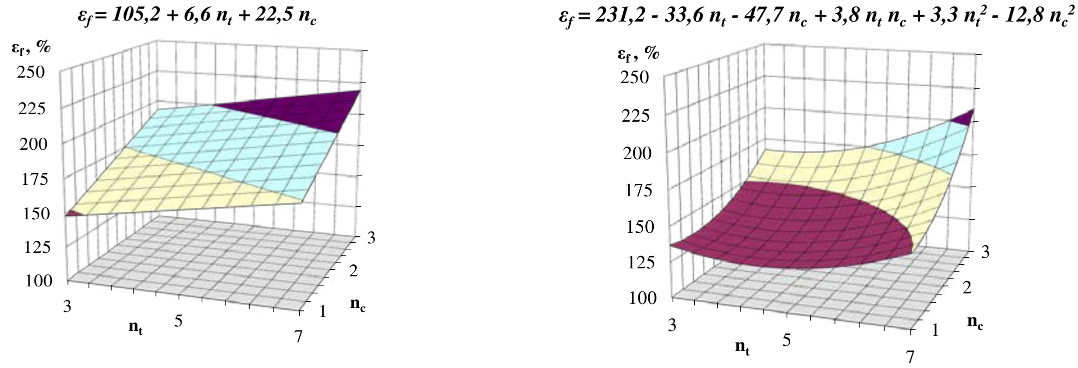
a) at one course of repeat *b) at two courses of repeat*

Figure 2: Full strain of warp knit fabric in which in-laying yarn is between the tricot's junctures



a) at one course of repeat *b) at two courses of repeat*

Figure 3: Full strain of warp knit fabric in which in-laying yarn wraps one tricot's juncture



a) at one course of repeat *b) at two courses of repeat*

Figure 4: Full strain of warp knit fabric in which in-laying yarn wraps two tricot's junctures

It should be noted a higher value of full strain of warp knit, in which the inlayed yarn wrapped the junctures of tricot loops (Fig. 3 and 4), compared to warp knit, in which the inlayed yarn is in a structure without wrapping the junctures of tricot loops (Fig. 1 and 2).
There are following components in full strain of fabric:

- elastic strain which disappears right after unloading. It is calculated as the percentage difference to the initial length between the length of the sample after the load for 60 minutes and after removing the load;
- plastic strain with a long period of relaxation;
- residual strain that remains after removal of the load. It is calculated as the percentage difference between the lengths of the sample before loading and after 60 minutes rest after unloading.

The analysis of research results has shown that the dependences of elastic strain on the repeat of a fillet interlooping and on a variant of inlaying in a structure are a similar to dependences of full strain and only value is different: elastic strain is lower at 10-25%. Therefore, elastic strain, as well as full strain mainly depends on the degree of relaxation of elastomeric inlayed yarns in the structure of fillet warp knitted fabric.

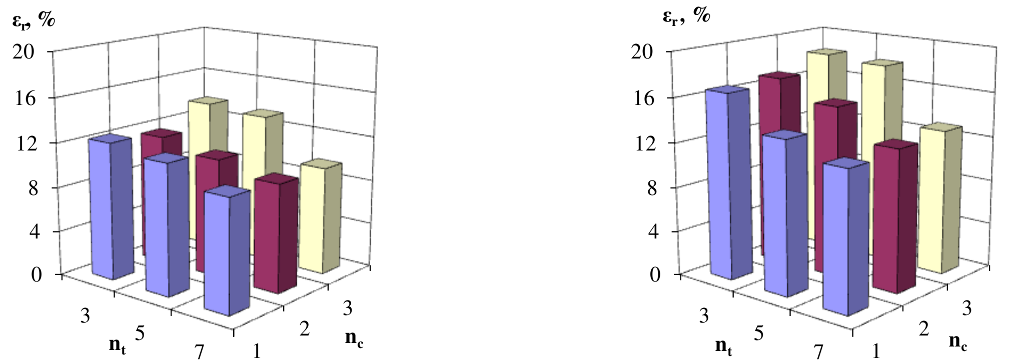
Plastic strain of warp knitted fabric is insignificant: it changes in the range of 4-10%. This strain does not depend neither on repeat of fillet interloping nor on a variant of inlaying positions in the structure.
The value of the residual strain determines a shape stability of the textile material. The research result have showed (Fig. 5 to 8) that the residual strain of warp knitted fabric varies widely (from 2 to 20%) and depends on both factors: the repeat of fillet interloping and inlaying position in the structure.

It should be noted that the knitted fabric in which the elastomeric inlayed yarn wrapped the junctures of tricot loops (Fig.7, 8) has considerably lower residual strain than the knitted fabric in which elastomeric inlayed yarn is fixed in structure without wrapping the junctures of tricot loops (fig.5-6). This can be explained by the fact that processes during the load-unload cycle are associated only with the extension of the elastomeric yarns under load and its subsequent relaxation after unloading and rest. In addition to these processes in the warp knitted fabric, in which inlayed yarn is fixed in structure without wrapping the junctures of tricot loops, there is also an irreversible redistribution of the elastomeric yarn that results an increase of residual strain. For these variants of warp knit (Fig. 5 and 6) the residual strain depends on amount of tricot courses at the repeat because the contacts between inlayed yarn and ground yarns are at the vertical rib of cell which forms by tricot loops.

The relation between different deformations in the full strain is important in order to characterize mechanical properties of the textile materials. If the share of elastic strain is larger, the material retains the dimensions and a shape better. At the same time, residual strain's dominance is leading to a change in a shape and the sizes of knitted fabric. Analysis of the research results (Table) of fillet warp knitting fabric with different position of inlayed yarn shows that elastic strain is the largest part (> 0.86) of the full strain. Value of residual strain's part varies widely, but generally it does not exceed 0.11.

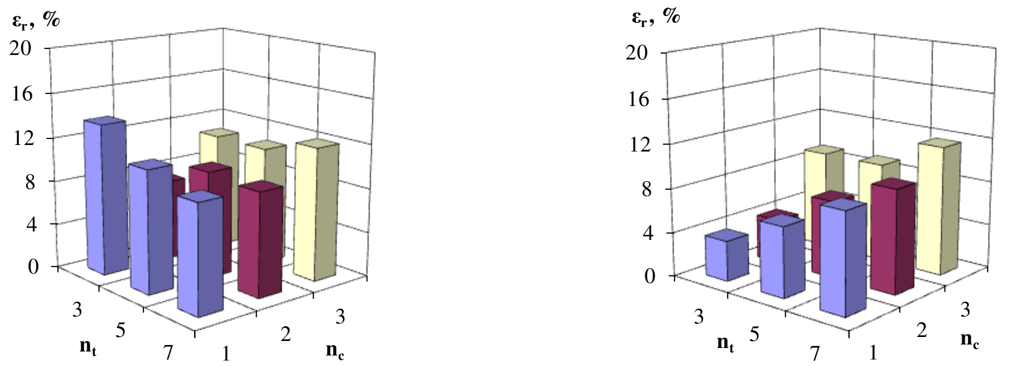
Table: Parts of full stretch of fillet warp knit with elastomeric in-laying yarn

The position of inlayed yarn in fillet warp knit structure		Parts of full strain	
		elastic $\Delta\varepsilon_e$	residual $\Delta\varepsilon_r$
in-laying yarn turns from the back to the front side	at one course of repeat	0,884 ÷ 0,936	0,045÷ 0,097
	at two courses of repeat	0,860 ÷ 0,920	0,070 ÷ 0,110
in-laying yarn is between the tricot's junctures	at one course of repeat	0,891 ÷ 0,934	0,046 ÷ 0,089
	at two courses of repeat	0,915 ÷ 0,956	0,028 ÷ 0,058
in-laying yarn wraps one tricot's juncture	at one course of repeat	0,940 ÷ 0,970	0,014 ÷ 0,031
	at two courses of repeat	0,905 ÷ 0,957	0,021 ÷ 0,057
in-laying yarn wraps two tricot's junctures	at one course of repeat	0.920 ÷ 0,945	0,008 ÷ 0,036
	at two courses of repeat	0,860 ÷ 0,952	0,013 ÷ 0,049



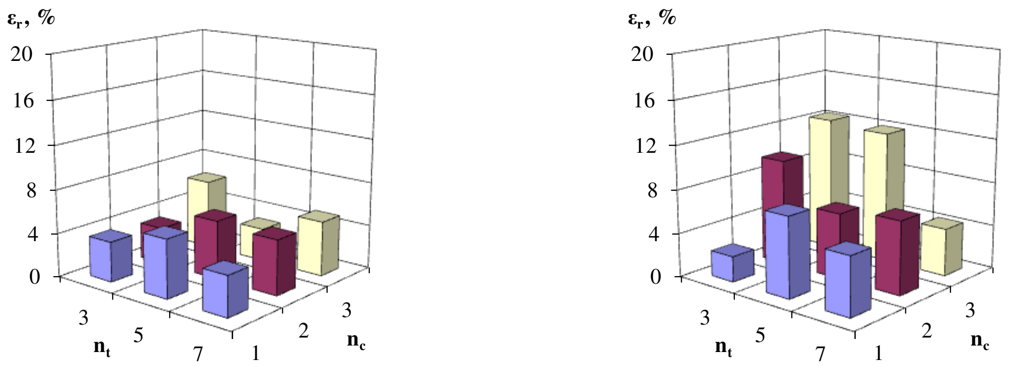
a) at one course of repeat *b) at two courses of repeat*

Figure 5: Residual strain of warp knit fabric in which in-laying yarn turns from back to front side



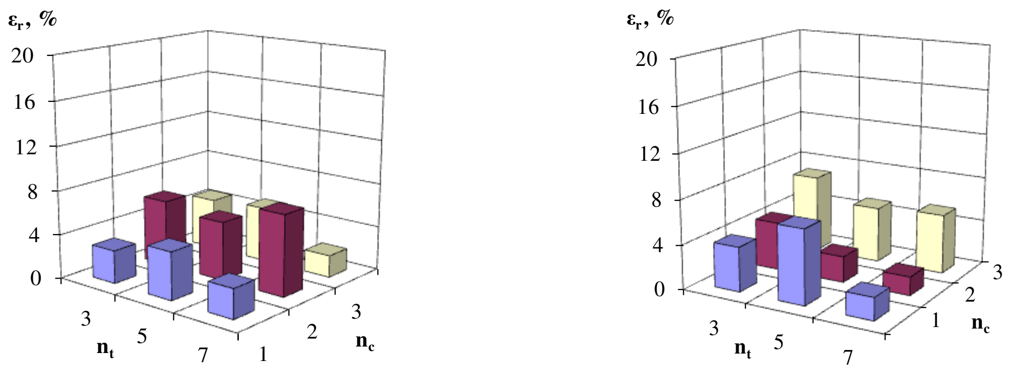
a) at one course of repeat *b) at two courses of repeat*

Figure 6: Residual strain of warp knit fabric in which in-laying yarn is between the tricot's junctures



a) at one course of repeat *b) at two courses of repeat*

Figure 7: Residual strain of warp knit fabric in which in-laying yarn wraps one tricot's juncture



a) at one course of repeat *b) at two courses of repeat*

Figure 8: Residual strain of warp knit fabric in which in-laying yarn wraps two tricot's junctures

5. CONCLUSION

The array of data for the various design options provide analytical tool for making comparisons about the mechanical properties of the warp knit fillet structures with elastomeric inlayed yarn. It is observed that the repeat of fillet interloping and the position of in-laying yarn have some effect on stretch characteristics of warp knit structures. It is a consequence of a different relaxation of inlayed yarn in structure. Elastic strain is the largest part (> 0.86) of the full strain of warp knit fabric and the part of residual strain does not exceed 0.11. Thus, the different positions of the inlaid yarn within the structures and the different amount of tricot and chain courses on repeat of fillet interloping offer other possibilities that could be explored when designing warp knit structures.

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ADAPTING HUMAN BODY MODEL POSTURE FOR THE PURPOSE OF GARMENT VIRTUAL PROTOTYPING

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Abstract: *In daily life physically disabled persons are exposed to a sitting posture where the own body weight represents high burdening on the organism. Forced sitting posture leads to damage of the human's tissue, affects the body physiology as well as body shape and size of the body segments. For the purpose of clothes virtual prototyping for people with special needs it is necessary to obtain a parametric body model in a sitting position to supply body measurements for non-standard body shape characteristics. In our research we performed measuring and analysis of body measurements change on a scanned 3D human body to test the applicability and reliability of 3D measurements in comparison with traditional ones. We investigated 29 body measurements using cross-sectional determination to observe circumferences and linear dimension tools to observe lengths and heights. We compared a 3D body model in a standing posture with feet apart and hands extended, a 3D body model in a sitting position with 100° knee bend and hands extended and a 3D body model with 100° knee band and hands extended, which sitting position was obtained by kinematic skeleton construction. Based on the results we also tested the suitability of a 3D skeletally body model and established relevant ease values' to construct pants- and T-shirt-patterns to perform virtual fitting to the 3D human bodies.*

Key words: *3D body model, skeleton construction, garment virtual prototyping, physically disabled people.*

1. INTRODUCTION AND MOTIVATIONS

According to the United Nations, people with lower body part disfunction belong to the group of persons with disabilities who represent the most numerous minority in the world with over 650 million inhabitants (approximately 10 percent of the world's population) (www.stat.si). Forced sitting position leads to bedsores formation and other health problems, such as incontinence and scoliosis. 3D human body in a sitting position would provide an effective garment pattern adaptation to specific physical dimensions to construct comfortable and aesthetic garments for opportunities such as sportswear, eveningwear and professional wear. It would enable a better choice of good looking and functional garments for unique figures, which do not always fit into standard sizes that are available in the stores.

2. THEORY

The CAD systems for garments' virtual prototyping usually offer parametric mannequins, whose adjustment of body dimensions is limited to the average body figure (Rudolf A. et al., 2013). For garment virtual prototyping for people with disabilities, an accurate 3D body model in a sitting position was developed (Kozar et al, 2012). Backbone injury or illnesses, which lead to sensory loss, is causing dysfunction of lower body parts. Therefore the dressing ability of such persons is completely affected (Pruthi et al., 2005). Some researches were oriented to develop functional textile materials and garments for people with paraplegia state (Sybilska et al., 2009). The differences between the standing and sitting position to develop appropriate garments for paraplegics and to assessed their fit to the human body in terms of wearing comfort on certain specific parts of the body in a 3D body model in a sitting position were identified (Rudolf et al., 2013).

3. METHODS

For the purpose of garment virtual prototyping for paraplegics we focused on the human body model adaptation to supply body measurements for nonstandard body shape characteristics. To perform 2D garment pattern design and simulation of garment's behavior we developed a 3D body model in a sitting posture. In our research we carried out the following activities: 3D human body scanning, measuring of 31 body measurements with virtual measuring tools and conventional measuring tape, kinematic skeleton construction for posture adaptation and garment pattern design and simulation.

3.1. 3D human body scanning

In our research we used the GOM Atos II 400 optical scanner (www.gom.com) to digitize the human surface with characteristics, shown in Table 1. The test person was scanned in a standing posture with feet apart hands extended and in a sitting posture with 100^{o} knee bend and hands extended.

Table 1: Configuration of GOM Atos II 400 (GOM MbH, 2005)

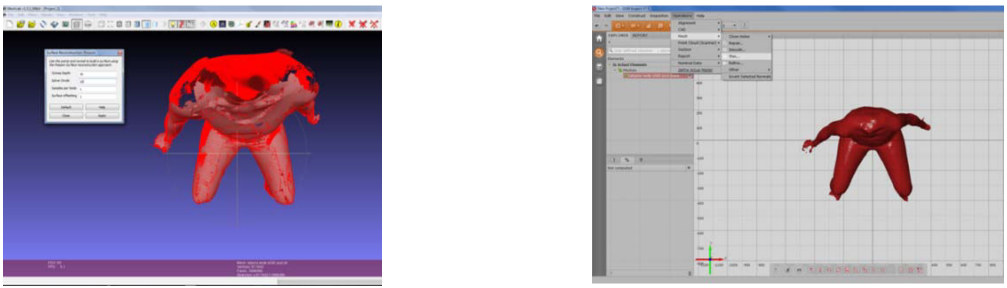
GOM Atos II 400	Measuring volume (mm^3)	Measuring point distance (mm)	Projector lens (mm)	Camera lens (mm)	Camera angle (α)	Measuring distance (mm)
	1200×960×960	0,94	6	8	22^{o}	1120

Based on a triangulation principle, the sensor unit projects fringe patterns onto the scanned subject, Figure 1(a), which are recorded by two cameras. The scanner generates up to 4 million data points per each measurement. We required several individual measurements from different heights and angles in order to digitize a complete subject. Each single measurement was polygonized into an independent mesh using the software Atos V6.0.2. The obtained polygonal meshes were then registered into a global coordinate system with the help of reference points (circular markers), Figure 1(b) and 1(c).

(a) (b) (c)

Figure 1: 3D scanning with GOM Atos II 400 optical system and registration of individual polygonal meshes with circular markers (Rudolf et al., 2013)

During the process deviations from the plane of the body were caused by small movements of test person's body. In addition to the difficult registration of individual polygonal meshes we performed accurate 3D body model reconstruction by using the Atos program for reducing number of polygons, Figure 2(a). For surface reconstruction we used the program MeshLab and its tool Poisson, Figure 2(b).

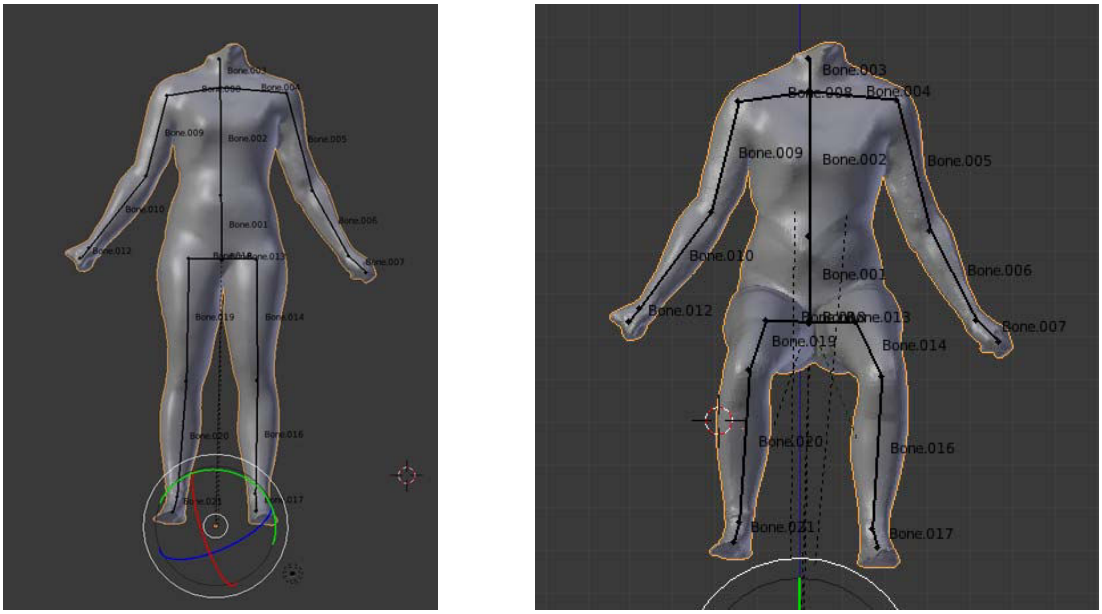


(a) (b)

Figure 2: Reducing number of polygons with program Atos (a), Surface reconstruction with program MeshLab (b)

3.2 Kinematic skeleton construction

For posture adaptation we carried out kinematic skeleton construction inside the watertight mesh of a 3D body model in a standing posture, Figure 3(a). We used the 3D graphic software Blender 2.68, which were later used to simulate posture adjustment, Figure 3(b). Blender is an open source freeware 3D graphic program, maintained by the Blender foundation. It enables creating animated films, visual effects, 3D printed models, interactive 3D applications and video games. (www.blender.org)



(a) (b)

Figure 3: Constructed skeleton inside the 3D body model (a), Posture adaptation(b)

A kinematic skeleton is a hierarchical structure of individual joints and bones and their transformations. Our kinematic skeleton is constructed by 19 bones and 20 joints and represents an approximation to the real human skeleton. To simulate posture adaptation in the window “Pose Mode” it was necessary to establish prior relationship “Parent- Child” between the watertight 3D mesh and the constructed skeleton. Individual skeleton segments are defined on the basis of transformations, such as translations and rotations.

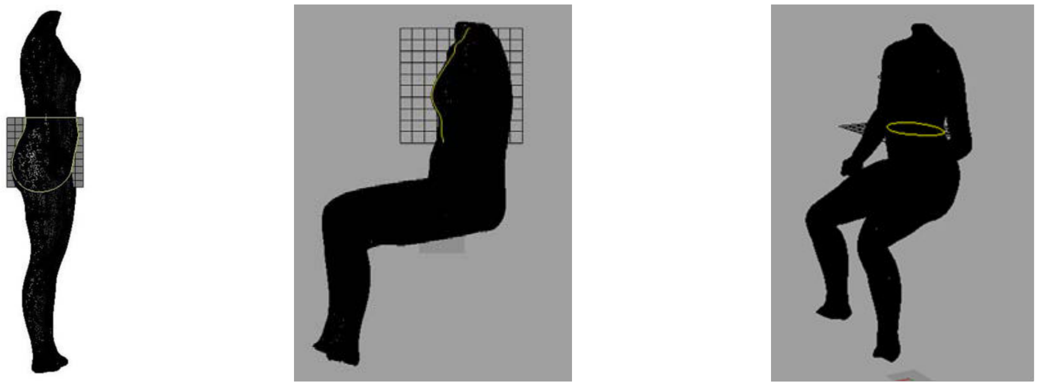
3.3 Virtual registration of body measurements

The aim of this study was to identify the applicability and reliability of 3D body models in a standing and sitting posture, obtained with an optical scanning system GOM Atos II 400 and also to test the suitability of the 3D skeletally body model, which posture was adapted true kinematic skeleton construction. We determined 29 body measurements from standard ISO 8559, shown in Table 2, and compared them with measurements, observed with conventional measuring tape on a real human.

Figure 3 shows 3D body models, imported as a .stl file in the 3D software Rhinoceros to observe virtual measurements of a 3D body model in a standing posture, Figure 3(a), of a 3D body model in a sitting posture, Figure 3(b), and a 3D adapted skeletally body model in a sitting posture, Figure 3(c). Rhino is a 3D nurbs, surface and solid modeller for Windows. It is designed for designing and creating 3D models and has some rendering capabilities (Rhinoceros Version 3.0, 2002). In order to observe body circumferences, we performed cross-sectional measurements with tools like “Mesh”, “Mesh Intersect” and “Analyse Length” and measurements of the body lengths and body height using a tool “Linear dimension”. Four body dimension were measured according to standard ISO 8559 and compared them with measurements of a real human body performed using a conventional measuring tape.

Table 2: Measured body dimensions, defined by International Standard ISO 8559 for garment construction and anthropometric surveys

Measured body dimensions			
1.	Upper breast circumference	17.	Upper arm circumference
2.	Breast circumference	18.	Outside leg length
3.	Under breast circumference	19.	Inside leg length
4.	Waist circumference	20.	Thigh length
5.	Upper hips circumference	21.	Arm length
6.	Hips circumference	22.	Cervical to breast point
7.	Total crotch length	23.	Front waist length
8.	Thigh circumference	24.	Back waist length
9.	Middle thigh circumference	25.	Shoulder width
10.	Knee circumference	26.	Waist height
11.	Under knee circumference	27.	High hip height
12.	Calf circumference	28.	Hip height
13.	Ankle circumference	29.	Knee height
16.	Wrist circumference		



(a) (b) (c)

Figure 4: Measured total crotch length on a 3D body model in a standing posture (a), Measured front waist length on a 3D body model in a sitting posture (b), Measured waist circumference on a 3D skeletally body model (c).

4. RESULTS AND DISCUSSION

4.1. Results related to virtual body measurements change values in comparison with traditional ones

When comparing real person's body measurements between a standing and a sitting posture, it is well known that some measurements increase dramatically in a sitting posture, such as hips circumference from 102,2 cm to over 107,49 cm for our example. Such changes affect the fit and wearing comfort which is especially important for garment pattern design for paraplegics. In order to test the accuracy and reliability of scanned data, which were observed with the optical scanning system GOM Atos II 3D, the traditional measurements and 3D scan measurements were compared as shown in Table 3, 4 and 5. We calculated change values and change rates for better imagination. It is evident that scanned measurements, such as hips-, waist- and upper arm circumference- were a little larger. Knee height and outside leg length were shorter due the incomplete mesh reconstruction at the sole area. Despite existing differences between the two types of measurements, the used optical scanner shows to be a useful technique to observe 3D body measurements.

Table 3: Body measurements change values (cm) and rates (%) of a 3D body model- standing posture

Body measurements	*Real person- standing posture (cm)*	*3D body model- standing posture (cm)*	*Change values (cm)*	*Change rate (%)*
Hips circumference	102,2	103,38	1,6	1,56
Calf circumference	39,29	38,2	-1.09	-2,7
Knee height	50,20	49,84	-0,36	-0,7
Outside leg length	105,25	104,8	0,45	0,43

Table 4: Body measurements change values (cm) and rates (%) of a 3D body- sitting posture

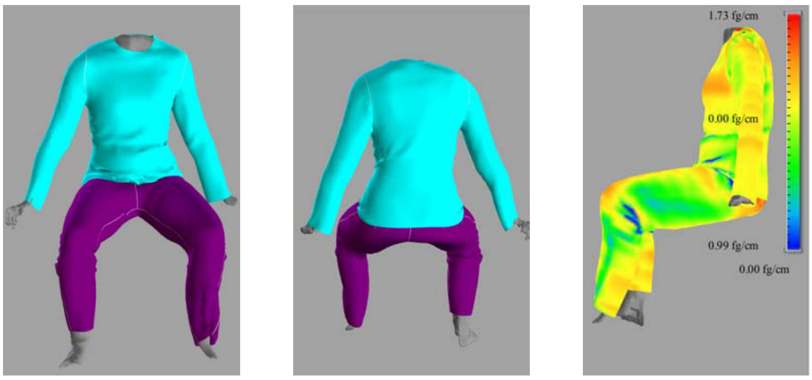
Body measurements	*Real person- sitting posture (cm)*	*3D body model- sitting posture (cm)*	*Change values (cm)*	*Change rate (%)*
Waist circumference	74,5	75,10	0,6	0,8
Hips circumference	107,49	109,20	1,71	1,5
Upper arm circumf.	27,76	28,75	0,99	3,5
Breast circumf.	84,2	85,6	1,4	1,6
Knee height	50,20	49,84	0,36	0,71
Outside leg length	104,5	103,78	-0,72	-0,68

Table 5: Body measurements change values (cm) and rates (%) of a 3D adapted skeletally body model

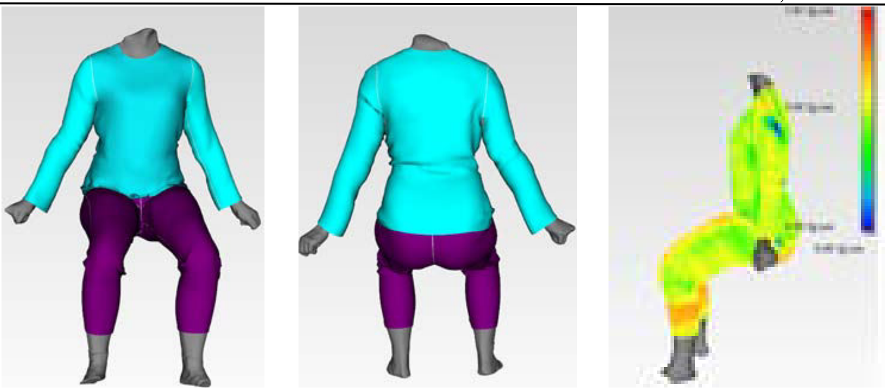
Body measurements	*Real person- sitting posture (cm)*	*3D skeletally body model- sitting posture (cm)*	*Change values (cm)*	*Change rate (%)*
Hips circumference	107,49	108,8	1,31	1,2
Under knee circumf.	35,23	36,34	1,11	3,1
Calf circumference	39,29	38,2	-1,09	-2,7
Knee height	50,20	48,9	-1,3	-2,5

4.2. Virtual prototyping of garments on 3D body models in a sitting posture

We established pants- and T- shirt patterns construction in order to simulate the garment behaviour and virtual fitting to the observed 3D body models in a sitting posture, Figure 5 (a, b).



(a) 3D body model - sitting posture



(b) 3D skeletally body model - sitting posture

Figure 5: Knitted cotton fabric deformation's (tension xy) on the 3D body models

We have used the Optitex 3D program and performed pattern design for cotton knitted fabric. To avoid trousers tension at the hips area, we took 1cm ease value at front trousers leg width and 1cm at back trousers leg width. To display measurement changes on body parts we used the tool Tension map. Higher fabric deformation is visible at the thigh-, bottom-, breast- and sleeve area on the 3D body model in a sitting position, Figure 5(a). On the 3D skeletally body model the highest deformation is visible at the calf-, thigh- and bottom area, Figure 5(b). Garment's deformation characteristics are in accordance with change rates from previous section.

5. CONCLUSIONS

In this study we performed 3D body modelling for a sitting posture for garment's virtual prototyping for people with nonstandard body shape characteristics. We established the great potential of optical scanning system GOM Atos II 400 for calculating change rates between the real- and scanned body measurements and simulating garment's behaviour as well as fabric deformations on the observed 3D body models. The constructed skeleton body model also shows good results which are evident by garment's appearance and small differences at change rates. In future work we will continue studying posture adaptation and establishing mesh parameterization of a 3D body model in a sitting posture to assure appropriate garment's design for people with physical disabilities.

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CONTRIBUTIONS TO THE PRODUCTION OF NEW TYPES OF KNITTED TEXTILE PRODUCTS WITH FUNCTIONAL BIOACTIVE AND CONDUCTIVE PROPERTIES

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Abstract:*Bioactive textiles produced on flat knitting machines as part of this research are designed to protect the body from germs, fungi, mites which can cause allergies and skin problems; they provide high comfort and ecological impact on the environment.*
The objective of the research was to diversify the assortments of knitted fabrics by:
- using new types of bioactive yarns (lenpur, lyocell, amicor, etc.) and conductive yarns in various mixtures;
- using conductive fibres and yarns in various knitted structures ensuring protection of persons working in environments with in high risk factors;
- scientific design of knitted structures using electronic flat knitting machines, by combining them in order to develop special bioactive, ecological and biocompatible properties;
The comparative study between lenpur fibers and lyocell, viscose, linen, cotton and synthetic fibers, respectively, revealed the main performances of lenpur fibers, which provide a high capacity for absorbing perspiration and release of liquids, as well as body temperature self-regulation *and anti-stress, with the view to prevent body odors. Moreover, lenpur yarns and knits proved high wear and care resistance correlated with excellent dyeability, thus minimizing the occurrence of streaks and unevenness in dyeing. New types of innovative knitwear for children and adults contribute to an increase of competitiveness for the knitted goods manufacturers by showing high quality of products as part of the research project.*

Key words*: innovative knitted structures, bioactive properties, lenpur fibers, conductive fibers and yarns*

1. INTRODUCTION

Textile materials that provide comfort, antimicrobial, antiallergenic and anti-stress protection, shielding for persons working in environments with high risk factors are increasingly needed to protect consumers' health, prevent disease and reduce environmental impact.
A new concept was created under the name of bioactive textiles with a view to transforming the passive role of textile materials to an active role with all its influence for the industry and for consumers.
To keep up with the strategy for upgrading the textile companies, the researchers' main objective was to achieve high performance technologies with low impact on the environment and human body, promotion of the use of raw materials with superior hygienic, antibacterial, antiallergenic and protective properties of the persons working in hazardous environments;

2. THEORY

There are several possible ways to add additional features to textiles: new fibers, fabric structure and/or superior finish. Fabric structure plays an important role in use, but can also have physiological and ecological functions. Product design can be adequate to the intended use, which means developing research and design studies on various types of machines. The following methods were used in research:
- adding fibres and yarns with new properties into knitted structures:

- superior antibacterial, antiallergenic, antistatic, ecological and comfort properties (lenpur, amicor, lyocell in various % and blends);
- conductive properties (obtained from spinning of textile fibres on a metal or carbon filament core, yarns produced from 100% conductive fibres or from blends in various proportions, yarns produced from pure conductive polyaniline fibres through conductive polymer coating or metal plating).

- characterization of new types of fibres and yarns;
- production of new types of textile structures and knitted fabrics that exploit the properties of new fibres and yarns correlated with their intended use;
- testing, analysis and characterization of new types of knitted fabrics;
- evaluation of the impact on the environment and human body.

Lenpur is a novel textile fibre selected from the branches of special trees. The fibre is eco-friendly and has a soft touch. The remarkable properties of wood provide textile materials made from Lenpur with extraordinary properties. Lenpur is considered the best "vegetable fibre produced by man". Fibres retain the wood's natural properties. The properties of Lenpur fibres (US Patent no. 005599784) are owed to the specific types of timber used for its production, independent of the process used for its manufacture. The main differences in Lenpur compared to other cellulose fibres is its *softness, its absorption capacity, its ability to release dampness (as a yarn or fabric), its deodorant properties, and its adsorption characteristics (due to its morphology).* When mixed with other fibres, Lenpur creates a "mechanical synergy" with them.
Unlike other cellulose fibers - which also use wood as a raw material, but are not limited to wood - Lenpur fibre is made of 100% cellulose. This particular resource from which the fiber is produced shows that its morphology and performances are extremely varied, as it is specified in U.S. Patent.

The main performances of Lenpur that are already observed in the past are a surface-like cashmere, high capacity to absorb perspiration and release of liquids, and a self-regulation capacity, thus avoiding the occurrence of odors, as seen in Fig. no 1. It is also characterized by a very good resistance to washing and by an excellent ability to retain its shape. Lenpur fibers can be used in the pure state or blended with any type of fiber. Laboratory tests have shown the following: capacity for absorption of this fibre derived from wood is by 35% higher than that of cotton, while this is almost double than that of viscose. Ideal knitted fabrics have the ability to control body heat. Microscopic studies revealed the following: Lenpur fibre has a grooved section with irregular diameter caused by convolutions, Lyocell fibres have a section which is almost cylindrical, the Modal section is two-lobed, the Viscose section is grooved an fairly regular in diameter and the Lenpur section is very grooved with irregular diameters caused by the “convolutions“.

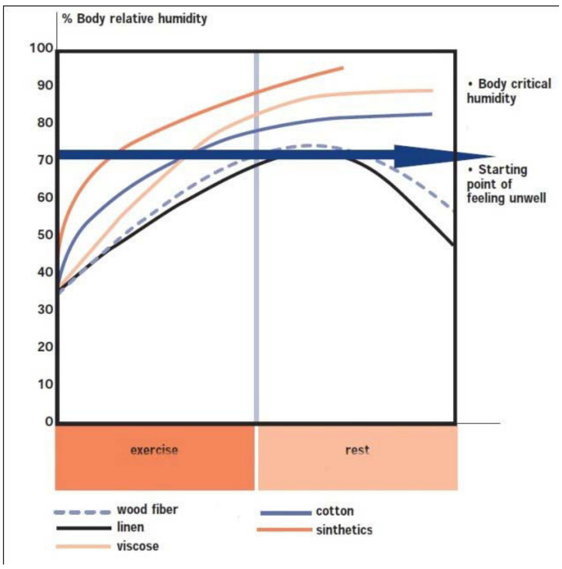

Figure 1: Capacity to absorb perspiration and release of liquids

3. METHODS AND FINDINGS

3.1. Characterization of Lenpur yarns

As shown in Table 1 the following considerations were made on physical-mechanical and appearance properties of Lenpur Ne20 yarns:
- uniformity of fineness is at an appropriate level, of 1.85 to 3.75%, thus providing a good uniformity of knitted fabrics, including plain knitted fabrics;
- tensile strength and coefficient of variation (CV) show adequate values, as a result good processability on automatic flat knitting machines and high productivity;
- elongation at break shows high values ranging from 7.45-7.99%, which allows the production of a wide variety of knitted structures;
- twist and coefficient of twist variation show very good values providing the knitted fabrics with very good appearance uniformity, good processability on machines.

Table 1: Physical-mechanical and appearance properties of Lenpur Ne20 yarns

No.	Properties	UM	Sample			Standard
			Lenpur yarn – light green	Lenpur yarn - orange	Lenpur yarn - black	
1	Length density	Tex (Nm)	29.0 (34.2)	27.6 (36.2)	29.6 (33.8)	SR EN ISO 2060:97
		Cv%	3.75	3.0	1.85	
2	Tensile strength	N	2.78	2.55	2.72	SR EN ISO 2062:2010
		Cv%	6.81	8.62	7.85	
3	Elongation at break	%	7.99	7.45	7.77	
		Cv%	7.62	5.9	7.83	
4	Twist direction		Z	Z	Z	ISO 2/1973
5	Twist	t/m	626.8	628.8	623.1	SR EN ISO 2061: 2011
		Cv%	5.27	5.25	7.5	
6	Apparent diameter	µm	252.6	217.3	253.2	SR 13152:93

Data presented in Table 2 with reference to colour fastness of Lenpur Ne20 yarns show:
- colour fastness values are very good, providing very good wear and care behavior correlated with excellent dyeability, thus minimizing the occurrence of streaks and unevenness in dyeing;
- cold and hot washing resistance is better than that of conventional cellulose man-made fibers. Excellent dyeability for the dye minimizes the occurrence of streaks. Lenpur fibers have also excellent dyeability.

Table 2: Colour fastness properties of Lenpur NE20 yarns

No.	Properties			Sample			Standard
				Lenpur yarn - orange	Lenpur yarn – light green	Lenpur yarn - black	
1	Colour fastness to washing	Color change		4 - 5	4 - 5	4 – 5	SR EN ISO 105-C 06: 2011
		Colour bleeding	Diacetate	5	5	4 – 5	
			Cotton	5	5	4 – 5	
			PA	5	5	4 – 5	
			PES	5	5	4 – 5	
			Acryl	5	5	4 – 5	
			Wool	5	5	4 – 5	
2	Colour fastness to acid perspiration	Colour change		5	4 - 5	4 – 5	SR EN ISO 105-E 04: 2012
		Colour bleeding	Diacetate	5	5	4 – 5	
			Cotton	5	5	4 – 5	
			PA	5	5	4 – 5	
			PES	5	5	4 – 5	
			Acryl	5	5	4 – 5	
			Wool	5	5	4 – 5	
3	Colour fastness to dry rubbing			5	5	4 – 5	SR EN ISO 105-X12: 2003

4	Colour fastness to wet rubbing			5	4 - 5	4 – 5	
5	Color fastness to water	Colour change		5	5	4 – 5	SR EN ISO 105-E 01: 2011
		Colour bleeding	Diacetate	5	5	4 – 5	
			Cotton	5	5	4 – 5	
			PA	5	5	4 – 5	
			PES	5	5	4 – 5	
			Acryl	5	5	4 – 5	
			Wool	5	5	4 – 5	

3.2. Characterization of knitted fabrics made from Lenpur yarns

Table 3: Physical-mechanical properties of knitted fabrics made from Lenpur yarns

No	**Properties**	**UM**	**Sample**				
			L.1	**L.2**	**L.3**	**L.4**	**L.5**
1	Mass	g/m^2	183	382	338	548	447
2	Density	Do/10cm	65	69	58	18.5	79
		Dv/10cm	87	92	102.5	24.5	106
3	Bursting strength	(kgf)	No burst	No burst	No burst	No burst	No burst
4	Abrasion resistance	no. of cycles	>10000	>10000	>10000	>10000	>10000
5	Pilling	note	4 – 5	4 – 5	4 – 5	4 – 5	4 – 5
6	Hygroscopicity	(%)	10,8	11,2	10,8	10,8	10,8

Correlation between physical-mechanical properties of knitted fabrics produced shows:
- uniform appearance of knitted fabrics;
- very good abrasion resistance (> 10,000 cycles) which is due to both the properties of yarns (high tensile strength) and the corresponding settings of knitting machines as well as the design of structural parameters appropriate for the field of application;
- very good pilling (grade 4 – 5);
- superior hygroscopicity as compared to knitted fabrics made from other cellulose yarns

3.3. Development of conductive knitted products

As there is a need to develop knits that offer protection to persons who work in hazardous environments, highly complex research activities are under way in order to correlate the comfort and protection characteristics by combining knitted structures with new raw materials.
Considering that we have previously approached especially the comfort characteristics of yarns and knits, we shall refer in these chapters to technical aspects of the protective characteristics of persons who work in hazardous environments. The study and the research work were conducted by introduction in the knitted structure of new conductive fibres and yarns.

Conductive yarns can be obtained from conductive fibres, conductive filaments, classical yarns coated with conductive polymers, metal-plated yarns, conductive yarns obtained from 100% conductive fibres or from a mix of various ratios, yarns coated with conductive powders such as carbon, metal powders. These can be used in applications as anti-static products, heating elements, signal transfer, electromagnetic shields. Highly conductive yarns can offer static control in a large variety of industrial fields: conveyor belts, woven filters. Conductive yarns can generally be sewn, knitted or woven: metal coated yarns; carbon core yarns; conductive polymer yarns; metal yarns (mono-filament and multifilament).

Figure 2: Conductive yarns

3.4. Use of conductive fibres and yarns in knitting products made on flat knitting machine

Conductive fibres and yarns are instruments to be developed on those markets where uncontrolled static discharge may pose quality, health and security problems. As many textile producers are looking for new opportunities with a higher added value for their clients, besides the mass production, the products developed to control electrostatic discharge are a current theme.

Current ESD clothing articles do not fully solve the problem of accidental electrostatic discharges. In order to develop an ESD clothing product with better characteristics the development of a two-layer structure was proposed in the current project: an external and an internal layer. The two layers differ in terms of electrostatic behaviour and allow for solving problems that cannot be solved by the use of one single layer.

The external layer is the surface of the material being in direct contact with the human operator work environment and the internal layer is the surface being in contact with the operator. In these conditions the two layer approach permits the demarcation of the accidental discharge path from the controlled discharge path of the material electrical charges.

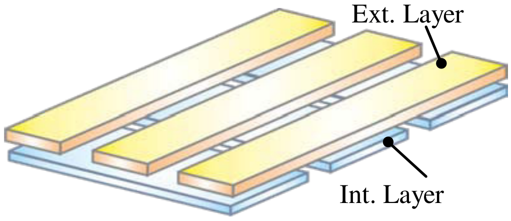

Figure 3: The equivalent structure for knitted textiles

The external layer needs to have a higher surface resistivity so that it does not allow for a path with high circulation of static energy. This is accomplished by using insulating/dissipative materials. Moreover, the structure of the external layer is composite, the constituent yarns having conductive core. The conductive part of the external layer has no contact with the environment. The internal layer was introduced to provide a larger drainage surface for the electrical charges than the surface ensured by the conductive part of the external layer. This layer can be made of composite yarns with conductive core, but also of composite yarn with conductive core that has no contact with the environment.
The external layer is predominantly dissipative and it provides protection to short circuit and the limitation of the electrostatic energy that can be dissipated to the work environment and the internal layer is predominantly conductive, providing controlled drainage of cumulated electrostatic charges.
An additional requirement for the internal layer is to provide comfort to the user.

An important activity is to determine the yarn/fibre type/structure on the basis of ESD/EMC tests and investigations in order to ensure higher ESD properties to the two-layer knitted structure.

4. CONCLUSIONS

The development of new types of bioactive and conductive products on automatic flat knitting machine is expected to lead to a more efficient using of the machines in the textile companies. Better antibacterial, antiallergenic, antistatic, protective, conductive, ecologic and comfort properties lead to higher quality products due to: prevention of skin diseases and allergies; improvement of comfort characteristics (rapid drying, reduced weight, thermal insulation capacity, higher elasticity, good hygroscopicity, soft touch, pleasant adherence to the body, freshness and coolness); protection of persons who work in hazardous environments; easy care, good wear resistance; low environmental impact.

AKNOWLEDGEMENTS

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THE INFLUENCE OF AIR GAP BETWEEN NANOFIBROUS LAYER AND RIGID WALL ON THE SOUND ABSORPTION BEHAVIOR

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Abstract: *Low frequency sounds are very difficult to absorb with fibrous material made up of coarser fibers because of their long wavelength. For low-frequency absorption, the structures based on the resonance principle of nanofibrous layers are found to be relatively efficient in converting acoustic energy into thermal energy. This paper deals with the sound absorption behavior of a nanofibrous resonant membrane. The nanofibrous layer was produced using a needleless electrospinning process, from PA6 solution. Two-microphone Impedance Measurement Tube Type 4206 was used to measure the sound absorption coefficient in the frequency range 50Hz to 6.4kHz. The effect of the air gap between the nanofibrous layer and rigid wall on the sound absorption coefficient of nanofibrous membrane was analyzed. The results of the study indicate that the sound absorption coefficient of nanofibrous membrane increases with the increase in air gap.*

Key words*: low frequency sound, nanofibrous resonant membrane, two-microphone impedance tube, sound absorption coefficient, air gap*

1. INTRODUCTION

Sound absorption materials are used to reduce sound pressure level to an acceptable level since high sound pressure level could create listening discomfort in the closed spaces. There are mainly four types of sound absorption materials available that can be used as sound absorbers, namely, porous absorbers, Helmholtz resonators, membrane absorbers and perforated panel absorbers. Fibrous textile materials as porous absorbers are widely used in acoustic applications. However, for lower-frequency sound when the incident wavelength is larger, the absorption is problematic with fibrous material made up of coarser fibers. In that case, highly efficient sound absorption materials from much finer fibers must be developed. For low-frequency absorption, structures based on the resonance principle of nanofibrous layers are employed in which the resonance of some elements allows acoustic energy to be converted into thermal energy.

The literature review showed that there is a limited number of reports on acoustic behavior of nanofibrous membranes, despite the fact that the use of such structures is common in the acoustic applications. The sound absorption behavior of nanofibrous resonant acoustic membranes was studied by some researchers [1-6]. The results of these studies have shown that nanofibrous material is a highly efficient sound absorber [1,2]. In addition to the finding above, it was demonstrated that the resonance frequency of the nanofibrous membrane decreases with increasing mass per unit area of the membrane and increases with decreasing average diameter of the nanofibers [3]. A comparative study which investigated sound absorption behavior of nanofibrous layer and polyethylene foil with the same mass per unit area implied that nanofibrous layer had higher sound absorption coefficient than foil [4]. Ozturk et.al. [5] developed a novel optical method for predicting the sound absorption behavior of the membranes in their paper and analyzed the effect of measurement equipment settings on resonant behavior of the nanofibrous membrane. Finally, Ozturk et.al. [6] compared resonance frequency of a nanofibrous membrane with a homogenous membrane structure under different experimental set-ups with using this novel optical determination method.

This paper deals with the sound absorption behavior of a nanofibrous resonant membrane and analyzes the effect of the air gap size between the nanofibrous layers and a rigid wall (5; 10; 15 mm) on the acoustic behavior of nanofibrous membrane.

2. EXPERIMENTAL STUDY

2.1 Material

PA6 polymer was used for preparation of the solution for the experiment. The solution containing PA6, acetic acid and formic acid was stirred at 80°C for 5h. PA6 solution was prepared with concentration of 10%wt.

2.2 Sample preparation by electrospinning process

PA6 nanofibers were prepared with a commercially available NanoSpider™ machine (Elmarco s.r.o. Liberec, Czech Republic, http://www.elmarco.com/) equipped with wire rotational electrode (see Fig. 1).

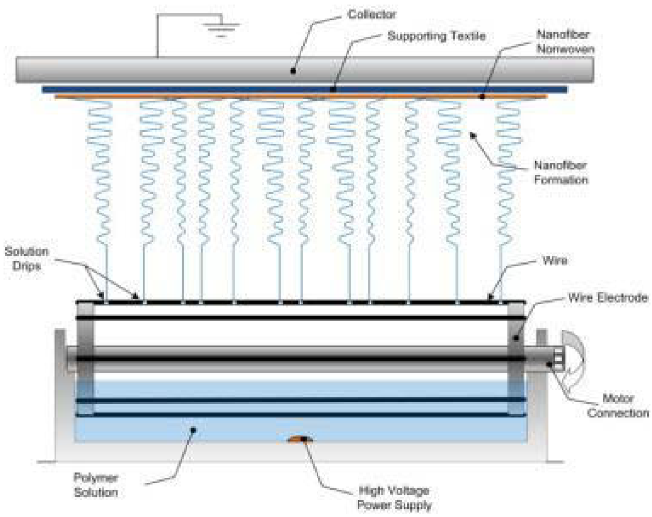

Figure 1. Scheme of the electrospinning process [7]

The experimental conditions were as follows: relative humidity 29.2%, temperature 22.9 °C, electric voltage between wire rotational electrode and collector (electrode) 120kV, distance between electrodes 200mm, rotational electrode speed 3 rpm and speed of supporting textile collecting nanofibers was 0.04 m/min (4 times). Mass per unit area of the nanofibrous layer was 5.05 g/m^2.

2.3 Characterization

The fiber structure and fiber diameter of the electrospun PA6 fibers were determined using scanning electron microscopy (SEM). A small section of the fiber mat was placed on the SEM sample holder and was sputter-coated with gold (Quorum Q150R Rotary-Pumped Sputter Coater). Carl Zeiss Ultra Plus Field Emission SEM using an accelerating voltage of 1.48 kV was employed to take the SEM photographs. The average fiber diameter was calculated from the SEM images using image analysis software (NIS Elements BR 3.2). More than 100 fibers were counted from at least 4 SEM images which were taken from different places of a sample. Average diameter of nanofibrous membrane is 160±40nm.

2.4 Measurement of the Sound Absorption Coefficient

The nanofibrous membrane was cut in suitable sizes for putting into the impedance tube for both large and small tube and was placed to a supporting ring (Figure 2).

Figure 2. Nanofibrous membranes supported in ring

Two-microphone Impedance Measurement Tube Type 4206 was used to measure the absorption coefficient in the frequency ranges 50Hz to 6.4kHz (Standard Large Tube setup for samples diameter 100mm: 50Hz to 16kHz, Standard Small Tube setup for samples diameter 29mm: 500Hz to 6.4kHz).The test was made according to standard ISO 10534-2 [8]. Pulse software was used for acoustic analysis.

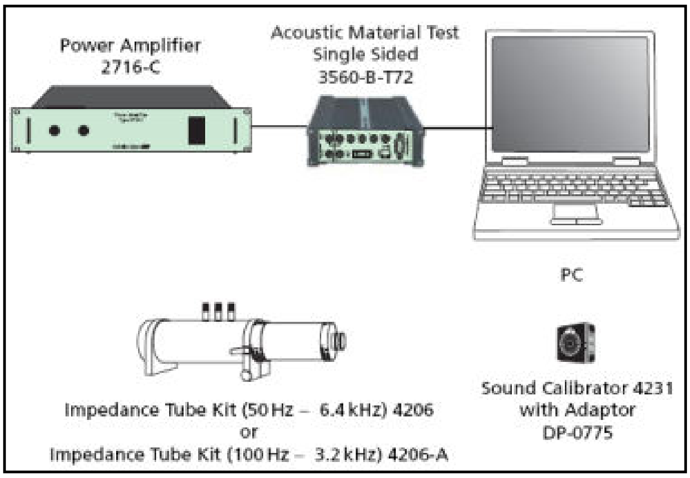

Figure 3. Impedance Tube Setup [9]

3. RESULTS AND DISCUSSION

The results of measured sound absorption coefficient α as a function of the frequency *f* and size of air gap between the membrane and rigid wall are compared.

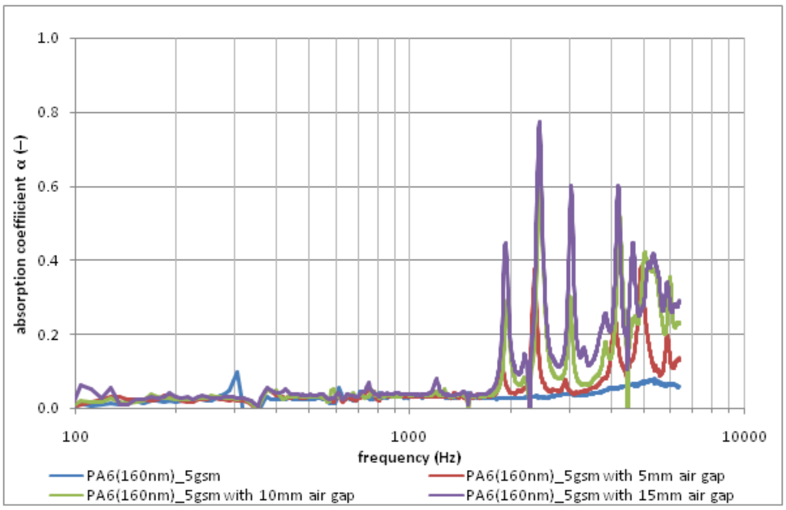

Figure 4. Measured sound absorption coefficient (α) of the nanofibrous membrane as a function of sound frequency f.

The figure shows that the presence of an air gap between the nanofibrous membrane and a rigid wall improves the sound absorption property and the absorption increases with increasing air gap size. On the other hand, from the figure it can also be seen that the resonant frequencies seem to be constant. The incident sound wave causes the PA6 nanofibrous membrane to vibrates. No space is left to the membrane to vibrate when the membrane is adjacent to the wall. With the presence of the air gap, the membrane can more easily vibrate and dissipate the acoustic energy to heat. It is also apparent that the maximum sound absorption values are obtained at resonant frequencies of the membrane and the curves suggest that the membrane shows not only resonance but also anti-resonance which is the cause of the loss of absorption.

4. CONCLUSION

In this paper, the effect of the presence of an air gap behind a PA6 nanofibrous membrane on the sound absorption behavior the membrane was studied. The results suggested that increasing the air gap between the nanofibrous membrane and the rigid wall improved the sound absorption capacity of the system. On the other hand, the air thickness did not seem to have an effect of the resonant frequency of the membrane where its sound absorption of reached the peak values.

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COMPUTER MANAGING OF TEXTILE AND APPAREL PRODUCTION PROCESS BY APPLICATION OF THE PIPP PROGRAM

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Abstract: *Textile and clothing production processes are developing simultaneously with the progress of human knowledge and science. Today, the modern clothing production includes a complex technology and a variety of managing processes toward a high quality production and finding adequate markets. For instance, the application of electronic computers in the textile and clothing industry has started immediately after their commercial appearance on the market and today it represents in the CIM concept unavoidable and more accurate to say the dominant factor in the managing of complex processes.*
Within this the contribution of the application of the specialized user suitable computer program for planning and monitoring of production based on the original PIPP program has been objectively researched, as an integral system for methodological improvement of managerial and production processes in the textile and clothing industry. The PIPP program besides that also contributes to the further rationalization of the overall process, productivity and quality of the production as well as the exact monitoring of all production activities.

Key words: *Technological aspects of fashion apparel, learning, knowledge, science, computer programs, rationalization process*

1. INTRODUCTION

As previously mentioned in the abstract, the technological processes of the production of textiles, technical textiles, the apparel and fashion industry are constantly evolving with the progress of technology [1,2]. The assumption is that the higher education is going to develop as well and it will adapt to the needs of modern industry. This implies that high education system needs to provide adequate training for the students, and to provide them all the necessary knowledge as they could gain skills and practical abilities for successful and complete integration of learning and work [3] Concentrated and motivated learning during education in the high education system is of an invaluable social interest as well for the individual, expert in the textile and fashion industry. The author of the article suggests learning as a lifelong challenge, about that further more in the extension of the article. Gaining practical and computer knowledge has to be the main goal of educational institutions, teaching the skills or active business knowledge, within a certain practical context. Therefore educational institutions in high education system need to understand today's fast dynamic production and market circumstances, and they have to encourage computer and innovation projects with which they will achieve the necessary changes and progress of the education with practical application. Traditionally planning of textiles and clothing in the modern industrial processes is in the past, it is now dominantly replaced by sophisticated computer programs that combine the overall planning and production process which will be further explained in extension of the article [1, 2]. Therefore, the use of appropriate and productive computer programs is a fundamental precondition for success in complex technological processes [3, 4]. Success is gained by skill; a skill is gained by exercise with strengthening of the theoretical knowledge [5]. Then it means, that in the field of technical sciences the synthesis of this two factors is lifelong, affirmative and motivational experimenting [4].

2. SCIENCE, CREATIVITY AND COMPUTER PROGRAMS

Clothing technology has long ago ceased to be only the technology of "scissors, needle and thread".

This is now just the basis for the production of clothing. For this reason it is necessary in this article to explain the role and the importance of the scientific approach and the concept of creating custom computer programs.

Under the creation one should comprehend the creative abilities in creation, production, making, development, performance, invention, invention of certain works: paintings, sculptures, clothing design, creation and construction, poems, novels, symphonies, new products. Such acts can only create exceptionally talented and motivated people, skilled, experienced, creative, inventive, people who know how to manage their mind, people who know how to organize and how to work dedicatedly. There is no special need to prove the scientific fact that without science there is no creation, but without creation there is no science. So one can speak about scientific creation, and creation based on science, without which there would be no past, present and future.

Thus, the creational computer programs and scientifically grounded computer programs began to appear in the clothing and fashion industry about two and a half decades ago, therefore somewhat later than in some other industries. My first encounter and familiarizing with these sophisticated computer programs took place at IMB in Kölln in the year 1991, during the exhibition of machinery and equipment for the clothing and fashion industry.

Since this is so, all the intelligent beings on the planet Earth should classical creation not only transform into scientific creation but with all human, moral and ethical resources and potentials, the latter gradually anticipate in sustainable scientific creation.

Creative works were creating and are still creating, and will create them in the future, intelligent, educated, talented, creative, inventive, skilled , experienced, lucid, witty, diligent, disciplined, hardworking people in all areas of their activities, such as: philosophers creating philosophical works, artists create their works, writers create literary works, economists create economic acts (economic laws, economic legitimacy, economic theory), lawyers create legal acts (rules of law, legal institutions, legal acts), construction engineers create construction works (buildings, bridges ...). Textile engineers create production- organizational and logistical structures. Creating technological lines take responsibility for the hundreds of workers to provide them work, how to produce in as short time as possible, with high quality, ingenuity, dressing comfort, clothing fit: clothing attractiveness. Special roles have the designers, creators and their solutions for today and tomorrow.
For this last part which we want to explain there are in use two ways of thinking as follows:
Convergent (non-creational) thinking. Such thinking is focused directly to one goal or solution. When one thinks convergent, he is satisfied with one correct answer or solution that satisfies the given condition which comes in particular case from superiors in the organizational hierarchy.
Divergent thinking. For such thinking the multilateral approach to the solution is of significance. Based on one information by divergent thinking we create two or more information. Such thinking is significant for creative creators. This can be more a characteristic for the fashion designer as well as for the programmer and technologist in creating high performance custom computer programs.
Focus. Through focus one can check what some data may mean. Focus is the way someone manages its openness. In the creation process the data must be selected, extracted and purified. What is extracted in the process is the focus. It is in the center of interest. Focus is the direction of thinking.
Discipline. There is no creativity and creation without work and discipline; we all who worked in the demanding textile and fashion industry know what means a good discipline when hundreds of workers are involved in making only one or a few products.
Completion. Every well designed creative venture should be also completed. In reality it is not so. Many creative processes start, and only a few of them finish: about 25 %, as the scientific studies show.

Creators need to be educated according to special programs. With their education should begin in kindergarten and elementary school, and to continue intensive and targeted in high school (...) to the doctorate. And it's not the end of their training: it continues and lasts the entire work or life

expectancy.
Each educational process of creative creator has three main phases:
1) the preparation process of education (with many sub phases),
2) the implementation of educational process (with many sub phases), and
3) completion of the education process (with many sub-phases..).

In every economic sector: primary, secondary, tertiary, quaternary and quinary there are creators who create their works. All such acts are highly sophisticated works that are based on science and creativity All this supports the way of interactive synergy between science and art.

In the last fifty-sixty years more changes occurred compared to several centuries before that. This is particularly evident in the visible changes in the field of science, creativity, business, engineering, technology, culture, communication, social changes. There are obvious changes of organic and inorganic systems as a direct or indirect result of the actions of the previously mentioned visible changes. There are also many invisible changes in nature, society, family, that have local, regional and global features. In the extension is specially described, the scientifically based, creative and conceptual contribution which refers to a sophisticated computer program for planning and monitoring of production in the fashion industry under the commercial name PIPP.

3. THE CONCEPT AND IMPLEMENTATION OF THE PIPP COMPUTER PROGRAM

Philosophy, scientific approach, conception and implementation of the PIPP computer program is based on synergetic scientific and professional connection and interaction of excellent technologists, designers and computer programmers.

In a situation to create the concept of a computer program PIPP one should know all of the organizational and technological-constructional legalities in all production and logistic structures from the procurement of materials and raw materials to the delivery and wholesale of the finished goods. It is a very demanding and responsible work that requires the maximal coordination, concentration and motivation.

The three mentioned can even be said colossus, require several months or over a year period of mutual cooperation if the desired result is" a custom computer program". Set up in a full functional basis with the intention of methodological and organizational improvement. The PIPP computer program requires a complete scientific approach, for example some segments of the program require sophisticated correlation and have to be significant in practice. For example, planning the utilization of textile materials is based on data from the storage and computer subroutine of cutting plan to a specific work order. These work orders in the PIPP computer program are complete and provide greater accuracy, motivation for work and production and control of procedures. The PIPP program is all the time in interaction and it allows the direct and immediate access to all data. Further the selection of cutting pattern from subroutine cutting plan the PIPP program automatically recalculates how many cutting layers can be cut out from the activated block of materials and displays material consumption for the amount of cutting out one cutting layer to as much material as it can be cut out. Consequent after activating the work order for the production process and a clear choice amount of material the PIPP program currently takes away all the necessary quantities of material and it automatically displays the new, real state of the warehouse in all segments of the production.

The PIPP computer program becomes very quickly efficient and economically profitable. A special feature of the PIPP dedicated program is his modular character according to which it can be upgraded and modified again in a common synergy of excellent designers, technologists and programmers with a high scientific and professional approach in all business activity segments. In this way the textile and fashion industry can become actually competitive in the global market, it can provide all efficient and organizational requirements, and thereby reduce the overall business costs as the PIPP program covers the entire business activity segment.

4.CONCLUSION

Today the modern clothing production includes a complex technology and a variety of management processes in order to develop high quality production and finding adequate markets. The implementation of appropriate and productive computer programs is fundamental prerequisite for success in complex technological processes. Philosophy, scientific approach, conception and implementation of the PIPP computer program is based on synergetic scientific and professional connection and interaction of excellent technologists, designers and computer programmers.

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RESEARCH OF GARMENT FIT TO BODY SHAPE THROUGH EASE ALLOWANCE QUANTIFICATION

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Abstract: *The garment fit to the body shape through ease allowance quantification was investigated within this study. For this purpose we have chosen test persons of different body shapes and dimension and the basic dress pattern designs without sleeves was carried out according to the measured body dimension. The dress pattern designs were prepared with three different ease allowances considered on measures of the breasts, waist and hips circumferences. The assessment of garments' fit to body shapes in areas of the breasts, waist and hips was carried out in the standing and sitting position in relation to the ease allowance, as well as the subjective evaluation of test persons' comfort when wearing garments. The results of the research showed that perception of comfort when wearing garments differ for different body shapes, although these were constructed according to the same construction rules and body dimensions of the test persons with the same ease allowances. The deviation of garments fit to different body shapes was also significant. It was found that body shape with greater circumferences in the breasts, waist and hips needs greater ease allowance than those with smaller circumferences.*

***Keywords**: Body shape, garment pattern design, garment fit, ease allowance.*

1. INTRODUCTION

Garment fit to the body shape is one the most important futures for appearance in the garment that attracts attention of the customers. It is also essential for garment comfort and consumer satisfaction. Moreover, garment fit refers to several areas, such as garment pattern design, anthropometry, garment comfort, apparel psychology etc. The definition of garment fit changes from time to time. The most important factors that affect consumer's perceived satisfaction of garment fit are physical comfort, psychological comfort and appearance (Shan Y. et al., 2012, Fan J. et al., 2004).

Dressing requires finding clothes that fit our bodies and the way we look (Laitala K. et al., 2011, Entwistle J., 2000). The fit of clothing contributes, among other things, to the confidence and comfort of the wearer (Laitala K. et al., 2011, Alexander M., 2005, Klepp I., 2008). Fit refers to how the clothing conforms to the three-dimensional body in a comfortable and pleasing manner. It is determined by proportional relationship between dimensions and the body shape of the used sizing system (Ashdown S.P., 1995, Brown P., 2001, Fiore A.M., 2010). Moreover, fit is crucial to consumer satisfaction. It was researched the importance of determining levels of satisfaction with retail attributes and the fit of ready-to wear clothes. When clothing does not fit well, consumers blame their bodies, which results in a negative body image (Apeagyei P.R., 2008, LaBat L.K. et al., 1990). It was found that the clothing size number had influence on women's self-image and less on the decision to buy clothes (Selko U. et al., 2012). In addition, for younger women between ages of 19 and 30 years the size number was more important when buying clothes than for older women between ages of 31 and 40 years. The younger women were also more interested with their body shapes. Therefore, they had greater pretension about their ideal body figure and size number (Selko U. et al., 2012). A number of other studies had also shown that the appearance and physiological comfort are important attributes when wearers assessing the garments fit.

The sizes of garment pattern design depend on body dimensions and addition or subtraction of the ease allowance. Ease allowance is the numerical difference between the dimensions of the pattern and those of the subject (Gill S., 2011). When determining the garment dimensions, the body dimensions are constant and the ease allowance variable. Amount of ease provide well-fitting and functional garment.

In generally, ease allowance is divided in two types (Shan Y. et al., 2012). Firstly, the wearing ease allowance, which refers to the amount of added fabric allowed over and above body dimension to ensure comfort, mobility and drape of the garment, and secondly, design ease, which refers to the amount of added fabric to achieve certain design and shape of the fabric. Ease allowances can be classified also according to three different functions (Ng R. et al., 2008). These are: (a) the basic movement, breathing and sitting require static ease allowance that is also known as standard ease, (b) the non-standard body shapes (fat, thin, big hip, strong leg,…) and for their movements (walking, jumping, running, etc.) need dynamic ease allowance and (c) styling ease, which is the extra spacing to conform the required shape. Similar ease allowances also refers Y. Chen (Chen Y. et al., 2008) and points out that it is important also fabric ease allowance, which takes into account the influence of mechanical properties of the fabrics of the garment. S. Gill (Gill S., 2011) stated that contributing factors of the ease allowance are function, comfort, oversize, fabric and styling. Functional ease allowance relates to the wearer being able to perform movements without the garment binding. Comfort ease allowance relates primarily to wearer perception based on sensorial comfort, while the oversize ease allowance is needed for outer garments. Fabric characteristics are essential for garment pattern design and adding of the positive or negative ease allowance, respectively. Styling ease allowance relates to the particular garment style, therefore, it isn't essential when defining the basic pattern block. Stretch fabric characteristics require special garment pattern design, especially those made up from knitted stretch fabrics (Rudolf A. et al., 2012). It can be summarized that garment fit is dependent on more details than the basic size. The size tables often based on four body dimensions, such as body height and breasts, waist and hips circumferences, while the proportions and distances between these body dimensions vary greatly between the individuals. Therefore, when constructing the garment it is important to use such ease allowance that complies with the type and intended use of the garment, used fabric and body shape of the individual.

This main aim of this research was to investigate the garment fit to body shapes through three different ease allowances considered on measures of the breasts, waist and hips circumferences by assessment of garments fit in areas of the breasts, waist and hips in a standing and sitting position, as well as the subjective assessment of the test persons' comfort when wearing garments.

2. EXPERIMENTAL

To investigate the garment fit to body shape through ease allowance quantification the conventional model of a narrow women's sleeveless dress was used. Such a model fit the body and at the same time must allow comfort when wearing a dress and undisturbed movement of the person in it, respectively. It must also allow normal breathing of the person, which should not be restrict by dimensions of the dress.

For the research two test persons of different body shapes and dimension were chosen and their basic body dimensions, such as body height, breast, waist and hips circumferences, were measured, Table 1. For the construction of basic pattern designs of women's dresses the proportional dimensions were calculated using expressions of the M. Müller & Sohn construction system (M. Müller & Sohn, 1992).

The dress pattern designs were prepared with three different ease allowances considered on measures of the breast, waist and hips circumferences. These were 2.0, 4.0 and 6.0 cm, Table 2. On the measure of the breast circumference the ease allowance was divided on proportional dimensions of the back width, armhole width and breast width, as can be seen in Table 2. The ease allowance for the measure of the armhole depth was the same for all dress pattern designs and amounted 1.0 cm. The dresses were sewn from white 100% cotton fabric in plain weave and surface mass of 155.26 gm^{-2} (Kocbek M., 2013).

Table 1: The basic body dimensions of the test person 1 (TP1) and test person 2 (TP2)

BODY DIMENSION (cm)	TEST PERSON		
	TP1	TP2	Difference between bodies dimensions (TP1 – TP2)
Body height	167.0	165.0	2.0
Breasts circumference	85.0	90.0	-5.0
Waist circumference	75.0	80.0	-5.0
Hips circumference	97.0	100.7	-3.7

Table 2: The ease allowances for construction of the dress pattern designs

DIMENSION (cm)	EASE ALLOWANCE		
	Dress pattern design 1 (DPD1)	Dress pattern design 2 (DPD 2)	Dress pattern design 3 (DPD 3)
Armhole depth	1.0	1.0	1.0
Back width	0.0	0.5	0.5
Armhole width	0.5	0.5	1.0
Breast width	0.5	1.0	1.5
½ breasts circumference	1.0	2.0	3.0
Breasts circumference	2.0	4.0	6.0
Waist circumference	2.0	4.0	6.0
Hips circumference	2.0	4.0	6.0

The assessment of the fit and comfort when wearing dresses was carried out on the basis of:
(a) analysis of the test persons' body shapes,
(b) analysis of the ease allowances on the sewn dresses,
(c) assessment of dresses fit to body shapes in area of the breasts, waist and hips in a standing and sitting position. It was observed if the dress: (1) is too tight, (2) fit the body shape and allows freedom of movement and breathing of the person in it and (3) is loose, and
(d) subjective assessment of the test persons' comfort when wearing dresses in areas of breasts, waist and hips in a standing and sitting position by means of a questionnaire.

3. RESULTS WITH DISCUSSION

3.1 Analysis of the test persons' body shapes

The test person 1 is higher than the test person 2 for 2.0 cm. Her breasts and waist circumferences were smaller for 5.0 cm and the hips circumference for 3.7 cm when comparing with the test person 2, Table 1. The test person 1 due to the greater body height and smaller body circumferences than test person 2 has appearance of a rectangle body shape. At the same time it can be defined as a pear body shape due to the relationship between hips/waist ratio and breasts/waist ratio. Because of the uniform ratios between the body dimensions breasts/waist and hips/waist, a test person 2 could has the hourglass body shape. However, her appearance from the front reminds an oval shape due to the greater abdomen.

3.2 Analysis of the ease allowances on the sewn dresses

The dimensions of the breasts, waist and hips circumferences were measured on the sewn dresses. It was found that measures of the sewn dresses deviate from the construction measures. Therefore, the real ease allowances were calculated, Table 3, and taken into account when assessing the dresses fit to test persons.

Table 3: Real ease allowances on the sewn dresses

CONSTRUCTION MEASURE	EASE ALLOWANCE (cm)					
	TP1			TP2		
	DPD1	DPD2	DPD3	DPD1	DPD2	DPD3
Breasts circumference	1.0 (2.0)	3.0 (4.0)	5.0 (6.0)	3.0 (2.0)	4.0 (4.0)	6.4 (6.0)
Waist circumference	3.0 (2.0)	5.0 (4.0)	5.0 (6.0)	3.0 (2.0)	5.2 (4.0)	7.0 (6.0)
Hips circumference	2.8 (2.0)	5.0 (4.0)	5.6 (6.0)	2.0 (2.0)	2.6 (4.0)	4.6 (6.0)

Note: In brackets are ease allowances considered in the construction of dress pattern designs.

3.3 Assessment of the dresses fit to the test persons

When assessing the dress fit to the test person 1 it was observed that the dress marked DPD1 in a standing and sitting position was too tight in the breasts area and creates pressure to the body, which prevented normal breathing of the person. The real ease allowance in the breasts measure was only 1.0 cm. A good fit to the observed body shape in areas of the waist and hips, both in a standing and sitting position, was achieved with this dress. The real ease allowances were in the waist measure 3.0 cm and hips measure of 2.8 cm. The dress with ease allowances of 4.0 cm (marked DPD2) was well fitted the body of the test person 1 in the area of breasts, both in a standing and sitting position, while in the area of waist and hips it was loose. The real ease allowance was in the breast measure 3.0 cm and for the waist and hips measures 5.0 cm, Figure 1. The dress marked DPD3 fitted the body of the test person 1 in the area of breast very well, while on the same line of observation on the back part of the body was too loose. This reflects greater real ease allowance, which was 5.0 cm. This dress was also too loose in the areas of waist and hips. The real ease allowance was for waist measure 5.0 cm and hips measure of 5.6 cm.

Figure 1: A dress fit (DPD2) to the test person 1 in a standing and sitting position

It can be concluded that the best fit of the dress to the test person 1 in the breasts area was achieved for real ease allowance of 3.0 cm, in the waist area at ease allowance of 3.0 cm and in the hips area at the ease allowance of 2.8 cm. Therefore, it could be supposed that the best dress fit to this body shape would be achieved at the ease allowance between 2.0 and 4.0 cm in all three assessed areas and breasts, waist and hips measures, respectively.

Furthermore, the assessment of the dress fit to the body shape of the test person 2 was performed. It was observed in the area of breast in a standing and sitting position that the dress marked DPD1 created a strong pressure to the body and it was too tight in the waist and hips areas. This was particularly evident on the back part of the dress, Figure 2. The real ease allowance was in the breasts and waist measure 3.0 cm and in the hips measure 2.0 cm. When observing the dress fit to the test person 2, the dress marked DPD2 was tight in the areas of breasts and hips. The real ease allowance was in the breast measure 4.0 cm and in the hips measure 2.6 cm. In the area of waist the dress fit to the body was appropriate on the front and back part of the body in a standing and sitting position. The real ease allowance was in the waist measure 5.2 cm. When assessing the dress fit (DPD3) to the test person 2, the appropriate fit was observed in the areas of breasts and hips. The dress was loose in the area of waist due to greater real ease allowance, which was in the waist measure 7.0 cm, while the real ease allowances were in the breast measure 6.4 cm and in the hips measure 4.6 cm.

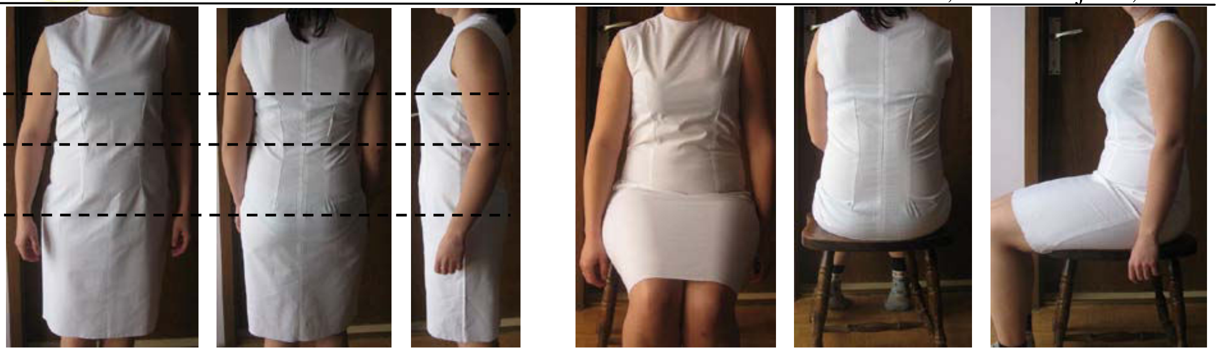

Figure 2: A dress fit (DPD1) to the test person 2 in a standing and sitting position

On the basis of the assessment of the dress fit to the test person 2 can be supposed that the best dress fit to this body shape would be achieved with ease allowance of 6.0 cm in the breasts and waist measures and when the ease allowance between 4.0 and 6.0 cm would be used in the hip measure.

3.4 Subjective assessment of the test persons' comfort when wearing dresses

By using the questionnaire subjective estimates of the test persons comfort (TP1 and TP2) in areas of the breasts, waist and hips were obtained when wearing dresses in a standing and sitting position. Subjective assessment of test persons was carried out in a bright and warm place, individually for each test person. In the room there was no mirror. In this way we wanted to avoid the self-assessment of the test persons' appearance in a dress and consequently their assessment of the comfort when wearing dresses. Before the assessment was explained to the test persons that:

(a) dress is uncomfortable when in any assessment area is too tight and creates a pressure on the body and restricts normal movement and breathing (person perceive in the assessment areas that dimensions of the dress are smaller than the dimension of the body) and

(b) dress is comfortable when in any assessment area is not too tight, lightly touches the body and does not creates a pressure on the body, and enables normal movement and breathing (person perceive in the assessment areas that dimensions of the dress are greater than the dimension of the body).

When wearing dress marked DPD1 the test person 1 felt discomfort in the area of breasts in a standing and sitting position, while she felt comfortable in this dress in areas of waist and hips in both assessing positions. When wearing dress marked DPD2 and DPD3 she felt comfortable in all three assessed areas, both in a standing and sitting position.

The uncomfortable feeling perceived the test person 2 when wearing the dress marked DPD1 in all assessing areas in a standing and sitting position. The uncomfortable feeling was also perceived when wearing dress marked DPD2 in both assessing positions. When wearing dress marked DPD3 the comfort was perceived in all assessment areas in a standing and sitting positions.

It can be concluded that the subjective assessment of comfort of the test persons when wearing dresses with different ease allowances was in accordance with assessment of the dresses fit to body shapes of the test persons.

4. CONCLUSIONS

This study has been focused on garments fit to the body shape through the ease allowance quantification. The assessment of garments' fit to body shapes in area of the breasts, waist and hips was carried out in a standing and sitting position in relation to the ease allowance, as well as the subjective assessment of test persons' comfort when wearing garments. For this purpose test persons of different body shapes and dimension were chosen. The basic dress pattern designs without sleeves was carried out according to the same construction rules and measured body dimensions of the test persons. The dress pattern designs were prepared with three different ease allowances considered on measures of the breasts, waist and hips, and ease allowances of 2.0 cm, 4.0 cm and 6.0 cm, respectively.

It was found that perception of comfort when wearing garments differ for different body shapes, although dresses were constructed according to the same construction rules and measured body dimensions of the test persons with the same ease allowances. The deviation of garments fit to different body shapes was also significant. It was found that body shape with greater circumferences of the breasts, waist and hips needs greater ease allowance than those with smaller circumferences. Subjective assessments of test persons' comfort when wearing garments with different ease allowances were consistent with assessments of garments fit to body shapes. Based on the research results we can conclude that it would be necessary when constructing garments in the apparel industry, as well as for made-to-measure garments, to consider a different ease allowances for different body shapes.

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DEVELOPMENT OF A SUITABLE 3D BODY MODEL IN A SITTING POSITION

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Abstract: *This research focuses on capturing, 3D body modelling and surface reconstruction of a human body model to develop a suitable 3D body model in a sitting position. It is intended for use in commercial CAD systems for determination of the anthropometrical body dimensions, development of clothes for people with paraplegia state and their virtual prototyping. The 3D human body scanning was performed using a general-purpose GOM ATOS II 400, a 3D optical scanner and a scanning procedure of a human body was adopted for this purpose. When scanning with three-dimensional optical scanner the high-density point data sets of the whole body image were received. The captured data were typically noisy and had areas of occlusion, such as the branch points of the body, as well as there were spatial overlapping regions related to different views. Therefore, the dataset in 3D space approximately lies on the surface of the scanned human body. How to obtain the useful 3D body model in a sitting position for extraction of the anthropometrical body dimensions and garment virtual prototyping in a commercial CAD system and the methodology of processing techniques of the human body modelling and surface reconstruction techniques for building the human body model is described in this paper.*

Key words*: 3D scanning, 3D body model, body modelling, reconstruction, anthropometrical dimension.*

1. INTRODUCTION

Today, scanning technologies for non-contact 3D human body digitization are used to describe 3D characteristics of human body, by using the surface light, such as laser, white lights or infrared beam, projected on a human body and by photosensitive capturing equipment to form the image of a human body. Commonly used 3D scanners for human body capturing are Vitus Smart of Human Solutions, Symcad of Telmat, TC2 and Cyberware-WBX. They generate a complete three-dimensional image of the human body in a few seconds and quickly determine body dimensions based on obtained 3D data. Accordingly, dimensions of the parametric mannequin can be adjusted and simulation of the garment fit can be performed. It was established that the scanned and reconstructed 3D model body corresponds better to the real body when compared with the parametric 3D body model (Jevšnik S. et al., 2012). This was confirmed with assessment of jackets' fit to the real, scanned and parametric 3D body model. Furthermore, research on the fit of fashion garments and sportswear for professional purposes to the parametric body model and scanned 3D body model showed significant differences between virtual garments' fits to body models and successfulness of virtual prototyping using the scanned 3D body model (Rudolf A. et al., 2010, Stjepanović Z. et al., 2011). In addition a 3D body model in a sitting position was obtained using the 3D body scanner Vitus Smart at the Textile Technology Faculty, University of Zagreb, Croatia (Kozar T. et al. 2012).

Recently, scanning of the human body in a sitting position was carried out by using different scanning technologies (Rudolf A. et al., 2013). The research has shown that the GOM ATOS II 400 3D optical and ARTEC EVA hand scanners are suitable for scanning of the human body with the help of for this purpose developed frame with hand rails and marked reference points in order to facilitate the scanned data processing. This optical scanner is mainly used for scanning of smaller objects for the purpose of the reverse engineering (RE), inspection and quality management, rapid prototyping, cultural heritage documentation, restoration, medical applications, etc. (Brajlih T. et al., 2011, Drstvenšek I. et al., 2008). In addition, the research of the suitable 3D scanner for human body parts digitalization in the field of prosthetics and orthotics was performed (Koutny D. et al., 2012). The three hand-held portable scanners (two optical and one laser) and two optical tripod scanners were compared with respect of scanning details, simplicity of operation and ability to scan directly on the human body. The results showed that in a case of the plaster cast digitization scanners with higher resolution stationary placed on a stand are more suitable. Regarding the details, the ATOS I and the ATOS TripleScan predominate among the tested scanners (Koutny D. et al., 2012).

It is well known that there are many problems related to the quality of human body data captured by any scanning system (Buxton B. et al., 2000). Those problems require the development of human body modelling technology. The overall quality of the set of scanned points in 3D depends on following parameters: (a) density (to represent the continuous surface of the human body, a sufficient number of points per unit surface area must be obtained), (b) accuracy (the scanned points must lie on the body to within some given tolerance) and (c) completeness (a data set is complete, if all parts of the object surface are represented with points of sufficient and reasonably uniform spatial density) (Buxton B. et al., 2000).

The human body modelling refers to a series of software processing techniques that are relevant and need to be applied to any dataset from a particular scanner. The first step to be taken is normally registration of the multiple views and the next step is cleaning and removal of all points in the dataset that don't correspond to the body surface, respectively. The next step is usually surface reconstruction, which is one of the most difficult and crucial processing steps.

This study focuses on 3D human body scanning using a general-purpose GOM ATOS II 3D optical scanner, 3D body modelling and surface reconstruction of a human body model with the aim to developed a suitable 3D body model in a sitting position, which can be imported in the OptiTex program for extraction of the anthropometrical body dimensions and garment virtual prototyping.

2. EXPERIMENTAL

2.1. Scanning of the human body in a sitting position with GOM ATOS II 3D optical system

The GOM ATOS II 3D optical scanning system is installed and available for research work at the Faculty of Mechanical Engineering in Maribor. It is mainly used for a rapid development of non-contact 3D data acquisition systems intended for reverse engineering (RE), inspection and quality management, rapid prototyping and medical applications. Recently, the research was performed on the use of this scanner for the human body scanning (Rudolf A. et al., 2013). The research has shown that the ATOS 3D optical scanner is suitable for scanning of the human body with the help of for this purpose developed frame with hand rails and marked reference points in order to facilitate the scanned data processing.

The GOM ATOS II 3D optical scanning system is based on triangulation principle (Brajlih T. et al., 2011). The sensor unit projects four times indented fringe patterns onto the scanned subject, which are then recorded by two cameras. Each single measurement generates up to 4 million data points. The scanner records only those points visible by both cameras in a single scan. In this research scanning of a human was performed using the measuring volume of 1200x960x960 mm (LxWxH). Measuring point distance was 0.94 mm and 6 mm projector lens and 8 mm camera lens were used.

Scanning with ATOS II 3D optical system was performed in three steps. First, the calibration of the measuring system was carried out and measuring volume with a developed frame with hand rails was marked with reference points. In the next step the optical scanning of the subject from different angles and heights was performed in order to digitize a complete human. Using the Atos V6.0.2-6 software each scan was polygonized into an independent mesh.

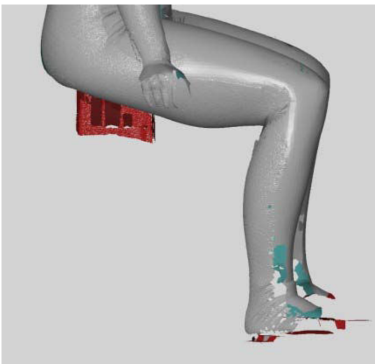
2.2. Registration of the multiple views

The next essential step was the mutual registration of scanned and CAD geometrical data using a GOM Inspect mesh processing software for dimensional analysis of 3D point clouds from white light scanners, laser scanners, CTs and other sources. Due to independent meshes being the results, the meshes were registered separately and a semi-automatic best fit registration was performed, Figure 1.

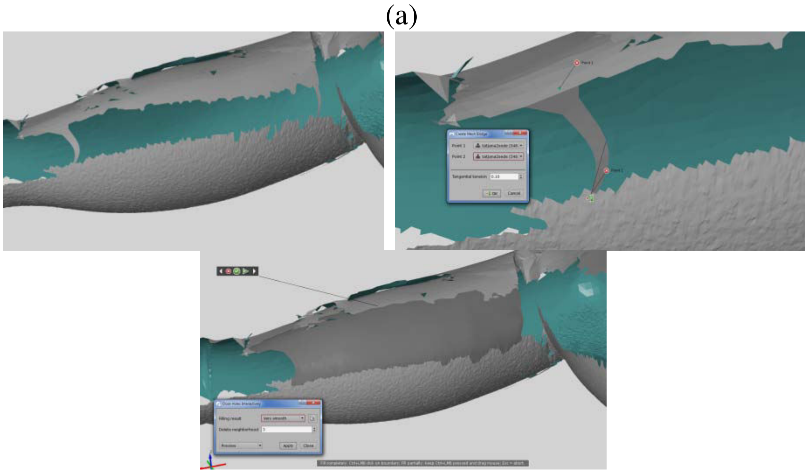
Figure 1: The aligned individual scans into a global coordinate system

2.3 Cleaning and repairing of the mesh

Cleaning and removal of all points in the dataset that don't correspond to the body surface, respectively, was performed using a GOM Inspect program, as well as repairing of the mesh. This action is required to close the holes in the body surface where the scanner has failed to capture any data. When scanning a person was seated on a chair, therefore, its points were cleaned, Figure 2 (a). Removed were also those scans that were not aligned properly (feet), Figure 2 (a). In addition, several tools were used and repeated to reduce the mesh errors. Using a mesh bridge tool the filling and repairing of the mesh was carried out, as shown Figure 2 (b) on the part of the calf.



(a)



(b)

Figure 2: Cleaning and repairing of the mesh

2.4 Surface reconstruction

The representation of the 3D body model should be true to the original data, free of holes, with a few errors and less noise that the raw-scanned point dataset, and storable that enables the extraction of the body dimension and virtual prototyping of the garments.

For the surface reconstruction of the 3D body model the graphic programs MeshLab, Blender and GOM Inspect were used. Our 3D body model is represented as the polygonal model, where the points are connected to form a set of polygons that approximate body surface. Firstly, the 3D body model was imported into the MeshLab program and a new average mesh was made over the existing scan using a tool Select All/Filter Selection. Furthermore, a surface reconstruction was carried out with the tool Poisson, Figure 3.

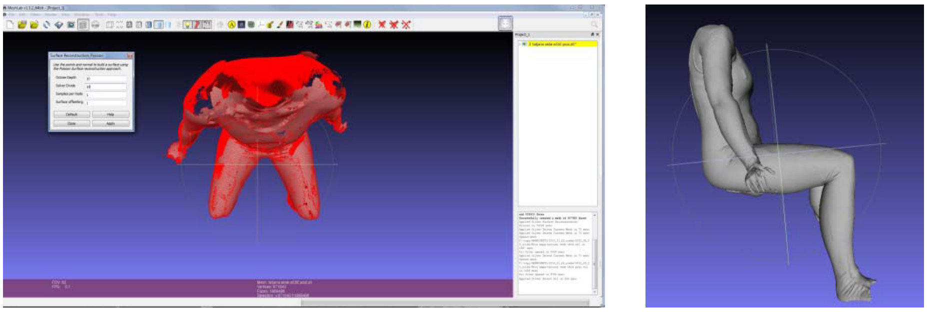


Figure 3: Surface reconstruction: Poisson of the 3D body model

Figure 4 shows imported 3D body model into the Blender program. It was used for 3D virtual sculpting of the 3D body model aimed to smooth the irregularities on the surface, resulting from alignment of the individual scans. Applied was a tool Sculpt Mode/Smooth.

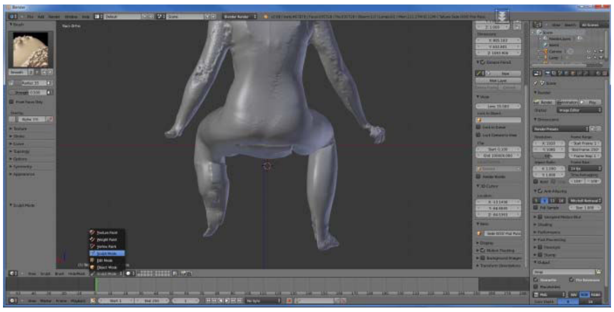


Figure 4: 3D virtual sculpting of the 3D body model

The last step was a reduction of the polygons. It was carried out with GOM Inspect program using a tool Thin Mesh, as can be seen in Figure 5.

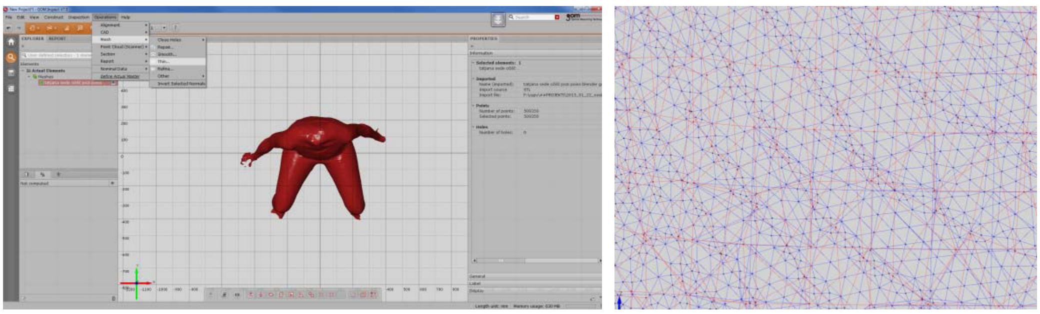


Figure 5: Reduction of polygons of the 3D body model in a sitting position

3. RESULTS WITH DISCUSSION

When scanning with three-dimensional optical scanner the high-density point data sets of the whole body image were received. The captured data were typically noisy and had areas of occlusion, such as the branch points of the body, as well as there were spatial overlapping regions related to different views. Therefore, the dataset in 3D space approximately lies on the surface of the scanned human body.

A careful 3D human body modelling and surface reconstruction were carried out with the aim to obtain the useful 3D body model in a sitting position for extraction of the anthropometrical body dimensions and garment virtual prototyping in a commercial CAD system OptiTex 3D program.

During the modelling and reconstruction, we are following the characteristics of the 3D body model mesh, Table 1. When the registration of the multiple views was performed, the 3D body model mesh had a large number of polygons and surface area. Because the mesh was not totally watertight, therefore it had no volume. With cleaning and repairing actions the 3D body model was connected into one uniform mesh and number of polygons and surface area were reduced, while the volume of the mesh was 67 570 cm^3.

The cleaned and repaired mesh was still not totally uniform and useful in a CAD system. Therefore, the surface reconstruction of the 3D body model using a tool Poisson, 3D virtual sculpting and reducing the number of triangles were performed. When a tool Poisson for surface reconstruction was used the number of polygons increased (935720), while the 3D body volume and surface area slightly decreased (66305 cm^3, 15210 cm^2). With 3D virtual sculpting the smoother surface of the 3D body model was achieved and number of polygons increased (1019010), while the 3D body volume and surface area slightly decreased (64325 cm^3, 14923 cm^2). To obtain a reliable 3D body model in a sitting position, which we can be imported into the OptiTex 3D program, we had to reduce the number of triangles. During this action we considered that to the modelled and reconstructed 3D body model we did not reduce the volume and surface area. With reduction of polygons of the 3D body model mesh on 10000 points a decrease to the value of 199992 polygons was achieved, while the 3D body volume and surface area remained almost the same (64322 cm^3, 14930 cm^2), Table 1.

Table 1: Characteristics of the 3D body model mesh

Characteristics of the 3D body model mesh	Modelling and surface reconstruction actions		
	Registration of the multiple views	Cleaning and repairing of the mesh	Surface reconstruction
No. of polygons	1 925 000	816 000	199 992
Volume (cm^3)	-	67 570	64 322
Surface area (cm^2)	25 241	15 592	14 930
File size (KB)		91 234	9 766

As a result the reconstructed and imported 3D body model in a sitting position into the OptiTex 3D program represents Figure 6, which is useful for extraction of the anthropometrical body dimensions and garment virtual prototyping.

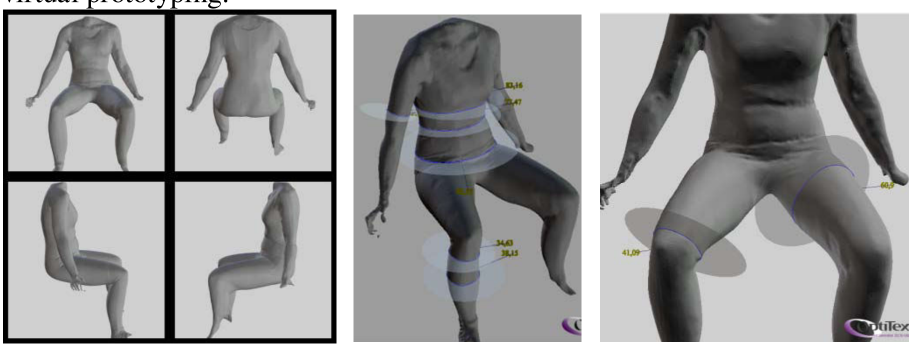


Figure 6: Reconstructed 3D body model in a sitting position imported into the OptiTex 3D program.

3. CONCLUSIONS

The presented study focused on capturing, 3D body modelling and surface reconstruction of a human body model to develop a suitable 3D body model in a sitting position. It is intended for use in an OptiTex 3D program for determination of the anthropometrical body dimensions, development of clothes for people with paraplegia state and their virtual prototyping.

The 3D human body scanning was performed using a general-purpose GOM ATOS II 400, a 3D optical scanner and the methodology of processing techniques of the human body modelling and surface reconstruction techniques for building the human body model are described in this paper. As a result the developed 3D body model in a sitting position is represented. For the body modelling and surface reconstruction different 3D graphic programs were used. In future research, we will focus on processing of 3D data using a chosen special 3D graphic program to achieve more rapid acquisition of a reliable 3D body model in a sitting position.

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ECO-FRIENDLY NATURAL TEXTILE DYEING OF SOME FIBERS WITH BLACK CARROT (*Daucus Carota L.*)

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Abstract: *Natural dyestuffs can be used for dyeing textile, wood, leather and food materials. These colorants are known as eco-friendly, non-toxic, sustainable and renewable. This study represents the natural textile dyeing of silk, cotton and wool fibers with black carrot (Daucus carota L.) extract which is not a common natural textile dyestuff source. Black carrot extract was applied to the selected fibers via simultaneous mordanting by exhaustion method. The color and fastness properties, such as rub, light and wash fastness, of dyed samples were explored. Black carrot extract imparts light bluish gray on the cotton and light blue colors on silk and wool fibers. The highest color yield value was observed on wool fiber. In general, dyed fabrics exhibited good wash fastness and moderate rub fastness.*

Keywords: *Black carrot, Daucus carota L., natural textile dyeing, alum, wool, silk, cotton.*

1. INTRODUCTION

Natural dyes were explored by our ancestor's centuries ago and colors obtained by natural dyes can survive for centuries (Betchold and Mussak, 2009). Natural dyes, obtained from insects, minerals and various parts of plants, impart wide range of shades to the fabrics. These dyes have been used to impart color in many different application areas such as food, wood, leather, textile etc. since ancient times. In the middle of 1800's, the cheaper and largely available synthetic dyes, that have moderate to excellent color fastness, were substituted for the natural dyes, having poor to moderate color fastness. However, the usage of natural dyes in textiles and leathers has been mainly continued for special products (Kumbasar, 2011).

Synthetic dyes are obtained from non-renewable petroleum sources and some of these dyes contain non-eco friendly, toxic or carcinogenic amines (Kadolph, 2005; Rungruangkitkrail and Mongkholrattanasit, 2012). In the world market, some permitted synthetic dyes had been declined due to their unhealthy structures as some of them are the sources of skin cancer (occupational), disorders and causes skin allergy and they generate hazardous waste and green house gases during their synthesis (Studies, 2013). As distinct from synthetic dyes, renewable and eco-friendly natural dyes are extracted from plants or animal sources (Kadolph, 2005). Therefore, worldwide, through the growing environmental awareness, the interest of dyeing textiles, foods, leathers with eco-friendly natural dyes are increasing (Kumbasar, 2011; Rungruangkitkrail and Mongkholrattanasit, 2012).

In natural textile dyeing, various recognized plant extracts can be used for dyeing textile fibers such as cotton, wool, silk. Although many different plants' extracts have been used for natural textile dyeing, natural dyes extracted from black carrot are not commonly used in textiles. Alhough it has not been used in textile coloration, black carrot (*Daucus carota* var L.) has been known as a food colorant (Studies, 2013; Barzak, 2005; Mortensen, 2006). Black (purple) carrots (*Daucus Carota L.*) orginated from Turkey, middle and Far East and these plants have been generally cultivated in Turkey, Afghanistan, Egypt, Pakistan and India for 3000 years (Montilla et al., 2011; Turkyilmaz et al., 2012). Black carrots have bluish-purple colors that contains the greatly anthocyanin pigments (Montilla et al., 2011; Khandare et al., 2011) (see also Figure 1).

Figure 1: Black Carrot (Daucus carota L.) (Carrotmuseum, 2013)

Anthocyanins are responsible for the red, blue and purple colors on the fruits, flowers and vegetables (Khandare et al., 2011; Lazcano et al., 2001). It's reported that black carrots mainly include cyanidin-based pigments (the acylated cyanidin derivatives) which display remarkable stability to pH changes and heat treatment (see also Figure 2) (Studies, 2013; Barzak, 2005; Montilla et al., 2011).

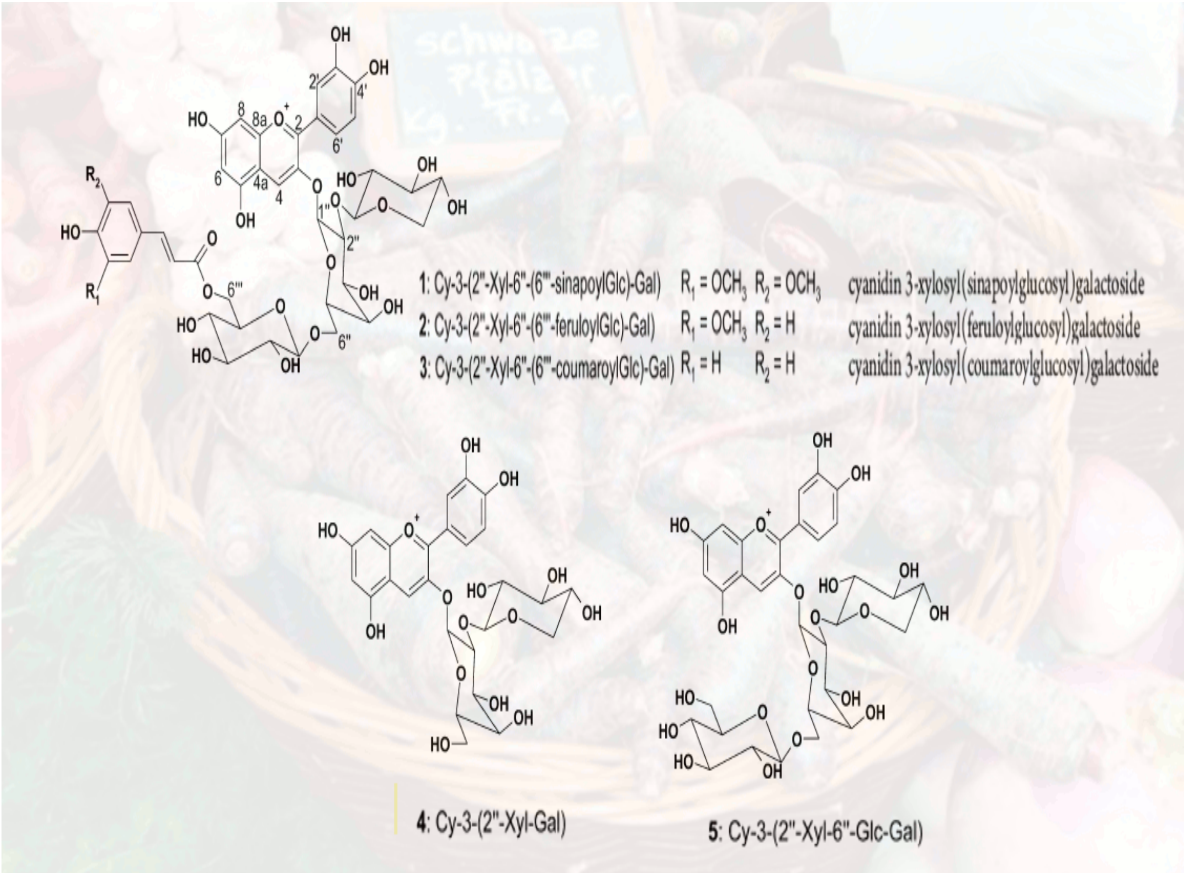


Figure 2: Black Carrots (Daucus carota L.) main anthocyanins structures (Cy; cynadin, Xyl; β-D-galactopyranose; Glc; β-D-glucopyranose) (Montilla et al., 2011; Schwarz et al., 2004)

In the natural dyeing, the natural dyes have been limited substantively to the fibers and mordant can be required for fixation of the natural dyes on the fibers by the formation of the complex with the dye. Alum, potassium dichromate, zinc sulphate, tannin, and tannic acid are the some significant mordants (Prabhu and Bhute, 2012). The complex formation of the mordant, dye and fabric is given in Figure 3.

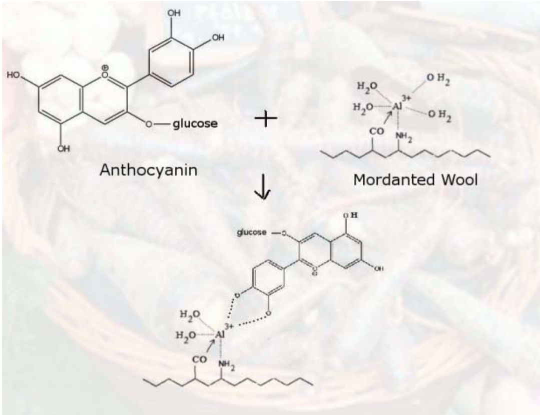


Figure 3: The complex formation structure of anthocyanin, aluminium and wool fibres (Parvinzadeh and Kiumasi, 2008)

In this study, silk, cotton and wool fabric samples were dyed with an eco-friendly and renewable black carrot extract via simultaneous mordanting. The color properties of samples are analyzed and compared. Moreover, rub, light and wash fastness properties of natural dyed samples are discovered.

2. EXPERIMENTAL

2.1. Materials

Three woven fabrics were used in this study: 100% cotton, silk and wool fabrics. The natural dyeing of these fabrics was carried out using black carrot extract. In the extraction process, black carrot wastes were boiled with purified water for one hour. The alum mordant was added to the natural dyeing bath for good fastness bonding properties.

2.2. Dyeing

Natural dyeing process with black carrot extract was carried out in an Atac Lab-Dye HT machine at a liqour ratio of 40:1, using the exhaustion method. In each bath, black carrot extract were used as 1:1 ratio. Simultanoues mordanting was carried out with 20% alum concentration during the dyeing process. The dyeing process was started at room temperature and the dyeing temperature was reached at 80 ^{o}C by increasing the temperature for 4 ^{o}C per minute. At the dyeing temperature, dyeing process performed for 45 minutes. After the dyeing, the baths were cooled; the samples were removed and rinsed in tap water. Then, the samples were air-dried. Afterwards, the samples were washed at 40 ^{o}C for 10 minutes with water to clear the remaining unfixed dyes on the fabric surfaces and air-dried again. These air-dried samples were used for color measurements and fastness tests.

2.3. Colorometric Measurements

The CIE Lab L^*, a^*, b^*, C^*, and h^o values were measured from the reflectance values 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 (*fk*) is calculated from the sum of the weighted *K/S* values in the visible region of the spectrum. The equation of *f (k),* Eq. (1) is given at below:

$$f_k = \sum_{\lambda=400}^{700} (K/S)_\lambda \ (\bar{x}_{10,\lambda} + \bar{y}_{10,\lambda} + \bar{z}_{10,\lambda}) \quad (1)$$

2.4. Fastness Properties

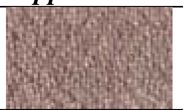
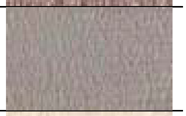
Rub, wash and light fastness properties were explored. Both dry and wet rub fastness testing were performed with the ISO 105: X12 protocol. Wash-fastness test was carried out in a M228 Rotawash machine (SDLATLAS, UK) according to ISO 105:C06 A2S test. Washing, dry & wet rubbing fastness properties were determined using ISO grey scales.

3. RESULTS AND DISCUSSION

3.1. Color Properties

It should be noted that although all dyed samples (cotton, wool and silk) have woven structure, the yarn counts are not exactly the same, therefore; one to one comparison for color properties of these fabrics could be inappropriate. However, in order to understand the usability of black carrot extract for natural textile dyeing on the various fibers, it is necessary to compare the color properties of these fibers to understand the performance of this extract on the most important natural textile fibers. The colorimetric data of the black carrot extract dyed samples are shown on Table 1.

Table 1: Colorimetric properties of black carrot dyed samples

Fabrics	L*	a*	b*	C*	h^o	f(k)	Appearance
Wool	54.33	-3.44	-3.92	5.22	228.76	24.26	
Silk	58.58	-4.30	-5.53	7.01	232.17	17.72	
Cotton	72.53	-1.32	3.28	3.54	111.99	6.60	

The highest color yield value was observed on wool fiber. The color yield values indicated that protein-based fibers exhibited higher color yields than the cellulosic-based fiber. It is known that dyeing the protein fibers with natural dyes is usually much easier than cellulosic fibers (Cage, 2013).

As seen on Table 1, highest hue angle values (h^o) were observed on protein-based fibers and these values of silk and wool were similar. In accordance with the hue angle results, visual appearance of the protein-based dyed samples was also similar (Table 1).

Colorimetric properties of the dyed samples are given on Figure 4 and 5. The colors of dyed samples have the various color shades of blue and purple, as supported with the reflectance-wavelength spectra (see also Figure 5 (d)) (Table 1). The shade of wool fabric is greener and bluer in appearance than that of cotton. Similarly, the color of dyed silk sample is more green and more blue not only than cotton but also than wool sample according to a* and *b** values (see also Figure 5 (a)).

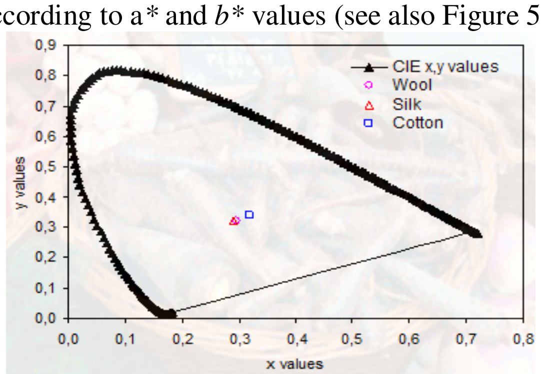


Figure 4: CIE chromaticity diagram showing the position of selected textile fibers dyed with black carrot extract in company with alum mordant

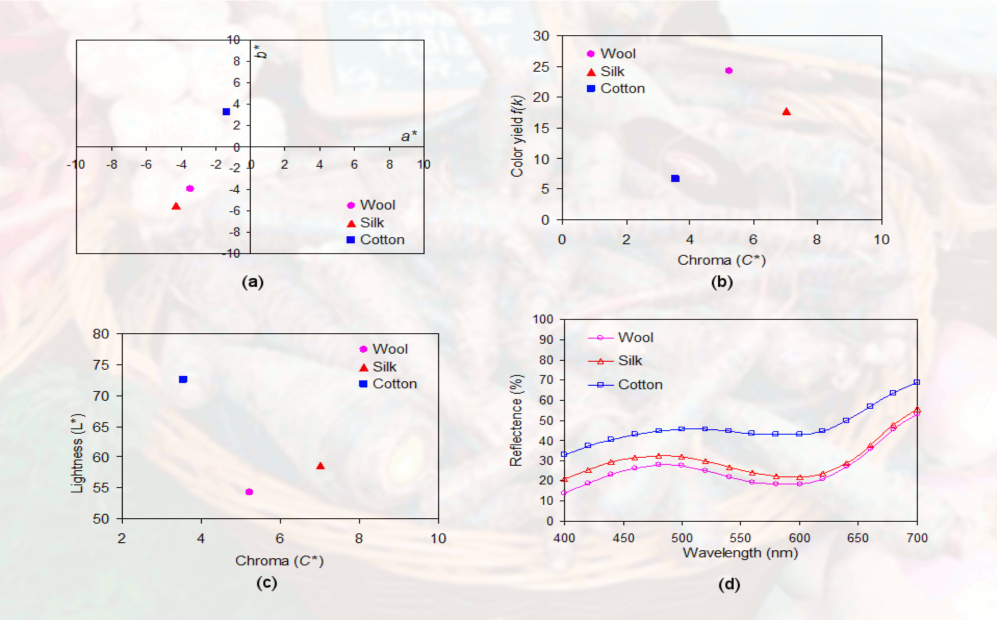


Figure 5: Color properties of dyed samples; (a): a-b*, (b): f(k)-C* (c): L*-C* plots, (d): reflectance-wavelength spectra*

The cotton sample exhibited the highest *L** value. This is actually in line with the color strength results. Since the cotton sample has the lowest color yield by 6.60 leading to the lightest appearance. Silk and wool fabrics had higher chroma and darker appearance than cotton sample. According to *L** and *C** values (Figure 5 (c)), dyed silk fabric shows brighter appearance than wool fabric with higher *L** and higher *C** values.

Overall, silk and wool fabrics exhibited higher color strength, higher chroma, and darker, greener and bluer appearance than cotton fabric. When silk and wool fabrics are compared, wool fabric exhibited higher color strength, duller appearance with lower chroma and lower lightness.

3.2. Fastness Properties

Measured color fastness values were given on Table 2. All dyed samples, exhibited excellent wash, light and rub fastness properties by 5 grey scale rating for staining.

Table 2: Fastness properties of dyed samples with black carrot extract and alum mordant

Fabrics	***Rub Fastness (Cotton staining)***		***Washing Fastness***						***Light Fastness***
	Dry	***Wet***	***WO***	***PC***	***PES***	***N6.6***	***CO***	***AC***	
Wool	5	5	5	5	5	5	5	5	2
Silk	5	5	5	5	5	5	5	5	*1-2*
Cotton	5	5	5	5	5	5	5	5	2

Although light fastness values of dyed samples were low (1/2-2), wash and rub fastness values were excellent with no staining whatsoever.

4. CONCLUSION

Since old times, natural dyes which are known as eco-friendly, non-toxic, sustainable and renewable, have been used to colorize the natural fibers such as cotton, wool and silk as well as fur and leather. Many different extracts from plants have been used for natural textile dyeing. However, natural dyes extracted from black carrot are not commonly used in textiles. In this study, natural dyeing of wool, silk and cotton fabrics with black carrot extract in company with alum mordant was studied.

The colors of dyed wool and silk samples have bluer and purplish color shades. The shades of wool and silk fabrics exhibited bluer and greener appearance than cotton. On wool fiber, the highest color yield value was observed. The color yield values pointed that the protein-based fibers had higher color yield values than the cellulosic-based fiber. Silk and wool fabrics had higher chroma and darker appearance than cotton sample. Dyed silk fabric showed brighter appearance than wool fabric with higher C^* and L^* values. Overall, silk and wool fabrics exhibited higher chroma, higher color strength and greener and bluer, darker appearance than cotton fabric. When wool and silk fabrics are compared, silk fabric exhibited lower color strength. Wool fabrics exhibited duller appearance with lower chroma and lower lightness in comparison to silk. All dyed samples exhibited excellent wash and rub fastness values but light fastness values were low.

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ECO-FRIENDLY TEXTILE PRINTING WITH RED BEET (*Beta Vulgaris L.*)

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Abstract: *Non-toxic, renewable, sustainable and ecofriendly natural dyestuffs can be used for coloration of textile, leather, wood and food materials. This study presents the natural textile printing of silk, soybean and wool fiber fabrics with red beet (Beta vulgaris L.) extract which is an unused natural textile dye source for printing. Selected fibers were printed with flat screen technique using two different printing pastes. Red beet extract were printed on fabric samples with and without mordant and then the printed samples treated with saturated steam under different times. The color and fastness properties, such as rub, light and wash fastness, of printed samples were analyzed. Beetroot pastes led to light bluish gray, beige and greenish colors on different fibres under different treatment times. The highest color yield value was observed on wool fiber which is printed with paste having mordant and steamed for 60 min. Overall, the printed samples exhibited good wash fastness, modarate light and rub fastness.*

Key words: *Beetroot, Beta Vulgaris L., natural textile printing, steaming, soybean, wool, silk*

1. INTRODUCTION

Natural dyes have been used to colorize the food substrate, leather, wood, natural fibers from the beginning of human history (Kumbasar, 2011; Boo et al., 2012). Up to the end of the 19th century natural dyes were the major colorants in the textile applications (Betchold et al., 2006). Owing to the production, storage, and stability difficulties of natural dyes, the synthetic dyes have been developed and synthesized immensely (Boo et al., 2012). Synthetic dyes were also cheaper and largely available than natural dyes and exhibited moderate to excellent color fastness in comparison with natural dyes (Kumbasar, 2011; Boo et al., 2012). However, in the recent years, production and usage of natural materials is getting stronger due to the increased expectations for better life quality and eco-friendly way of living with the respect to the environment (Boo et al., 2012). Synthetic dyes are acquired from non-renewable petroleum sources and some of these dyes contain toxic non-ecologic or carcinogenic amines (Kadolph, 2005; Rungruangkitkrail, 2012). Today, more than 10,000 synthetic dyes are commercially available and these dyes are difficult to degrade biologically due to their complex aromatic molecular structure and synthetic origin. The usage of the synthetic dyes often poses pollution problems in the form of colored wastewater. Moreover, some dyes are mutagenic, toxic and carcinogenic due to the content of metals and other chemical in their structure (Aksu and Isoglu, 2006). Renewable, sustainable and eco-friendly natural dyes are extracted from plants or animal sources and these dyes are non-toxic and non-allergenic (Kadolph, 2005; Samanta and Agarwal, 2009).

In textile dyeing and printing, natural dyes extracted from various plants can be used for textile fiber coloration. Though, many different extracted dyes have been used for natural textile coloration, natural dyes extracted from red beet are not commonly used in textile printing. Natural dyes extracted from red beet (*Beta Vulgaris L.*) are used in food coloration, textile and leather dyeing (Betchold et al., 2006; Vemurugan et al., 2010; Henry, 1996; Siyalkumar et al., 2009; Crinela et al., 2007; Atodiresei, 2011; Chen and Li, 2006; Frick, 2003). The beetroot (*Beta Vulgaris L.)* has been known as the garden beet, red beet, or just beet. Red beet is one of the many cultivated varieties of beets (*Beta vulgaris*) and the most commonly encountered variety can be found in North America, Central America, and Britain (Wiki, 2013) (see also Figure 1).

Red beet (*Beta* V*ulgaris* L.) is an excellent source of nitrogenous pigments, betanin, isobetanin which are mainly being composed of two red-violet betacyanins, (see also Figure 1) and minor yellow betaxanthins. Betanin has nontoxic properties and the red beet has been used as a red pigment in the pharmaceutical and food industries (*1*). Betalains are known to be very sensitive to low pH, elevated temperatures, or high water activity (*3-7*). Particularly, the thermal instability of the betalain is resulted limited usage (Wybraniec, 2005).

Figure 1: Red Beet (Beta Vulgaris L.) (123rf, 2013; Google, 2013; Chocolate, 2013; Seedforsec, 2013) and chemical structure of Betanin (Wybraniec, 2005)

In the natural coloration of textiles, the natural dyes have been limited substantively to the fibers. Mordants can be required for fixation of natural dyes on the textile fibers by the formation of the complex with the dye. Alum, potassium dichromate, zinc sulphate, tannin, and tannic acid are the some significant mordants (Prabhu and Bhute, 2012). The complex formation of the mordant, dye and fabric is given in Figure 2.

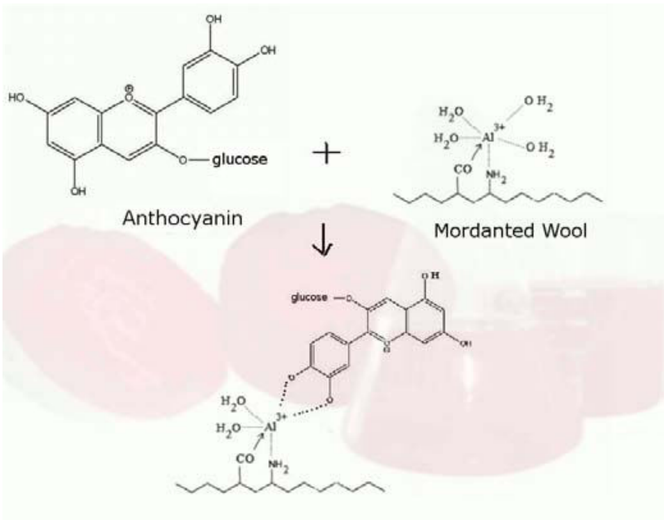


Figure 2: The complex formation structure of anthocyanin, aluminium and wool fibres (Paryinzadeh and Kiumarsi, 2008)

In this study, soybean fiber, wool and silk fabric samples were printed with an eco-friendly and renewable red beet extract via simultaneous mordanting and without the usage of mordant. The color properties of samples are analyzed and compared. Moreover, rub, light and wash fastness properties of natural printed samples are discovered.

2. EXPERIMENTAL

2.1. Materials

100% wool and silk fiber woven fabrics and 100% soybean fiber knitted fabric were used in this study. The natural printing of these fabrics was carried out with using red beet extract and alginate was used as a thickener. Alginate is produced from seaweed and an eco-friendly natural sustainable material. In the extraction process, red beet wastes were boiled with purified water for one hour. The potassium dichromate mordant was added to the natural printing paste for good fastness bonding properties.

2.2. Printing

Natural printing process with red beet extract was carried out using Atac printing machine (RGK-40), using the flat screen printing method. The paste is shown in Table 1.

Table 1: Printing paste recipes

Printing paste without mordant		Printing paste with mordant	
Alginate SMT 9%	33 g	Alginate SMT 9%	33 g
Alginate V9 4%	33 g	Alginate V9 4%	33 g
Water	4 g	Potassium dichromate	4 g
Extract (Red beet)	30g	Extract (Red beet)	30g
100 g		100 g	

Samples were printed with 2,2 m/min, at 4 press on and with doctor blade of 10 mm in diameter. The doctor blade was used two times for wool and soybean fiber fabrics, one times for silk fabric due to the fineness of silk fabrics. After the printing, the printed fabrics were dried in a laboratory-type drying machine (atac FT-200) at 100 ^{o}C for 3 min and fixed on a laboratory-type steamer (Atac flash ager) at 102 ^{o}C for 30 min or 60 min. Then, the printed samples were rinsed in tap water and air-dried. Afterwards, the samples were washed at 40 ^{o}C for 10 minutes with water to clear the remaining unfixed dyes on the fabric surfaces and air-dried again. These air-dried samples were used for color measurements and fastness tests.

2.3. Colorometric Measurements

The CIE Lab *L**, *a**, *b**, *C**, and h^o values were measured from the reflectance values with using a DataColor SpectraFlash 600 (Datacolor International, Lawrenceville, NJ, USA), spectrophotometer under illuminant D65, using 10º Standard observer for each printed samples. The color strength value (*fk*) is calculated from the sum of the weighted *K/S* values in the visible region of the spectrum. The equation of *f (k),* Eq. (1) is given at below:

$$f_k = \sum_{\lambda=400}^{700} (K/S)_\lambda \; (\bar{x}_{10,\lambda} + \bar{y}_{10,\lambda} + \bar{z}_{10,\lambda}) \qquad (1)$$

2.4. Fastness Properties

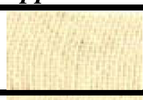
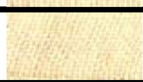
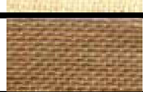
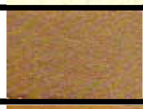
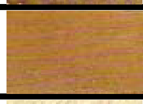
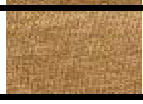
Rub, wash and light fastness properties were explored. Wash-fastness test was carried out in a M228 Rotawash machine (SDLATLAS, UK) according to ISO 105:C06 A2S test. Both dry and wet rub fastness testing were performed with the ISO 105: X12 protocol. Washing, dry & wet rubbing fastness properties were determined using ISO grey scales.

3. RESULT AND DISCUSSION

3.1. Color Properties

The fabric structures and yarn counts are not exactly the same, therefore; one to one comparison for color properties of these fabrics could be inappropriate. However, in order to understand the usability of red beet extract for natural textile coloration on the various fibers, it is necessary to compare the color properties of these fibers to understand the printing performance of this extract on the various natural textile fibers. The colorimetric data and colors of the red beet extract printed with and without mordant samples are shown on Table 2.

Table 2: Colorimetric properties of printed samples

Printed fabric samples	*L**	*a**	*b**	*C**	*h°*	*f(k)*	*Appearance*
Wool, w*ithout mordant*, 30 min steaming	74.62	1.25	15.96	16.00	85.53	7.33	
Wool, w*ithout mordant*, 60 min steaming	76.43	1.09	18.08	18.11	86.55	6.73	
Wool, *potassium dichromate*, 30 min steaming	50.47	1.19	15.76	15.80	94.31	42.42	
Wool, ***potassium dichromate***, 60 min steaming	47.15	1.44	21.25	21.30	86.14	60.81	
Silk, without mordant, 30 min steaming	81.52	0.61	14.26	14.28	87.55	3.68	
Silk, *without mordant*, 60 min steaming	81.49	0.79	14.37	14.39	86.85	3.71	
Silk, *potassium dichromate*, 30 min steaming	53.35	0.32	19.48	19.49	89.07	38.00	
Silk, *potassium dichromate*, 60 min steaming	58.54	3.69	24.35	24.63	81.37	29.95	
Soybean, *without mordant*, 30 min steaming	80.42	0.86	15.95	15.97	86.90	4.39	
Soybean, *without mordant*, 60 min steaming	80.42	0.75	17.77	17.78	87.58	4.68	
Soybean, *potassium dichromate*, 30 min steaming	59.10	0.13	20.99	21.00	89.64	26.65	
Soybean, *potassium dichromate*, 60 min steaming	61.24	1.69	22.36	22.42	85.69	23.71	

All mordanted fibers have higher *f(k)* values than un-mordanted ones. There's an important decrease on color yield values of un-mordanted samples in comparison with mordanted samples. The highest color yield value, 60.81, was observed on wool fiber which is mordanted with potassium dichromate and steamed for 60 minutes. When it compared with this wool sample steamed for 60 min, 30 minutes steamed mordanted wool fiber exhibited less color yield value by 42.42. Due to the fixation ability of mordants on to the fiber and formation of a chemical bonding with natural dyes, absorption and fixation of natural dyes can be easy on to the fibres and therefore; bleeding and fading of colors were also prevented leading to improved fastness properties (Prabhu and Bhute, 2012). It's known that mordants may improve the color strength and fastness properties.

As seen on Table 1, the highest hue angle value (h^o), 94.31, was observed on 30 minutes steamed mordanted wool fiber. Hue angle values (h^o) of samples were close to each other. Colorimetric properties of the printed samples are given on Figure 3 and 4. The colors of printed samples have the various color shades; mordanted samples exhibited brownish colors and un-mordanted samples exhibited beige colors as shown on Table 1. Also this can be observed from $a*$ and $b*$ values (see also Figure 4 (a)). The mordanted silk fabric steamed for 60 minutes was the yellower and redder in appearance than that of other samples. All mordanted fabric samples steamed for 60 minutes had higher yellowness and redness than un-mordanted samples steamed for 30 minutes.

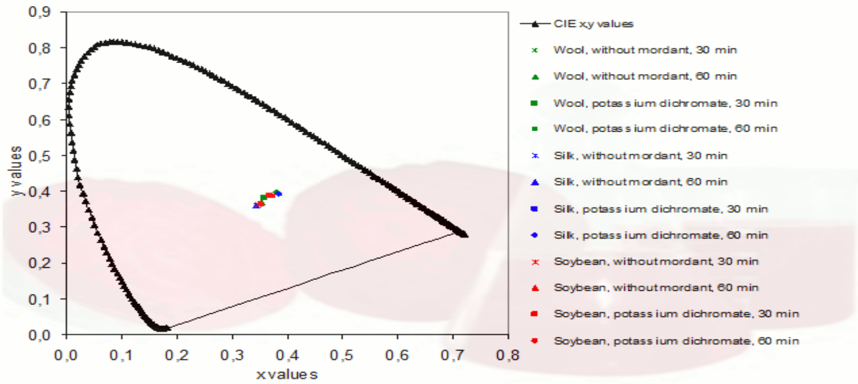


Figure 5: CIE chromaticity diagram showing the position of printed samples with red beet extract in company with mordant

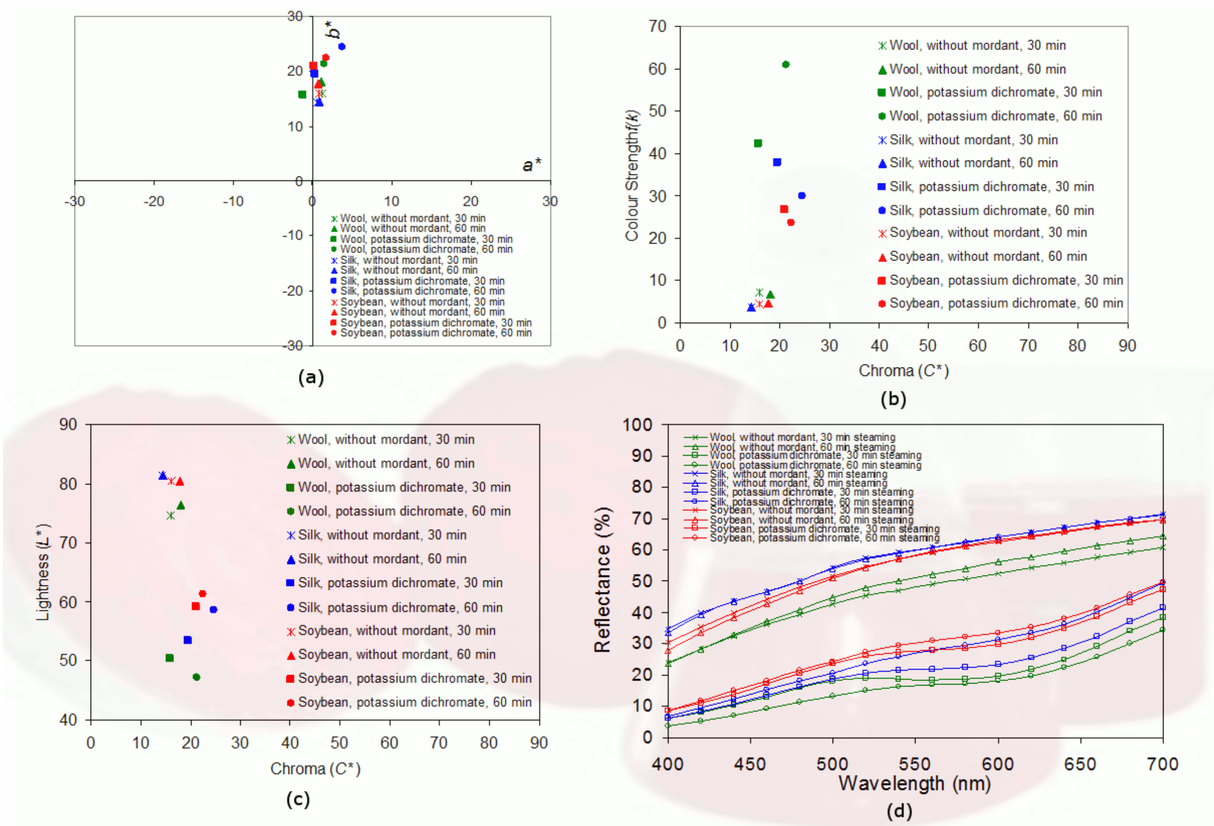


Figure 4: Color properties of dyed samples; (a): a-b*, (b): f(k)-C* (c): L*-C* plots, (d): reflectance-wavelength spectra*

From the above results, it can be concluded that steaming time is not that much effective on colometric values. Steaming time led to different effects on fibers. For example, increase on steaming time led to an increase on the color strength value (f(k)) of mordanted wool fabrics, whereas increase on steaming time resulted in a decrease on mordanted silk and soybean fabrics. And for all studied samples (with and without mordant), increase on steaming time led to yellower shades.

The un-mordanted silk sample exhibited the highest *L** value leading to lightest appearance. This is actually in line with the color strength results. Since the un-mordanted silk samples had the lowest color yield by 3.68 and 3.71 leading to the lightest appearance. Mordanted silk, wool and soybean fabrics steamed for 60 minutes had higher chroma values and darker appearance than un-mordanted samples. Mordanted wool fabrics exhibited the darkest appearance. According to *L** and *C** values (Figure 5 (c)), un-mordanted silk, soybean and wool fabrics shows brighter appearance than mordanted silk, soybean and wool fabrics with higher *L** and higher *C** values.

Overall, mordanted silk, soybean and wool fabrics exhibited higher color strength, higher chroma, and darker, yellower and redder appearance than un-mordanted fabrics. When mordanted fabrics are compared, mordanted wool fabric which is steamed for 60 minutes exhibited higher color strength with lower lightness.

3.2. Fastness Properties

Measured color fastness values were given on Table 3. The wash fastness degrees of printed samples were quite good. Washing fastness properties of printed samples exhibited 4/5- 5 grey scale rating for staining.

Table 3: Fastness properties of printed samples with red beet extract in company with and without mordant and then steamed for 30 min or 60 min.

Printed Samples (fiber, mordant, steaming time)	***Rub Fastness (Cotton staining)***		***Washing Fastness***						***Light Fastness***	***f(k)***
	Dry	***Wet***	***WO***	***PC***	***PES***	***N6.6***	***CO***	***AC***		
Wool, ***without mordant***, 30 min	5	4/5	5	5	5	5	5	5	3	7.33
Wool, ***without mordant***, 60 min	5	4/5	5	5	5	5	5	5	3	6.73
Wool, ***potassium dichromate***, 30 min	4/5-4	4-3/4	5	5	5	5	5	5	4-5	42.42
Wool, ***potassium dichromate***, 60 min	5-4/5	3/4	5	5	5	5	5	5	4	60.81
Silk, without mordant, 30 min	5	5	5	5	5	5	5	5	3-4	3.68
Silk, ***without mordant***, 60 min	5	5	5	5	5	5	5	5	3-4	3.71
Silk, ***potassium dichromate***, 30 min	5	5-4/5	5	5	5	5	5	5	4	38.00
Silk, ***potassium dichromate***, 60 min	5	4/5	5	5	5	5	5	5	4	29.95
Soybean, ***without mordant***, 30 min	5	5-4/5	5	5	5	5	5	5	3-4	4.39
Soybean, ***without mordant***, 60 min	5	5	5	5	5	5	5	5	3-4	4.68
Soybean, ***potassium dichromate***,30 min	5	3/4	5	5	4/5	5	4/5	5	4	26.65
Soybean, ***potassium dichromate***, 60 min	5	3/4	5	5	4/5	4/5	5	5	3-4	23.71

In general, good level of rub fastness values were observed on printed samples. Dry rub fastness values are higher than wet rub fastness values. The dry rub fastness values of samples were excellent. Mordanted wool fiber fabrics exhibited in the range of 4-5 dry and 3/4- 4 wet rub fastness degrees, respectively. Mordanted samples exhibited lower rub fastness levels. Moreover, all mordanted samples exhibited rub fastness in the range of 3/4-5. In general, higher color yields led to lower wet rub fastness values which can also be seen from the *f(k)* values on Table 3. Since, as mentioned earlier, these samples had higher color strength due to the higher dye content which in turn leads to lower wet rub fastness values. Steaming time is not effective on the fastness properties. The light fastness values of printed samples were in between 3 and 4-5 gray scale rating. Additionally, mordanted samples exhibited higher light fastness values than unmordanted samples. It seems that mordanting process is effective on light fastness improvement.

5. CONCLUSION

Eco-friendly, non-toxic, sustainable and renewable natural dyes have been used for coloration the food substrate, leather, wood, natural fibers from the beginning of human history. Many different extracts from plants or animals have been used for natural textile coloration. However, natural dyes extracted from red beet are not commonly used in textile printing. In this study, natural printing of wool, silk and soybean fabrics with red beet extract in company with and without potassium dichromate mordant for two different steaming times were studied.

All mordanted fibers have higher *f(k)* values than unmordanted ones. There's an important increase on color yield values of mordanted samples in comparison with un-mordanted samples. The highest color yield value, 60.81, was observed on mordanted wool fiber which is steamed for 60 minutes. The colors of printed samples have the various color shades; un-mordanted samples exhibited beige colors and mordanted samples exhibited brownish colors. All mordanted fabric samples steamed for 60 minutes had higher yellowness and redness than un-mordanted samples steamed for 30 minutes.

Overall, mordanted silk, soybean and wool fabrics exhibited higher color strength, higher chroma, and darker, yellower and redder appearance than un-mordanted fabrics. When mordanted fabrics are compared, mordanted wool fabric which is steamed for 60 minutes exhibited higher color strength with lower lightness.

The wash fastness degrees of printed samples were quite good. In general, good level of rub fastness values were observed on printed samples. Dry rub fastness values are higher than wet rub fastness values. In general, higher color yields led to lower wet rub fastness value. Light fastness degrees of mordanted samples were higher than those of unmordanted samples.

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STUDY ON THE WETTABILITY, MOISTURE MANAGEMENT PROPERTIES AND SORPTION CAPACITY OF TERRY FABRICS

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Abstract: In order to meet the requirement for softness of terry fabrics, they undergo special finishing. Unfortunately, often softening process leads to deterioration of hydrophilicity of the fabric and its sorption capacity. This work presents the results of a study for assessment of the impact of the type of softener and treatment time on the ability for wetting, moisture management and sorption capacity of terry fabric. The treatment of samples was carried out in industrial conditions. Two softeners were used - silicone and fatty acids based, and treatment was carried out for periods of 3, 5, 15 and 30 min. The results show that the use of fatty softener deteriorates the ability for wetting, the transfer of water and the total sorption capacity. Fabrics treated with silicone softener show better moisture management properties. The microsize of particles in the silicone emulsion and the high concentration of emulsifying elements lead to a more effective penetration into the structure of terry fabrics. The study of treatment time on the processes of wetting and capillary wicking allows to determine an optimal value at which the best sorption characteristics are achieved.

Keywords: terry fabric, softener, sorption, moisture management properties, wetting, liquid tester

1. INTRODUCTION

Terry fabrics are a special class of products, the primary function of which is to absorb water from the human body and other surfaces. To improve the sorption capacity, they are made with loop coverage. The location of the loops is perpendicular to the plane of the fabric and determines their different behavior at moisture management compared with conventional fabrics as well as their ability to absorb a significantly greater amount of adhesive humidity. At the same time, in order for good moisture management to be provided, it is necessary for the water absorbed by the fabric to be taken away quickly from the human body, i.e. the transfer of water from the wetted to the outer surface is also a point of interest.

In softening treatments, there is a change in the physico-chemical and physico-mechanical properties. The molecules of the softening substances are extracted by the bath and penetrate the fibers, causing internal plasticization and changing their surface properties. This leads to a change in the characteristics of the yarns and products made by them [0].

Depending on the ionic nature of the softeners and the fibers, the macromolecules of the softening substance are arranged differently on the surface of the fibers. The direction of their orientation leads to different softness and sorption properties of the softened materials. Cationic softeners provide excellent softness and smoothness, but they decrease the sorption properties of the fabrics [0, 0, 0]. The anionic ones improve hydrophilicity of the material, but softening effect is smaller compared with cationic softeners. For non-ionic softeners orientation depends on the properties of softened fiber surface. Hydrophilic surfaces attract the hydrophilic part of the molecule of the softener and form a new external hydrophobic surface, and vice versa – in the interaction of hydrophobic fiber surface with molecules of nonionic softeners, outer hydrophilic surface is formed [0].

Silicone softeners, due to their functional groups, provide very good softness, extremely pleasant touch, smoothness, elasticity, strength, and a wide range of the sorption properties of the treated fabrics - from hydrophobic to hydrophilic fabrics [0, 0].

Besides the type of softening substances used, the duration of conduction of the treatment also affects the softness, physico-chemical, physic-mechanical and sorption properties of finished fabrics.

Depending on the nature of the softener, the size of the emulsion particles, the process parameters (temperature, module of the bath, etc.), the nature and structure of the fibers, the yarns and fabric, the speed and manner of extraction of the softener are changed. Its location and amount determines the softness of the product [0, 0, 0, 0] as well as its sorption abilities [0, 0, 0, 0, 0, 13]. Other factors have influence on the properties of terry fabrics as well, such as their structural characteristics (yarn densities, height of loop coverage, etc.) [0, 0, 0, 0], pre-treatment (desizing, boiling, bleaching) [0, 19] and others.

2. MATERIALS AND METHODS

The study is carried out on a raw terry fabric with the following characteristics: 100% cotton, mass per square unit - 500 g/m^2, weave - rips 2/1, density of the warp yarns - 240 threads/dm, density of the weft yarns - 160 threads/dm; warp yarns - ring yarn with a linear density of 30x2 tex, weft yarns - rotor yarn with a linear density of 40 tex, pile yarns - rotor yarn with a linear density of 40 tex, height of loops - 7 mm.

Final treatments were carried out under production conditions and include the following stages:

1. Desizing with 2% alpha-amylase;
2. Boiling with 2 g/l sodium hydroxide and 1 g/l dispersing agent;
3. Softening with two types of softeners – silicon and fatty acids based with the following duration of the process – 3, 5, 15 and 30 min.

Sorption properties of terry fabric are evaluated by examining:

- wetting ability
- speed of transfer of the liquid in the structure of the fabric and
- sorption capacity.

The wetting ability is visually examined by the drop method as the samples are placed in free standing on a horizontal surface and are dropped with 6 drops of water solution colored with standard methylene blue dye. The dynamics of water spreading is monitored with a digital camera. Captures are made at the time of dropping, at the 6th, 15th, 20th minute and the 15th hour. Measuring the wetted area is performed using a software program for image analysis.

The speed of wetting and transfer of the liquid into the material is assessed through the following characteristics:

- Wetting Time – WTT (top surface) and WTB (bottom surface) [s];
- Absorption Rate – TAR (top surface) and BAR (bottom surface) [%/s];
- Maximum Wetted Radius – MWR_{top} (top surface) and MWR_{bottom} (bottom surface) [mm];
- Spreading Speed – TSS (top surface) and BSS (bottom surface) [mm/s];
- Accumulative One-Way Transport Index – R (from top to bottom surface) [%];
- Overall Moisture Management Capacity – OMMC [-].

The first four indicators evaluate the process of wetting and spreading of water in the surface of the fabric (top and bottom), the fifth – the transfer in a vertical direction and Overall Moisture Management Capacity is a comprehensive assessment of the ability of the material to wet and transfer water [20].

No standard has been developed yet for the work with this device and the method described in AATCC 195 [0] has been used. Based on preliminary tests, it was found that for a study of terry fabrics, the optimal parameters for the measurement are: 40 s time for wetting of the sample corresponding to 0,3 g liquid, and 100 s time to measure the spreading of water in the structure of the fabric [0].

The studies on sorption capacity of softened terry fabrics are done according to the standard BV S1008 [0] of the Bureau Veritas Consumer Products Service. Preconditioned samples with dimensions of 100 mm x 100 mm were placed for 1 min in distilled water at room temperature and drained for 3 min.

The total sorption capacity W_A was determined according to the formula:

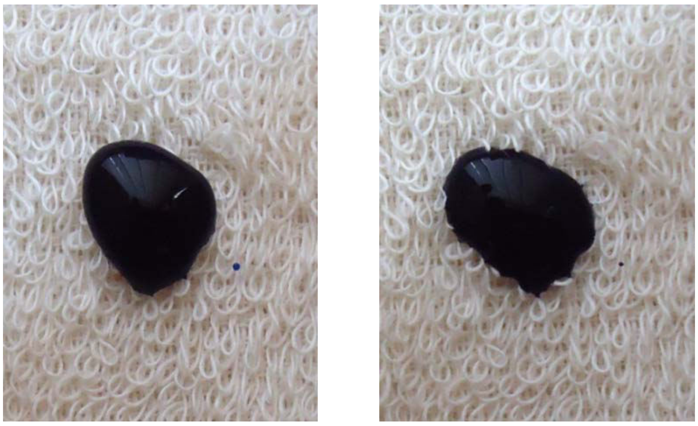
$$W_A = \frac{M_W - M_C}{M_C}.100, \tag{1}$$

where M_C is the mass of the conditioned samples, g;
M_W – the mass of the samples in wet state, g.

3. RESULTS AND DISCUSSIONS

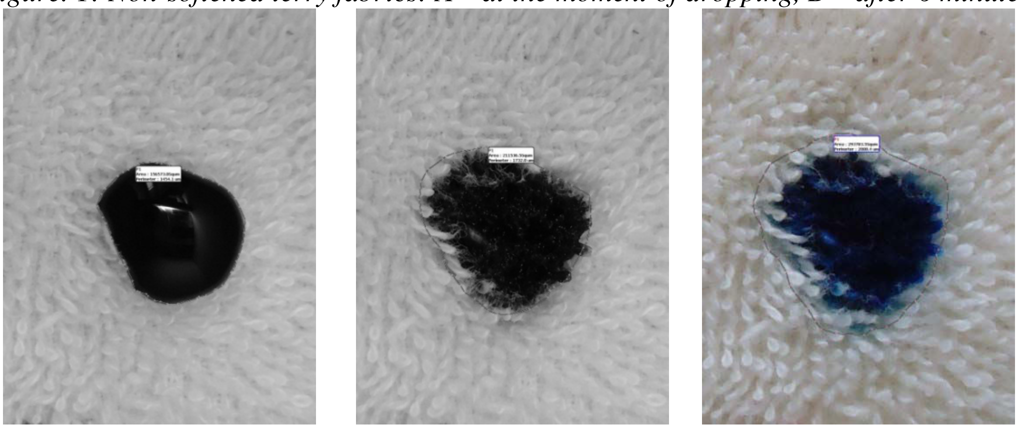
3.1. Study of wettability of fabrics

The results are presented visually and graphically in Fig. 1 to Fig. 10. The pictures show the process of wetting of the untreated and treated fabrics over time.



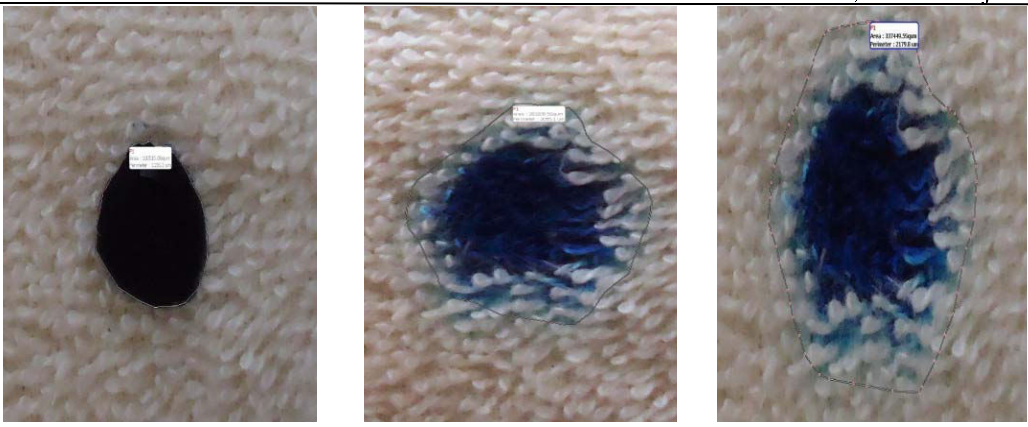
A B

Figure. 1: Non-softened terry fabrics: A – at the moment of dropping, B – after 6 minutes



A B C

Figure. 2: Terry fabrics treated for 3 minutes with Fatty Acids Softener. A – at the moment of dropping, B – after 6 minutes, C – after 15 minutes



A *B* *C*

Figure. 3: Terry treated fabrics for 3 minutes with Silicone Softener
A – at the moment of dropping, B – after 6 minutes, C – after 15 minutes

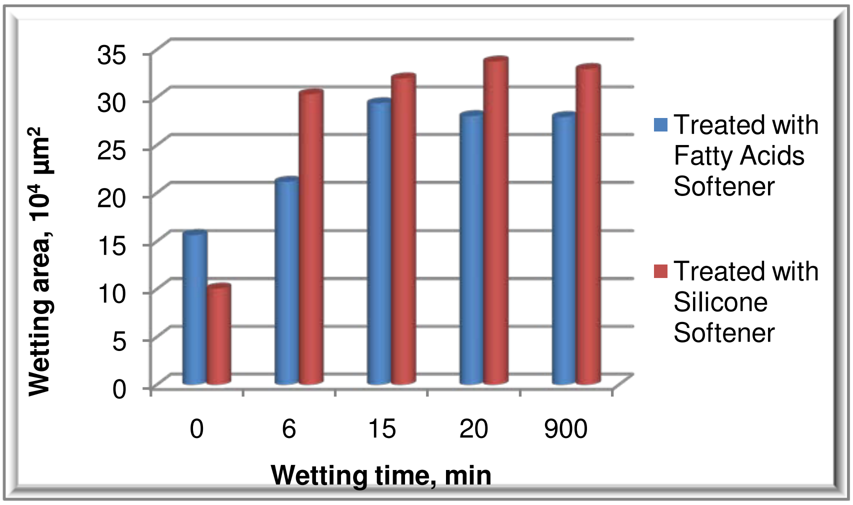


Figure. 4: Wetting area of treated for 3 minutes terry fabrics

A B C

Figure. 5: Terry fabrics treated for 5 minutes with Fatty Acids Softener
A – at the moment of dropping, B – after 6 minutes, C – after 15 minutes

A B C

Figure. 6: Terry fabrics treated for 3 minutes with Silicone Softener
A – at the moment of dropping, B – after 6 minutes, C – after 15 minutes

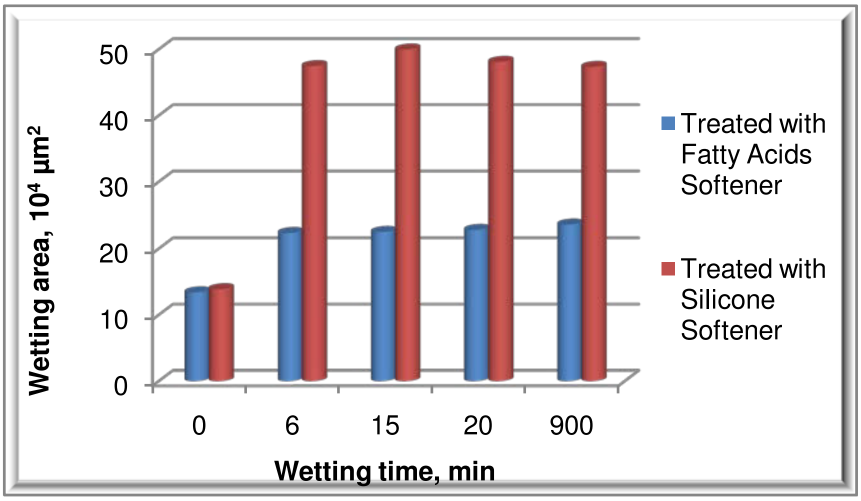
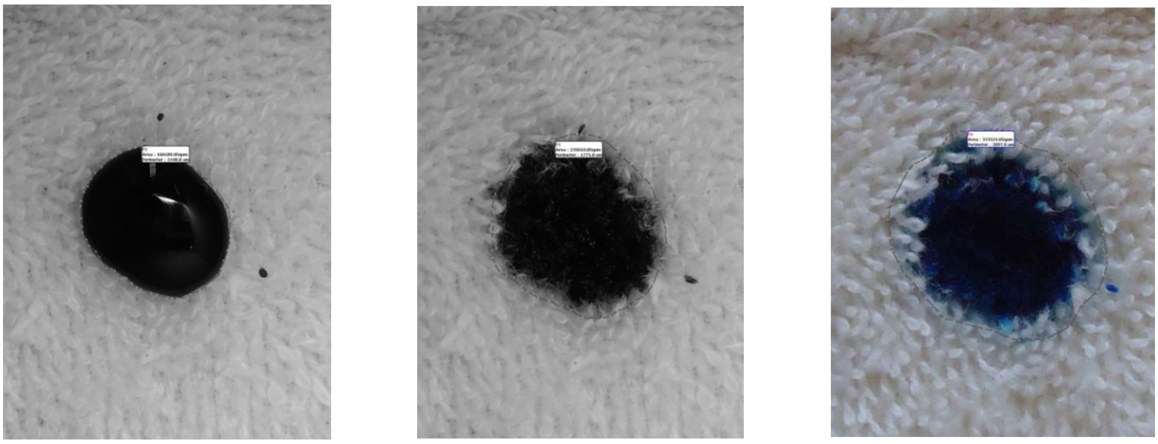
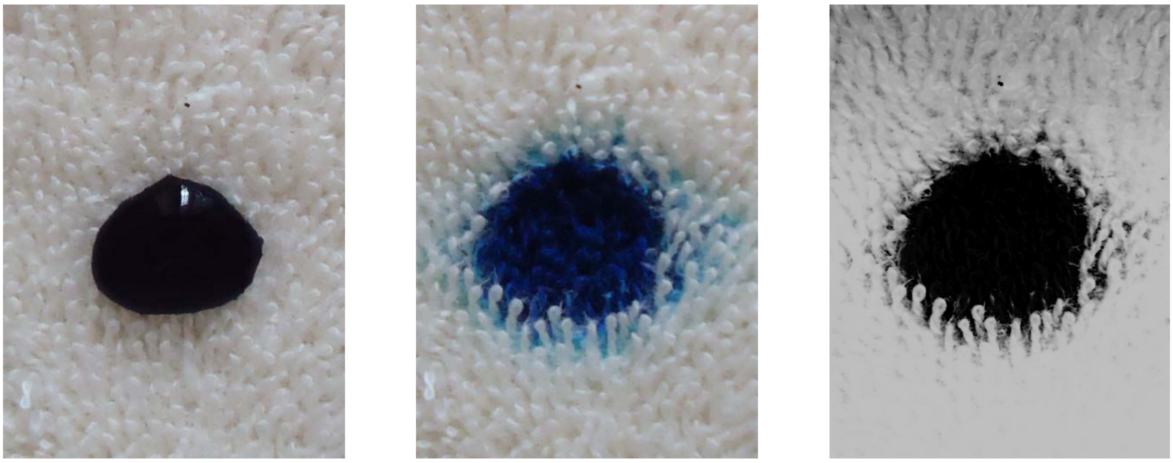


Figure. 7: Wetting area of treated for 5 minutes terry fabrics



A B C

Figure. 8: Treated terry fabrics for 15 minutes with Fatty Acids Softener
A – at the moment of dropping, B – after 6 minutes, C – after 15 minutes



A B C

Figure. 9: Treated terry fabrics for 15 minutes with Silicone Softener
A – at the moment of dropping, B – after 6 minutes, C – after 15 minutes

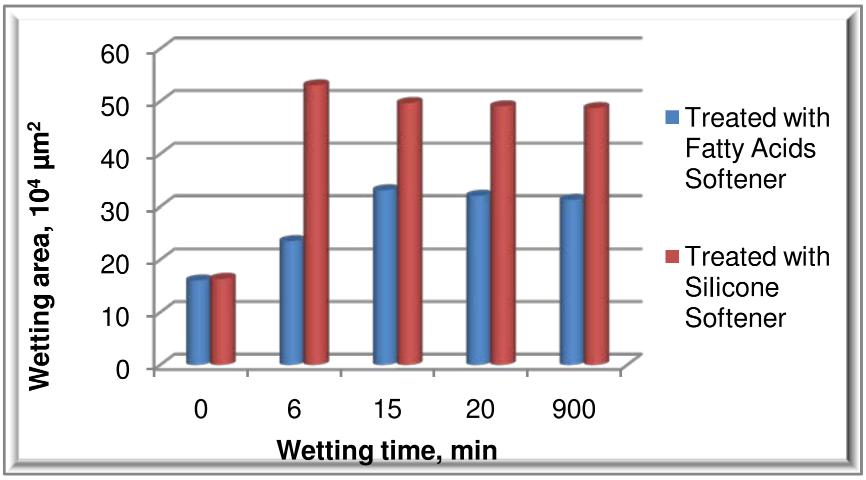


Figure. 10: Wetting area of treated for 15 minutes terry fabrics

The charts in Figures 4, 7 and 10 show that there are significant differences in the area of wetting after treatment with fatty and silicone softener. For the first one, wetting and moisture spreading is considerably hampered. This is mainly due to the fact that the molecules of the fatty softener are located mostly on the surface of cellulose fibers, while silicone, which is in the form of microemulsion penetrates inside the fibers. This is most apparent in the fabrics softened for 6 min.

There is also a different mechanism of adsorption and penetration of the softeners into the substrate. After a 3-minute treatment, softener emulsion is deposited on the fibers and penetrates poorly the structure. The results for the wetting area are similar, with a slight advantage for the silicon one. The 5-minute treatment leads to a great improvement in the hydrophilicity of terry fabrics treated with silicone softener. Those treated with fatty acids retain their properties. The reason is again the faster and deeper penetration of the silicone emulsion in the material. Further treatment leads to a very small increase in the wetting ability. The point of saturation is reached.The results for the change of the area of wetting also show that observations should be made within the first 20 min. A continuous monitoring the process is not necessary because the process of wetting with 6 drops of dye solution has already finished.

3.2. Study of the ability of fabrics for three-dimensional water transfer in their structure

Data from the studies is summarized in Table. 1.

Table 1: Three-dimentional water transfer in terry fabrics' structure

Properties	Scoured	Fatty Acids Softener				Silicone Softener			
		3 min	5 min	15 min	30 min	3 min	5 min	15 min	30 min
WTT, s	17.98	15	13.73	14.25	9.28	12.21	17.08	66.15	27.51
WTB, s	77.34	100	66.85	82.31	100	40.80	37.78	77.74	33.15
TAR, %/s	6.71	6.12	6.02	7.07	5.54	6.84	7.02	2.56	4.89
BAR, %/s	2.01	0	2.86	1.15	0	10.75	6.33	3.98	6.85
MWR_{top}, mm	6	7	5	6	5	6	6	2	5
MWR_{bottom}, mm	2	0	2	1	0	10	9	4	9
TSS, mm/s	0.3891	0.4593	0.4269	0.4503	0.5710	0.5069	0.4473	0.1486	0.3622
BSS, mm/s	0.0462	0	0.0563	0.0853	0	0.9559	0.7831	0.3574	0.7545
R, %	-23.62	-52.25	-21.53	-40.36	-51.70	7.88	8.36	3.12	18.86
OMMC	0.0331	0.0022	0.0328	0.0186	0.0013	0.0695	0.0653	0.0596	0.0814

The results are presented graphically in Fig. 11 to Fig.20.

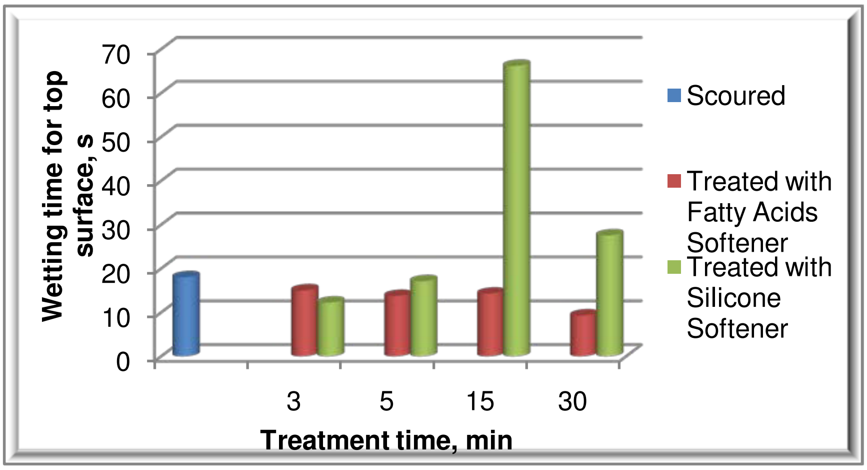


Figure. 11: Wetting time for top surface

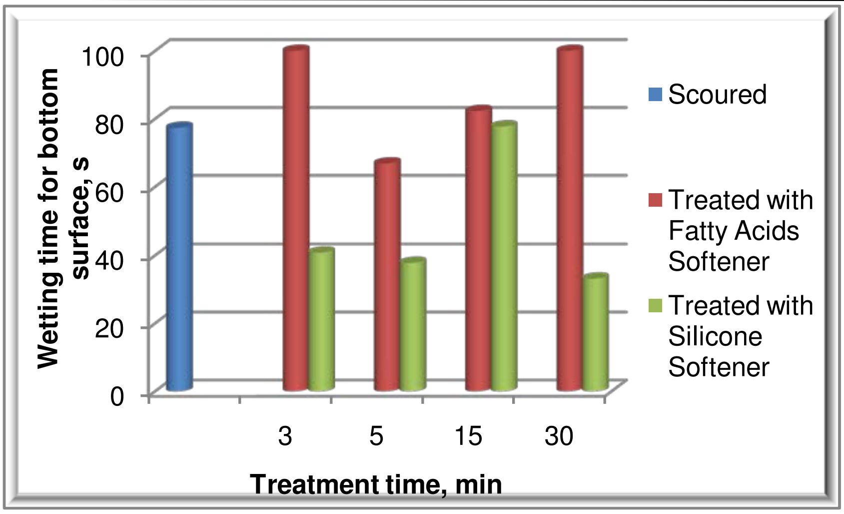


Figure. 12: Wetting time for bottom surface

Fig. 11 and Fig. 12 show that the top surface of the fabric is wetted much faster than the bottom one, which is more strongly expressed in samples treated with softeners based on fatty acids. This shows low transfer of the fluid from the top (wetted) to the bottom surface. This fact is confirmed afterwards by the one-way transport data.

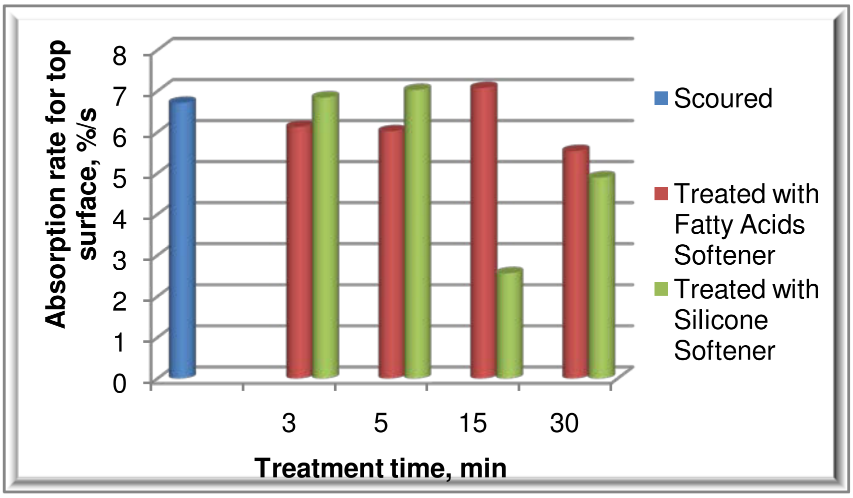


Figure. 13: Absorption rate for top surface

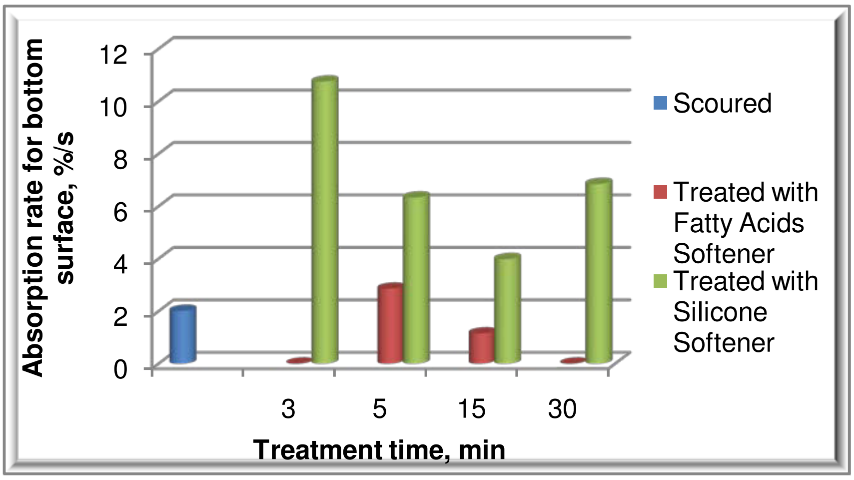


Figure. 14: Absorption rate for bottom surface

The analysis of the results for the speed of water absorption (Fig. 13 and Fig. 14) show a rapid uptake of liquid from the top surface of the fabric and its slower sorption by the bottom one, also more strongly expressed in fabrics softened with fatty softener. This is logical and is due to the smaller amount of water reaching the bottom surface.

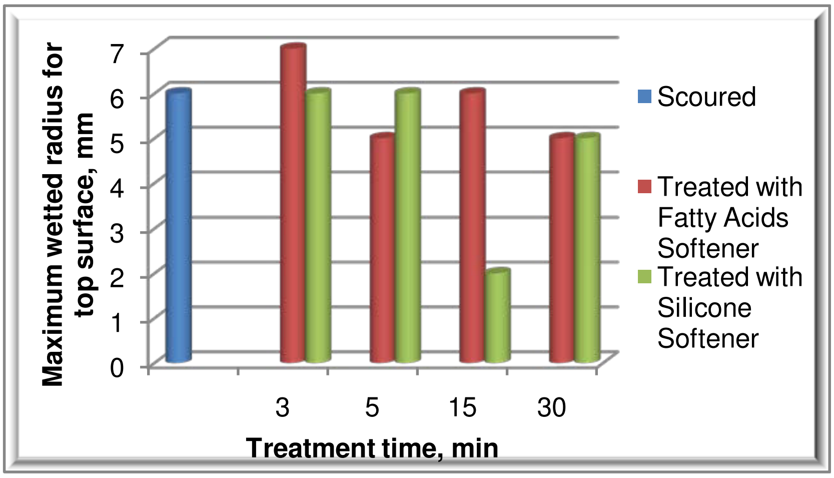


Figure. 15: Maximum wetted radius for top surface

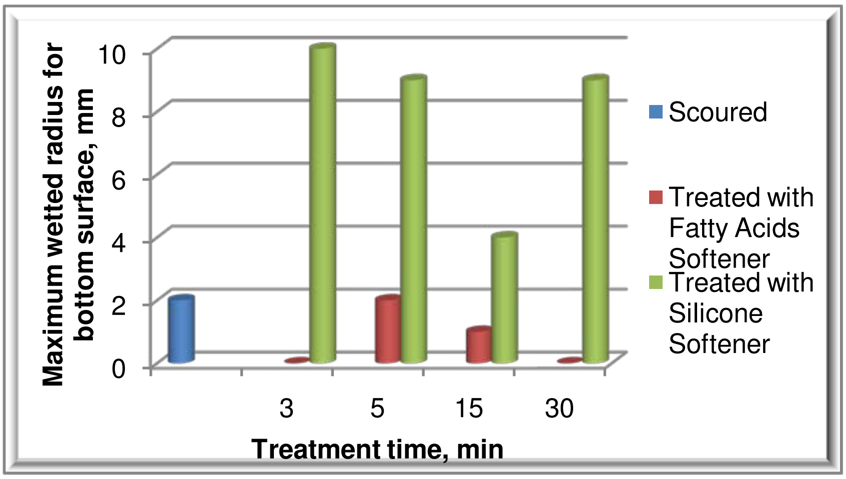


Figure. 16: Maximum wetted radius for bottom surface

From the values for the maximum wetted radius of both surfaces (Fig. 15 and Fig. 16), it can be concluded that the studied fabrics are poorly wetted. In practice, liquid is absorbed and retained in the top loop surface, which reduces its spreading in the horizontal direction. Significantly larger radius of wetting to the bottom surface and respectively better disposal of the fluid is observed for fabrics softened with silicone softener.

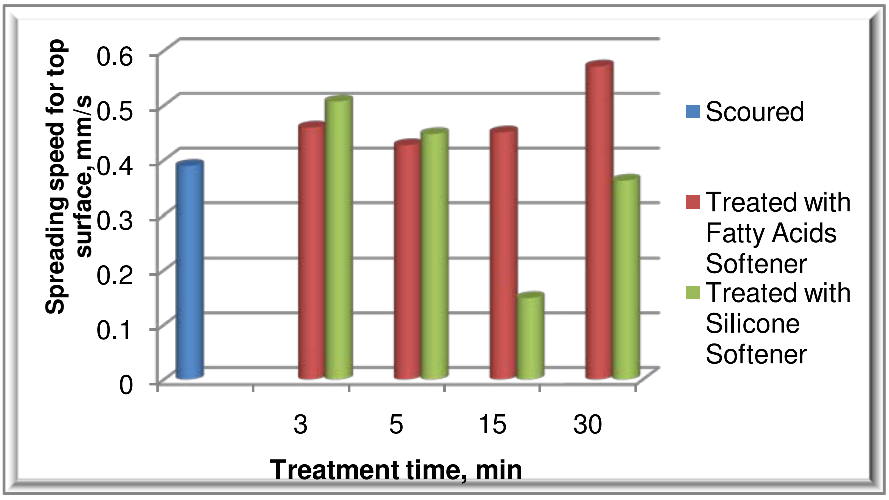


Figure. 17: Spreading speed for top surface

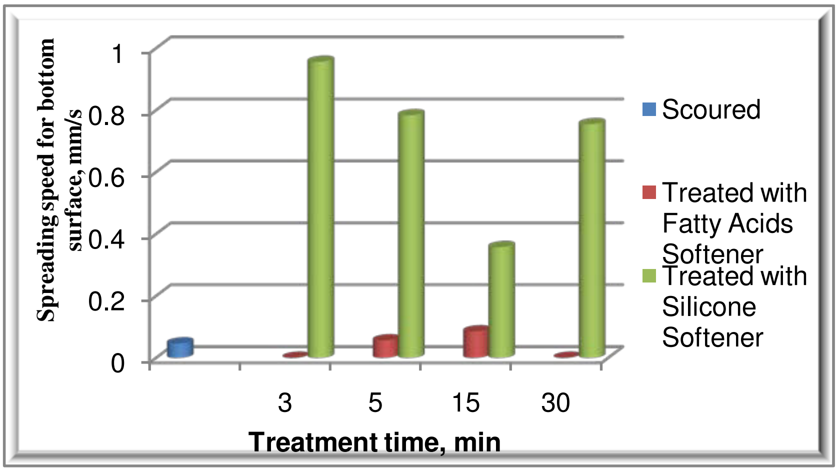


Figure. 18: Spreading speed for bottom surface

Similarly to the speed of water absorption, here (Fig. 17 and Fig. 18) the same trends are observed here as well. The reason is that there is a strong correlation between the two characteristics - speed of water absorption and speed of wetting. With the increase in the speed of water absorption, the speed of wetting increases as well.

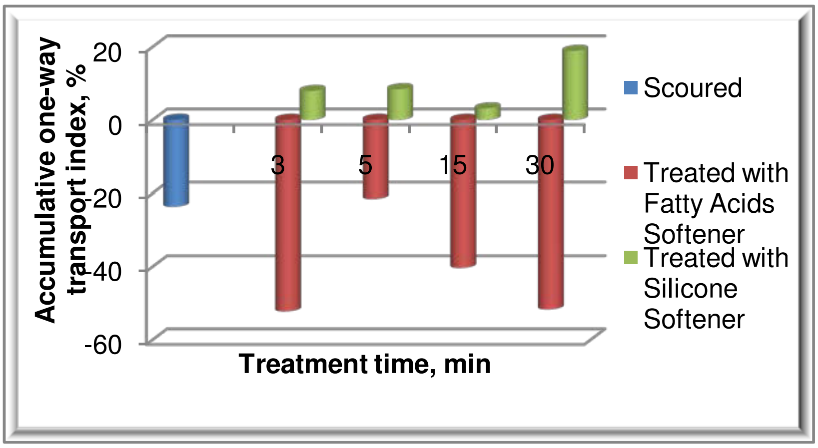


Figure. 19: Accumulative One-Way Transport Index

Fig. 19 clearly shows that the ability to transfer fluids from the top to the bottom surface is significantly higher in fabrics softened with silicone softener compared with boiled fabric and fabric treated with softener based on fatty acids. Silicone softener improves to a higher extent the capillary activity which leads to more efficient disposal of moisture from the wetted surface. The Accumulative One-Way Transport Index is essential for terry fabrics and the comfort of products made by them.

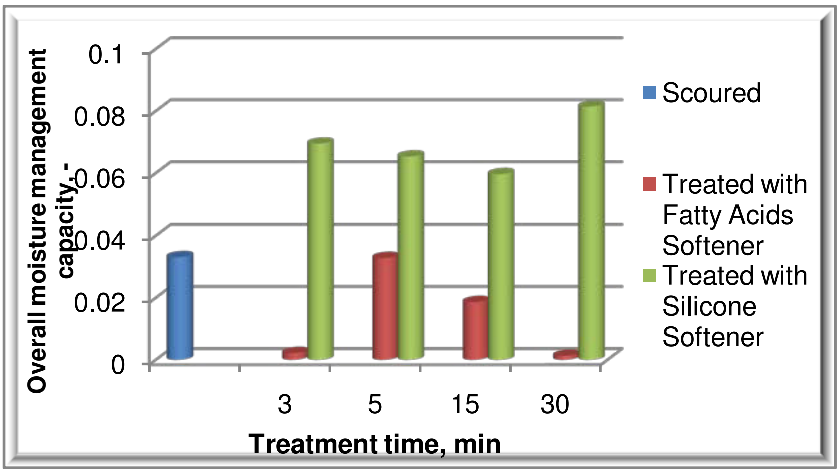


Figure. 20: Overall moisture management capacity

Terry fabrics softened with silicone softener have a higher total capacity of moisture management, i.e. they have a better ability to transport liquids in both vertical and horizontal direction compared with fabrics softened with fatty softener.

3.3. Study of sorption capacity

The values obtained for the total sorption capacity of the studied terry fabrics are presented in Table 2.

Table 2: Sorption capacity

Sorption capacity, %								
Scoured	Fatty Acids Softener				Silicone Softener			
	3 min	5 min	15 min	30 min	3 min	5 min	15 min	30 min
538.44	502.03	492.89	494.79	427.39	528.73	556.39	572.30	533.44

The results are presented graphically in Fig. 21.

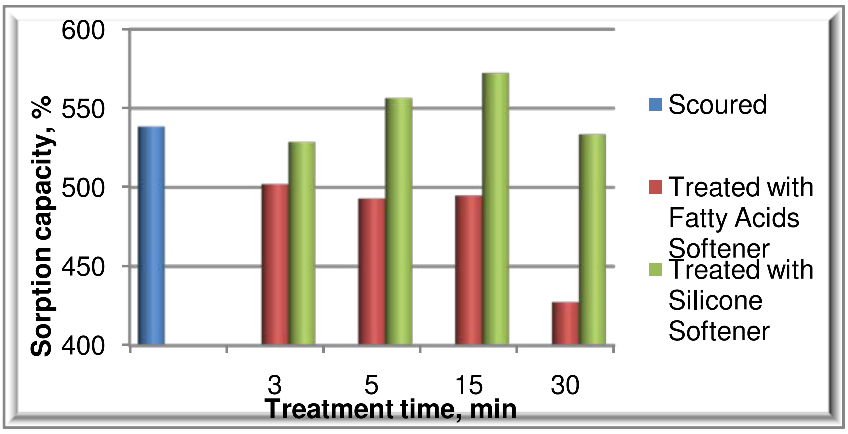


Figure. 21: Sorption capacity

As the chart shows, the use of silicone softener improves the sorption capacity of the fabrics. The fatty one improves softness [0, 0, 0] of the fabrics, but for treatment time between 3 and 15 min, it decreases their sorption capacity by 6.5 to 8.5%.

The results for the sorption capacity confirm the thesis for the mechanism of absorption of softeners - low penetration and formation of a layer of the fatty acids softener on cotton fibers. This leads to a reduction of the amount of water that can be absorbed by the treated fabrics. After a 30-minute treatment, the reduction of the sorption coefficient is 20% compared to the initial state (boiled fabric). The microsilicone emulsion penetrates deeply and improves the sorption properties.

4. CONCLUSIONS

A study has been conducted on the impact of the process of softening on the behavior of terry fabrics at wetting, measured by the area of wetting, the speed of three-dimensional transfer of the fluid in their structure and the total sorption capacity.

The area of wetting, respectively the wetting ability was significantly higher in fabrics treated with silicone softener, compared with those treated with fatty acids. The treatment time has a small impact at treatment with fatty softeners and in the interval 3-15 min improves the wetting ability of the fabrics treated with silicone emulsions.

Softening with silicone softener improves the total capacity of water absorption and provides significantly better results than the use of the one based on fatty acids.

The treatment time affects the sorption capacity as there is a different mechanism of impact. While the fatty softener is deposited on the material quickly, the microsilicone one penetrates more slowly into its structure. For the first one, treatment within 3 to 15 min did not result in significant changes in water absorption ability. For the silicon one, it was increased for the same period. Thirty minutes is an inappropriate treatment from both economic point of view and in terms of the resulting sorption effect.

The results obtained for the total capacity of water absorption correlate with those for water absorption speed. Treatment with silicone softener within 15 min increases the speed of water absorption for the top surface. Regarding the fatty softener, the speed is comparable to that of the silicon one, but this is due to poor water transfer from the top to the bottom surface and its retention in the top surface.

The speed of water absorption of the bottom surface is many times greater with silicone softener which indicates active transfer of water in a direction perpendicular to the surface of the fabric. This fact is confirmed by the results for the Accumulative One-Way Transport Index of which takes positive values only at treatment with silicone softener.

The use of silicone softeners for terry fabrics has a number of advantages. They improve both their softness and the total capacity of water absorption. In addition, they increase the speed of uptake of water not only in the plane of the fabric but also at its disposal from the body. This leads to improved moisture comfort and makes products more desirable and demanded.

Acknowledgement

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Abstract: *In this study, the printing possibilities of soybean, silk, wool and cotton fabrics with the extract of Rubia tinctorum L. (madder) were examined. All fabrics were pre-mordanted with alum prior to printing process. Alginate was used as a thickener for the printing paste. Printed samples were fixed under different steaming times at 102°C. The effects of different steaming times on color strength values of printed fabrics were also studied. The overall fastness and color properties of printed samples were evaluated and compared. Pink and red shades are obtained. Printing of protein fibers resulted in higher color strength, higher chroma and darker appearance than that of cotton. Natural dyestuff source of Rubia tinctorum L.(madder) is fixed with steaming at 102°C without the use of any binder in the printing paste. Fixation times of 60 and 90 minutes led to higher color strength and higher chroma. Wash and crock fastness of all printed samples were adequate. Higher light fastness values were obtained for the samples which exhibited higher color yield values. Overall, 60 min steaming at 102°C can be recommended for soybean, silk and cotton fabrics. For wool fabrics, 90 min steaming at 102°C was more appropriate.*

Key words: *saybean, silk, wool, cotton, Rubia tinctorum, printing*

1. INTRODUCTION

The studies regarding natural dyestuff coloration generally are concentrated on textile dyeing field. There are quite few printing studies with natural dyestuffs. The printing of cotton with the natural dyes from the bark of neem tree bark (Boonroeng et al., 2009), pigment-printing technique of wool, silk, cotton and flax with two natural dyes, alkanet and rhubarb (Rekaby et al., 2009), printing of cotton fabric with terminalia chebula dye (Patel and Chattopadhyay, 2009), printing of cotton with marigold flower (Agarval et.al., 2007), pigment printing of silk fabrics with natural dye from red mangrove bark (Nakpathom et al., 2011) were studied earlier by various researchers.

*Rubia tinct*orum L. (madder) is the most important plant to obtain red colors during natural coloration (see also Figure 1). Rubia tinctorum L. has a variety of anthraquinone dyes in its roots (see also Figure 1). The main anthraquinone dyes exist in madder are di- and tri-hydroxy anthraquinones, alizarin and purpurin and their derivatives; ruberythric acid (alizarin-primeveroside), pseudopurpurin and lucidin-primeveroside (Forouharshadi et al., 2013). Moreover, rubiadin, munjisti, quinizarin (1,4 dihydroxyanthraquinone), lucidin, nordamnacanthal, xanthopurpurin and 1,8-dihydroxyanthraquinone also exist in plant tissues (Forouharshadi et al., 2013). Approximately 36 different anthraquinones have been detected so far in *R. tinctorum* by different researchers (De Santis and Moresi, 2007).

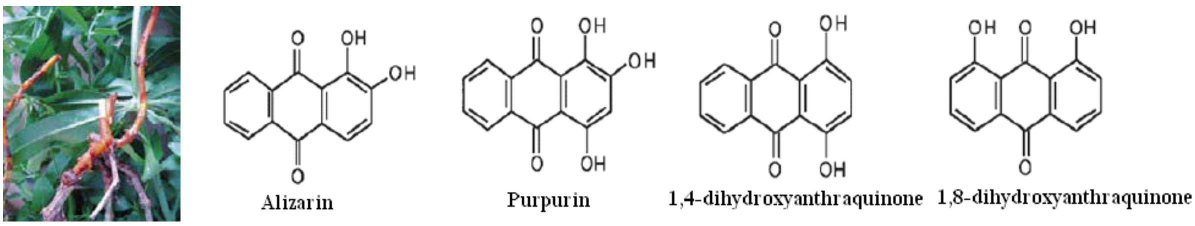


Figure 1: Madder plant (Karadağ, 2007) and chemical structures of the main anthraquinones in madder (Forouharshadi et al., 2013)

Most of the natural dyestuffs exhibit poor light and wash fastness properties. The usage of mordant, prior to coloration or during the coloration or after the coloration, might result in an increase on natural dye uptake leading to higher color yield and improved color fastness properties (Kumbasar, 2011). The complex formation structure of natural dyestuff and mordant metal with cotton and wool fibers are shown on Figures 2 and 3, respectively.

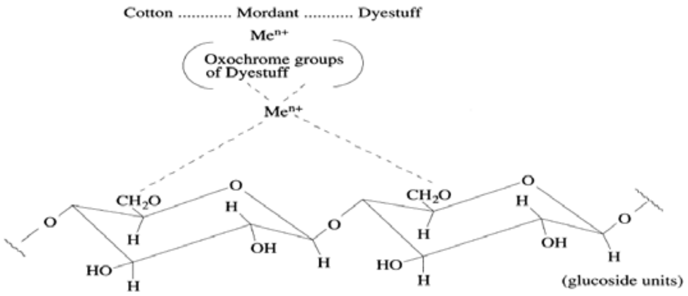


Figure 2: The complex formation structure of natural dyestuff, mordant metal and cotton fibers (Önal, 1996)

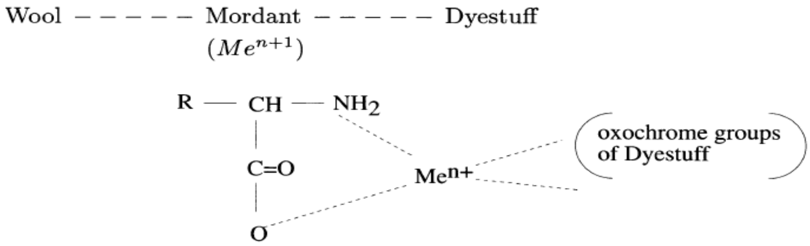


Figure 3: The complex formation structure of natural dyestuff, mordant metal and wool fibers (Önal, 1996)

For instance, for this purpose, alum can be used to increase the binding of the dye to the textile substrate (Bechtold and Mussak, 2009). Actually, the most generally used mordant was alum (aluminum potassium sulphate) for textile coloration, (Zarkogianni et.al., 2010). Among all types of alum mordant, potash alum mordant is cheap, easily available and safe to use since their environmental toxicity is almost nil (Kumbasar, 2011). Moreover, alum salts intensify the obtained color brilliance yet do not influence the color shade to the same extent and they improve the fastness properties and broaden the color range (Bechtold and Mussak, 2009).

In this study, the printing possibilities of soybean, silk, wool and cotton fabrics with the extract of *Rubia tinct*orum L. (madder) were examined. All fabrics were pre-mordanted with alum prior to printing process. Printed samples were fixed under different steaming times (30, 60 and 90 minutes) at 102°C. The effects of different steaming times on color and color fastness properties were evaluated and compared.

2. MATERIALS AND METHODS

2.1. Materials

100% soybean fiber single jersey knitted fabric, 100% plain woven silk, 100% plain woven wool, and 100% plain woven cotton fabrics were used for printing. Roots of *Rubia tinctorum L.* (madder) plant were used as a natural dyestuff source. The extraction of roots of *Rubia tinctorum L. (*madder) was carried out with an extract machine. Madder extract was produced stepwise. Before launching the roots into the extractor, they were vacuum-dried, and the vacuumed root fluid was then retained for further use. Then, dried madder root materials were mixed with 78% Ethyl Alcohol and 20% distilled water and waited for 24 hours. Then this mixture was spray-dried. Resultant extract, powder form of madder, was combined with root fluid, which had been recovered from the vacuuming process earlier, and used for printing process.

All fabrics were mordanting prior to natural printing process. Pre-mordanting process is carried out using Ataç Lab Dye HT model IR dyeing machine with 20% alum (potassium aluminum sulfate) and 1:20 liquor ratio at 100°C for 60 minutes. After pre-mordanting process, fabrics were left to air-dry.

2.2. Printing

Madder extract was added to the printing paste. The recipe for the printing pastes is given on Table 1. The printing process was carried out using Ataç MDK laboratory-type printing machine with 70 Nr polyester (PES) gauze template. Samples were printed with 2,2 m/min, at 4 press on and with doctor blade of 12 mm in diameter. The doctor blade was used two times for wool, cotton and soybean fiber fabrics, one times for silk fabric due to the fineness of silk fabrics.Then, printed fabrics were dried in a laboratory type drying machine at 100 ℃ for 4 min.

Table 1: Natural printing paste recipes with madder extract

Recipe : Printing paste
100 g. Madder extract 600 g. Alginate (CHT Alginate V9, % 8, low viscosity sodium alginates) 300 g. water
1000 g.

Printed wool, silk, soybean and cotton samples were fixed with steaming process at 102°C for 3 different time conditions; 30, 60, 90 minutes using Ataç GK40E Steamer. Then after fixation, all printed samples were rinsed in cold water and warm water for 5 minutes each, respectively and then air-dried. These air-dried samples were used for color measurements and fastness tests.

2.3. Colorometric and Fastness Measurements

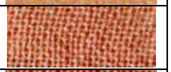
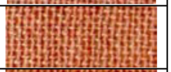
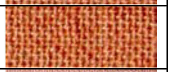
Colors properties of printed, fixed and washed wool, soybean, silk and cotton fabric were determined using DataColor SpectraFlash 600 (DataColor International, Lawrenceville, NJ, USA) spectrophotometer under illuminant D65, using a 10° standard observer. Wash, crock and light fastness tests were carried out according to ISO 105 C06 A2S, ISO X12 and ISO 105 B02 standards, respectively.

3. RESULTS AND CONCLUSIONS

3.1. Color properties

The colorimetric data of the *Rubia tinctorum L.* printed samples are shown on Table 2. Pink and red shades are obtained with the natural printing of cellulose (cotton) and protein (soybean, silk and wool) fabrics with the extract of *Rubia tinctorum L.*(madder), respectively. Obtained shades were slightly different between each other (Table 2). This visual observation was also detected on a^*, b^* and h^0 values (Table 2 and see also Figure 4). Slightly different a^*, b^* and h^0 values were obtained on naturally printed organic fibers.

Table 2: Colorimetric properties of Rubia tinctorum L. extract printed samples

Fabric Type	*Steaming time in minutes*	*L**	*a**	*b**	*C**	*h°*	*f(k)*	*Shades*
Soybean	30	74,59	9,16	18,97	21,07	64,23	7,76	
	60	72,91	10,84	19,48	22,29	60,92	9,00	
	90	72,47	10,82	20,62	23,29	62,31	9,63	
Silk	30	73,82	8,67	16,05	18,25	61,62	7,57	
	60	70,19	10,78	20,50	23,16	62,26	11,35	
	90	70,96	11,18	20,19	23,08	61,02	10,61	
Wool	30	68,77	12,69	17,21	21,38	53,59	11,59	
	60	67,59	13,42	19,54	23,70	55,52	13,41	
	90	66,65	14,21	21,70	25,94	56,78	15,22	
Cotton	30	77,23	9,58	11,05	14,62	49,07	4,87	
	60	76,89	8,88	11,23	14,32	51,68	5,06	
	90	77,71	8,74	11,54	14,48	52,86	4,73	

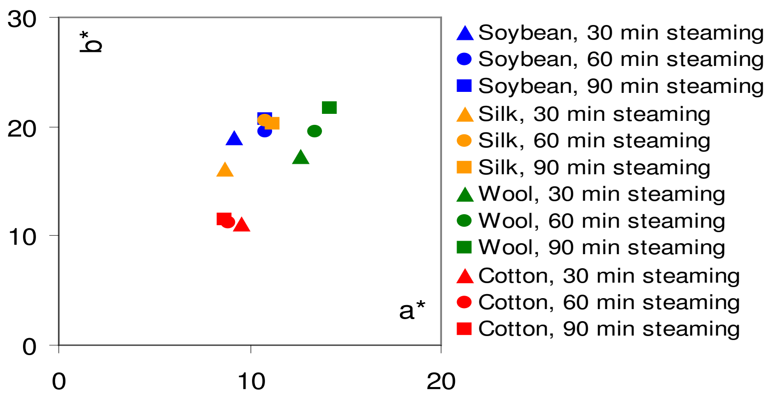


Figure 4: a-b* plot*

Color strength (*f(k)*) and chroma (*C**)comparison of printed fabrics is shown on Figures 5 and 6. The highest color yield values were observed on wool fiber fabrics (see also Figures 5 and 6). As expected, the higher color yield (*f(k)*) resulted in the lower lightness values (*L**) (see also Figure 5 and Figure 6 (b)). The lowest color yields and therefore the highest lightness values were observed on cotton fabrics. It is not unexpected since as it is known natural dyeing of protein fibers generally give better results than that of cellulosics. Similar to natural dyeing, natural printing process led to the same trend.

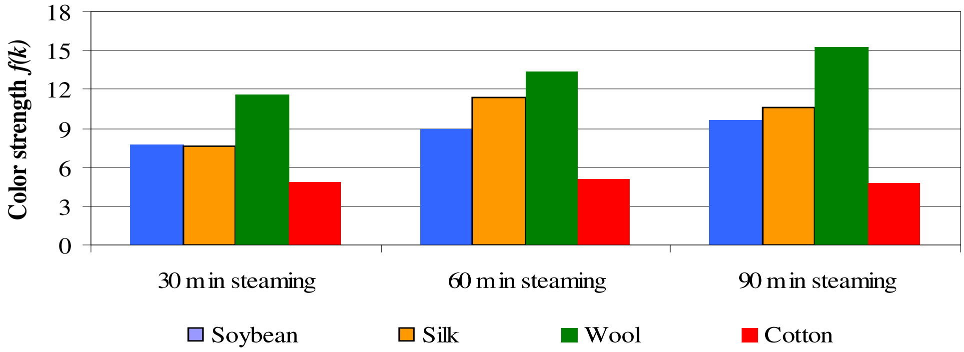
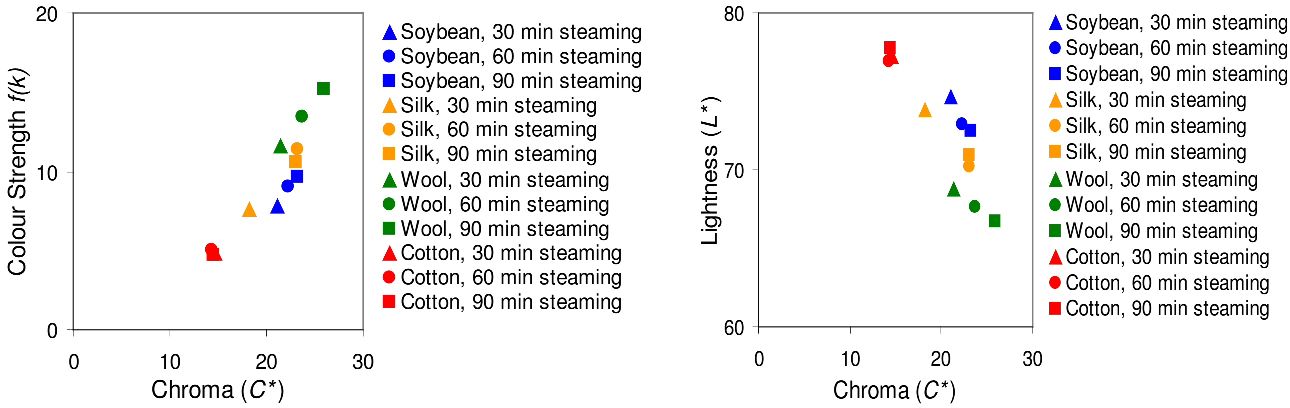


Figure 5: Color strength comparison of printed fabrics



(a) (b)

Figure 6: Colorimetric properties of printed samples: (a) f(k)-C plot, (b) L*-C* plot*

Prolonged steaming time on soybean fabrics led to an increase on both color yield and chroma (see also Figures 5 and 6). However, color strength values of 60 min and 90 min steamed samples exhibited close values. Therefore, due to the 30 minutes shorter steaming time advantage, 60 min steaming at 102°C can be also recommended for soybean fabrics. In the case of silk fabrics, although they exhibited quite close chroma values, 60 min steamed silk sample exhibited slightly higher color yield (see also Figures 5 and 6). As expected, 30 minutes steamed silk sample exhibited the lowest chroma and color strength values. Therefore, 60 min steaming at 102°C can be recommended for printing silk fabrics with madder from the color point of view. Similar to soybean fabrics, prolonged steaming time on wool fabrics led to an increase on both color yield and chroma values (see also Figures 5 and 6). The highest color yield and chroma values were observed on 90 min steamed sample. So, 90 min steaming at 102°C can be recommended for printing wool fabrics with madder from the color point of view. Cotton exhibited the lowest chroma and the lowest color strength values in this evaluation. On cotton fabrics, different steaming time led to very close chroma and color strength values (see also Figures 5 and 6). As a result of more detailed investigation, 60 minutes steaming resulted in the highest color yield (Table 2 and Figure 6).

3.2. Color fastness

Color fastness properties of the *Rubia tinctorum L.* printed samples are shown on Table 3. Printed soybean samples for all steaming times exhibited commercially acceptable wash fastness and crock fastness levels which is above 4 gray scale ratings. However, steaming for 60 and 90 minutes resulted in slightly better light fastness. Therefore, due to the slightly higher light fastness values, 60 and 90 minutes steaming at 102 °C can be recommended for soybean fabrics from the fastness point of view. Similar to soybean fabrics, printed silk samples for all steaming times exhibited commercially acceptable wash fastness and crock fastness levels which is above 4 gray scale ratings. Steaming for

60 minutes resulted in slightly better light fastness. Therefore, 60 minutes steaming at 102°C can be recommended for silk fabrics from the fastness point of view. Light fastness results are in parallel with the measured color yield values. The highest light fastness values were obtained for the samples which exhibited the highest color yield values.

Table 3: Color fastness properties of Rubia tinctorum L. extract printed samples

SOYBEAN fabrics	**Wash Fastness Staining on Multifiber (C06-A2S)**						**Crock fastness**		**Light Fastness**
Steaming time	*Acetate*	*Cotton*	*Nylon*	*Polyester*	*Acrylic*	*Wool*	**Dry**	**Wet**	
30'	5	5	5	5	5	5	5	4-5	2-3
60'	5	5	5	5	5	5	4-5	4-5	3
90'	5	5	5	5	5	5	4-5	4-5	3

WOOL fabrics	**Wash Fastness Staining on Multifiber (C06-A2S)**						**Crock fastness**		**Light Fastness**
Steaming time	*Acetate*	*Cotton*	*Nylon*	*Polyester*	*Acrylic*	*Wool*	**Dry**	**Wet**	
30'	5	5	4-5	5	5	5	5	3-4	2-3
60'	5	5	4-5	5	5	5	4-5	3	3
90'	5	5	4-5	5	5	5	4-5	3	3

SILK fabrics	**Wash Fastness Staining on Multifiber (C06-A2S)**						**Crock fastness**		**Light Fastness**
Steaming time	*Acetate*	*Cotton*	*Nylon*	*Polyester*	*Acrylic*	*Wool*	**Dry**	**Wet**	
30'	5	5	4-5	5	5	5	5	4-5	2-3
60'	5	5	4-5	5	5	5	4-5	4-5	3
90'	5	5	4-5	5	5	5	4-5	4-5	3

COTTON fabrics	**Wash Fastness Staining on Multifiber (C06-A2S)**						**Crock fastness**		**Light Fastness**
Steaming time	*Acetate*	*Cotton*	*Nylon*	*Polyester*	*Acrylic*	*Wool*	**Dry**	**Wet**	
30'	5	5	4-5	5	5	5	5	4-5	1-2
60'	5	5	4-5	5	5	5	4-5	4-5	1-2
90'	5	5	4-5	5	5	5	4-5	4-5	1-2

In the case of wool fabrics, printed wool samples for all steaming times exhibited commercially acceptable wash fastness and dry crock fastness levels which is above 4 gray scale ratings. Wet rub fastness of wool fabrics were in the range of 3 to 3-4. These samples exhibited the highest color yield in this study; therefore, they have higher dye content leading to slightly higher staining during rubbing action of the crock fastness test. When it comes to light fastness results, again as similar to soybean and silk fabrics, the sample with higher color yield exhibited slightly higher light fastness value. Overall, light fastness levels of all three printed fabrics (soybean, silk and wool) are in the range of 2/3-3. Again this is due to the higher dye content of these fabrics. Printed cotton fabrics exhibited quite high wash and rub fastness values as similar to soybean and silk fabrics. However, the light fastness values of cotton samples were quite low with 1-2 according to blue wool scale.

As earlier explained, *Rubia tinct*orum L. (madder) is belong to *Rubiaceae* family and it is around 1 to 2 meter perennial plant. In this study, the printing possibilities of soybean, silk, wool and cotton fabrics, which were all pre-mordanted with alum prior to printing process, with the extract of *Rubia tinct*orum L. (madder) were examined.

4. CONCLUSION

In conclusion, pink and red shades are obtained with the natural printing of cellulose (cotton) and protein (soybean, silk and wool) fabrics with the extract of *Rubia tinctorum L.*(madder), respectively. Printing of protein based organic fibers (soybean, silk and wool) resulted in higher color strength, higher chroma and darker appearance in comparison to cellulosics representative (cotton). Natural dyestuff source of *Rubia tinctorum L.*(madder) is fixed with steaming at 102°C without the use of binder in the printing paste. Fixation times of 60 and 90 minutes led to higher color strength and higher chroma in comparison to 30 minutes. The observed wash and crock fastness were adequate. Higher light fastness values were obtained for the samples which exhibited higher color yield values. Overall, 60 min steaming at 102°C can be recommended for soybean, silk and cotton fabrics. In the case of wool fabrics, 90 min steaming at 102°C was more appropriate. With an increase on the quantity of madder extract in the printing paste and the usage of different mordants for pre-mordanting process might lead to different shades of red and pink different color strength values.

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ECO-PRINTING OF WOOL, SOYBEAN AND SILK FIBERS WITH RED CABBAGE (*Brassica oleracea var. capitata f. rubra*) JUICE

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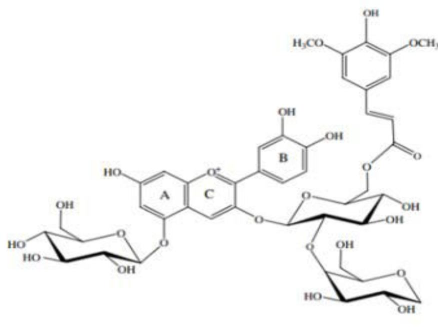
Abstract: *In this study; wool, soybean and silk fiber fabrics were printed with the juice of red cabbage (Brassica oleracea var. capitata f. rubra) using flat screen printing technique. Printing pastes were prepared with and without mordant stuff. The effects of different steaming times on color strength values of printed fabrics were also studied. The overall fastness and color properties of printed samples were evaluated and compared. Fabric samples exhibited different shades of beige and brown. All mordanted samples exhibited higher f(k) values than un-mordanted samples. Moreover, there is no clear trend about the effect steaming time on color strength. Printing with the juice of red cabbage led to good wash and rub fastness values.*

Key Words: *red cabbage, wool, soybean, silk, screen printing technique*

1. INTRODUCTION

Pigments gathered from mineral, animal or plant sources form natural dyes (Rekaby et al., 2009). Besides, vegetable source dyes are preferred for their low toxicity (Rekaby et al., 2009; Gogoi and Kalita, 1999). *Brassica oleracea var. capitata f. rubra* is commonly known as red or purple cabbage (Wiki, 2013), and is a member of Cruciferae family, which is rich in anthocyanins (Yen et al., 2012). Anthocyanins are water soluble pigments in fruit and vegetables with red, orange, blue or purple colour (Wiczkowski et al., 2013), so red cabbage take its colorant effect from these pigments. Red cabbage and its chemical structure can be seen on Figure 1 and Figure 2.

Figure 1:Close view of a sliced red cabbage (123rf, 2013)



Cyanidin-3-(sinapoyl)diglucoside-5-glucoside
Figure 2: Chemical structure of a red cabbage anthocyanin (Mcdougall et al., 2007)

Screen printing technique has started developing from the beginning of the 20th century (Krebs, 2009). It's a printing technique with an ink-blocking stencil supported with a woven mesh, the stencil has woven mesh which transfer the ink or other colorant materials onto the surface of fabric when pressed (Wiki2, 2013). In this research, three various fibers are printed with printing pastes containing red cabbage juice and potassium bichromate. Color and overall fastness properties of printed surfaces are analyzed.

2. MATERIALS AND METHODS

2.1. Materials

100% woven wool, silk and 100% knitted soybean fabrics were used for this printing study. Low and high viscosity sodium alginates were used as eco-friendly thickening agents. Sodium alginates were produced from seaweed. Red cabbage juice was used as a natural dye. While preparing for extraction, red cabbage wastes were boiled with distilled water for one hour. Potassium bichromate was used as a mordant for improving fastness and color shades.

2.2. Preparation of the printing pastes, printing andfixation p rocess

Samples were printed with a 10 mm doctor blade in diameter with a printing speed of 2.2 m/min at pressure of 4. The recipes of printing paste are shown on Table 1. Printing was carried out using ATAC printing machine (RGK-40). The doctor blade was used once for silk, and twice for wool and soybean fabrics during printing. Printed fabrics were dried with using ATAC drying machine (FT 200 model) at 100 °C for 3', then fixation procedure was applied with using ATAC steaming machine (LBH 300 model) at 102 °C for 30' and 60'. After steaming process printed samples were rinsed with cold water and air-dried. Then, samples were washed for 10' at 40°C to remove any unfixed dyes on the fabric surfaces. Eventually, the fabrics were air-dried, and then color and overall fastness properties were evaluated.

Table 1: Printing Paste Recipes

Printing Paste Recipe 1		**Printing Paste Recipe 2**	
Thickeners (Sodium Alginate)		**Thickeners (Sodium Alginate)**	
Low Viscosity (V9)	33 g.	Low viscosity (V9)	33 g.
High Viscosity (SMT)	33 g.	High viscosity (SMT)	33 g.
Distilled Water	4 g.	**Potassium bichromate**	4 g.
Red Cabbage Juice	30 g.	**Red Cabbage Juice**	30 g.
Total	100 g.	**Total**	100 g.

2.3. Color and Color Fastness Properties Measurements

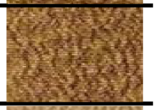
Color properties of printed samples were evaluated using DataColor 600 spectrophotometer (D65, 10° observer). The CIE L^*, a^*, b^*, C^* and $h°$ values were calculated from reflactance values. Color strength value (*f(k)*) is calculated according to K/S values in the visible region of the spectrum. Washing fastness tests were carried out using with SDL Atlas M228 Rotawash machine. Dry and wet fastness tests were performed using with Model 670 Hand Driven Crockmaster. Wash and rub (dry, wet) fastness tests were executed in terms of ISO 105: C06 A2S and ISO105: X12 standards, respectively. Washing, dry & wet rubbing fastness properties were evaluated by using ISO grey scales.

3. RESULTS AND DISCUSSION

3.1. Color Properties

Color strength values, CIELAB color values and the shades of printed samples are shown on Table 2. Color properties of printed fabrics are shown Figures 3-7.

Table 2: Color strength, CIELAB color values of printed samples

Printed fabric samples	*L**	*a**	*b**	*C**	*h°*	*f(k)*	**Appearance**
Wool, ***without mordant***, 30 min. Steaming	74.33	-2.11	14.52	14.67	98.29	7.43	
Wool, ***without mordant***, 60 min. steaming	60.66	9.27	27.83	29.33	71.59	27.61	
Wool, ***potassium bichromate***,30 min. Steaming	49.66	-4.51	14.31	15.01	107.47	43.79	
Wool, ***potassium bichromate***, 60 min. Steaming	57.12	-6.71	10.13	12.15	123.53	24.74	
Silk, ***without mordant***, 30 min. steaming	80.67	-3.13	9.61	10.11	108.07	3.62	
Silk, ***without mordant***, 60 min. steaming	70.05	5.31	18.62	19.36	74.08	11.05	
Silk, ***potassium bichromate***, 30 min. Steaming	50.96	1.71	21.08	21.15	85.36	45.98	
Silk, ***potassium bichromate***, 60 min.steaming	55.53	-1.19	17.10	17.14	93.98	30.91	
Soybean,***without mordant***, 30 min. steaming	80.90	-2.59	13.62	13.87	100.77	3.99	
Soybean, ***without mordant***, 60 min. Steaming	74.36	3.22	17.73	18.02	79.70	7.75	
Soybean, ***potassium bichromate***, 30 min. Steaming	60.32	-1.05	17.63	17.66	93.41	4	
Soybean, ***potassium bichromate***, 60 min steaming	60.24	-2.56	14.68	14.90	99.89	21.31	

Fabric samples exhibited different shades of beige and brown (Table 2, Figures 3,6,7). The highest color yield value (45.98) was observed on silk fiber fabric which was mordanted with potassium bichromate and steamed for 30'. As seen on Table 2, mordant usage was found to be useful for printing of wool, silk and soybean fabrics with red cabbage in order to obtain higher color strength. *f(k)* values of potassium bichromate mordanted and 30' steamed wool, and silk samples were 43.79 and 45.98, respectively. Steaming time has created a different effect on soybean fabrics and the highest *f(k)* value (21.31) was found on potassium bichromate mordanted and 60' steamed soybean fabric sample. There is no clear trend about the effect steaming time on color strength. Some samples exhibited higher color yield with 30 minutes steaming whereas some samples exhibited higher color yield with 60 minutes steaming.

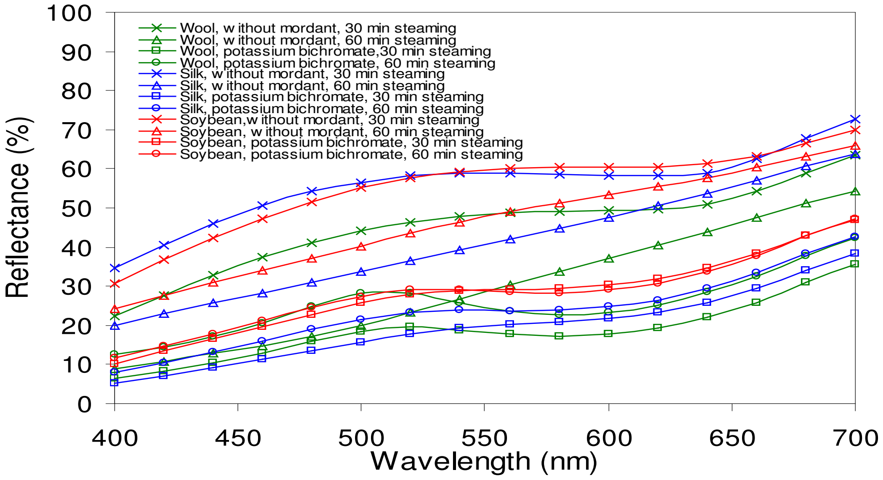


Figure 3: Reflectance-wavelength spectra

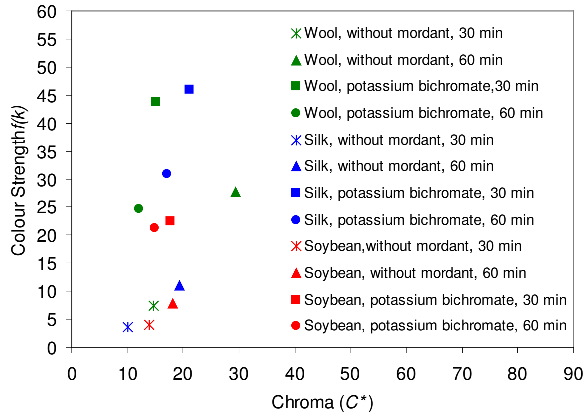


Figure 4: f(k)-C*plots*

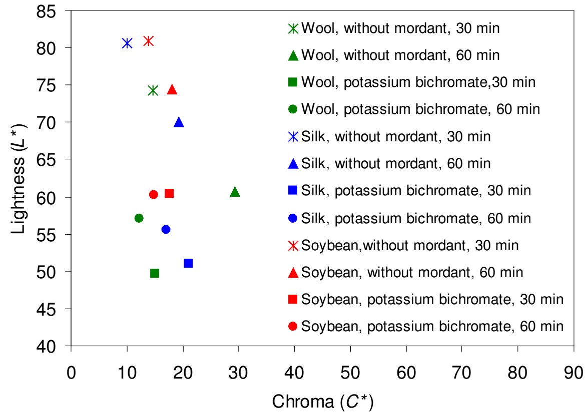


Figure 5: L-C* plots*

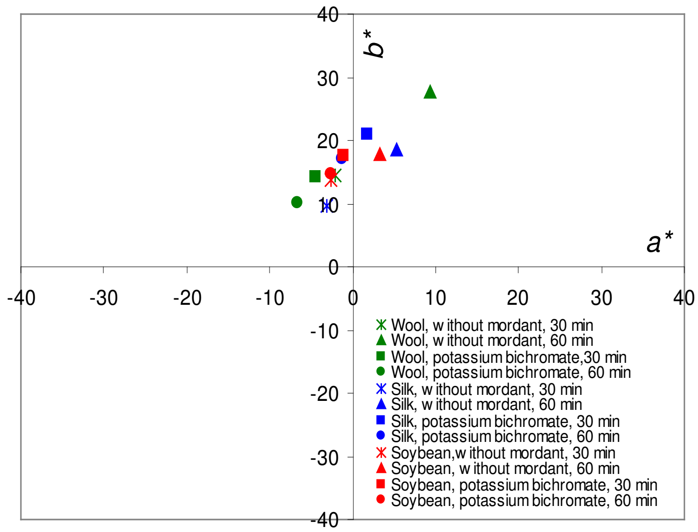


Figure 6: a-b* plots*

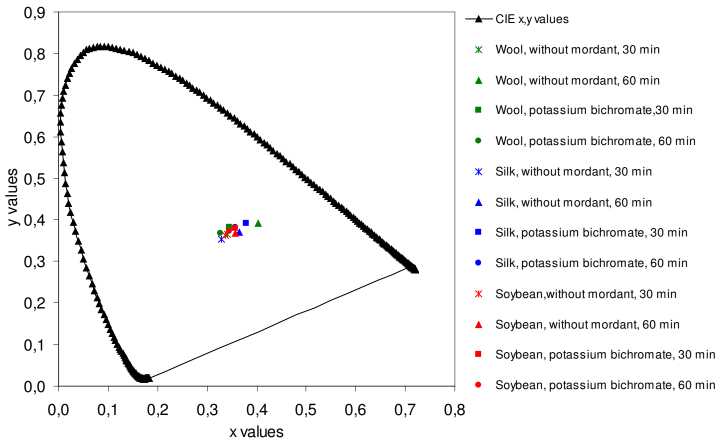


Figure 7: CIE chromaticity diagram showing the position of selected fibers printed with red cabbage juice an potassium bichromate mordant

Reflectance-wavelength graphic (see also Figure 3) and as Table 2 support that soybean samples generally exhibits the highest *L** values leading to weakest colors. The usage of a mordant generally resulted in stronger appearance in color according to the lightness-chroma graphic (see also Figure 5). The brightest color was obtained on silk fabric which was mordanted and steamed for 30' (see also Figure 4). Wool sample steamed 30' without mordanting was found to be greener and bluer than these of silk and/or soybean fabrics (see also Figure 6).

3.2. Fastness properties

Fastness properties of printed fabrics are shown on Table 3.

Table 3: Wash fastness and rub fastness values of printed samples

Printed Samples (fiber, mordant, steaming time)	*Rub Fastness X12 (Cotton staining)*						*Wash Fastness C06 A2S*		*Light fastness*
	AC	*CO*	*N6.6.*	*PES*	*PC*	*WO*	*Dry*	*Wet*	
Wool,without mordant,30 min.	5	5	5	5	5	5	5	4/5-5	3
Wool, without mordant,60 min.	5	5	5	5	5	5	5	4	3
Wool,potassium bichromate,30 min.	5	5	5	5	5	5	5	3/4	4
Wool,potassium bichromate,60 min.	5	5	5	5	5	5	5	4	5
Silk, without mordant,30 min.	5	5	5	5	5	5	5	5	2-3
Silk, without mordant,60 min.	5	4/5-5	5	5	5	5	5	5	2-3
Silk,potassium bichromate,30 min.	5	5	5	5	5	5	5	4	4
Silk,potassium bichromate,60 min.	5	5	5	5	5	5	5	5	4
Soybean,without mordant,30 min.	5	5	5	5	5	5	5	5	2-3
Soybean, without mordant,60 min.	5	4/5-5	5	5	5	5	5	5	3
Soybean,potassium bichromate,30 min.	5	4/5-5	5	5	5	5	5	¾-4	4
Soybean,potassium bichromate,60 min.	5	5	5	5	5	5	5	¾-4	4

As seen on Table 3, wash fastness values of printed samples are either 4/5-5 or 5 gray scale rating for all printed samples. All dry rub fastness values exhibited perfect results by 5 gray scale rating. On the other hand, wet rub fastness values were slightly lower than dry rub fastness values. Wet rub fastness values were found to be in between ¾-4 and 5 gray scale rating. Wool and soybean samples printed in company with potassium bichromate and steamed for 30'-60' exhibited moderate to good fastness values. The highest rub and wash fastness values were observed in silk fabrics. Light fastness values of printed samples were in the range of 2-4 gray scale rating. Mordanted samples exhibited the highest fastness values in this evaluation.

4. CONCLUSION

In this study, eco-friendly natural dye printing has been studied with flat screen printing technique using red cabbage as a colorant agent. Fabric samples exhibited different shades of beige and brown. When mordant material was used for printing fabrics, deeper color shades were observed. All mordanted samples exhibited higher *f(k)* values than un-mordanted samples. Moreover, there is no clear trend about the effect steaming time on color strength.

Printing with *the juice of red cabbage (Brassica oleracea var. capitata f. rubra)* led to good wash and rub fastness values. Wash fastness values of printed wool, silk and soybean samples were above 4/5 gray scale rating. All dry rub fastness values exhibited perfect results by 5 gray scale rating. On the other hand, wet rub fastness values were slightly lower than dry rub fastness values. Wet rub fastness values were found to be in between ¾-4 and 5 gray scale ratings. Silk fabrics exhibited higher wash and rub fastness values than comperative wool and soybean fabrics. All mordanted printed samples had higher light fastness values than un-mordanted counterparts.

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A CASE STUDY FOR WASTEWATER (GENERATED BY THE TEXTILE FINISHING) TREATMENT

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Abstract: *The present paper presents the results of researches carried out over a period of two years on developing solutions for the reduction of water pollution in the Romanian-Bulgarian cross-border area. For Giurgiu-Ruse cross-border area correlations between the main pollutant factors generated by each technological phase (from textile industry companies) and their influence on quality indicators have been studied, so that the wastewater treatment plants will operate according to the national norms and European regulations. New technologies and the modernization of the studied WWTPs led to: (10 - 26)% treatment efficiency improvement (decreases in the following consumption parameters: chemical oxygen demand (COD), biochemical oxygen demand (BOD_5), NH_4, total P, SO_4, detergents and degree of discoloration), sludge amount reduction, reduction of the consumption of chemicals used for treatment operations (coagulation, flocculation, pH correction, discoloring), treatment time reduction. The use of the combined processes for waste water treatment also led to an increased efficiency, with up to (50 - 70)% of the waste water being reused in the industry process.*

Key words: *wastewater treatment, monitoring, aerobic basin, modeling, simulation*

1. INTRODUCTION

Modern textile dyes are supposed to have high chemical degree and photolytic stability in order to keep their forms and colours. For these reasons the dyes are produced showing resistance to the sunshine, detergent, soap and water. These characteristics of the dyes affect the methods of cleaning water. Thus removing colour has become the most important environmental problem that can be faced in the matter of wastewater (Petropol G.D., 2009).

2. CASE STUDY – WASTEWATER TREATMENT PLANT (WWTP) FROM GIURGIU NORTH INDUSTRIAL AND TECHNOLOGICAL PARK

2.1. Experimental research on the finishing biotechnology (pretreatment and dyeing) of the cellulosic textile materials

The classical finishing technologies and biotechnologies for textile finishing were simultaneously experienced at Giurgiu North Industrial and Technological Park (GNTIP), in order to compare both mechanical and physico-chemical properties of the textile materials as well as the results in terms of wastewater pollution. The comparative technological scheme of conventional and organic cellulosic textile materials finishing (Figure 1) and the dyeing process diagram (Figure 2) highlight the advantages of using biotechnology instead of classical technologies.

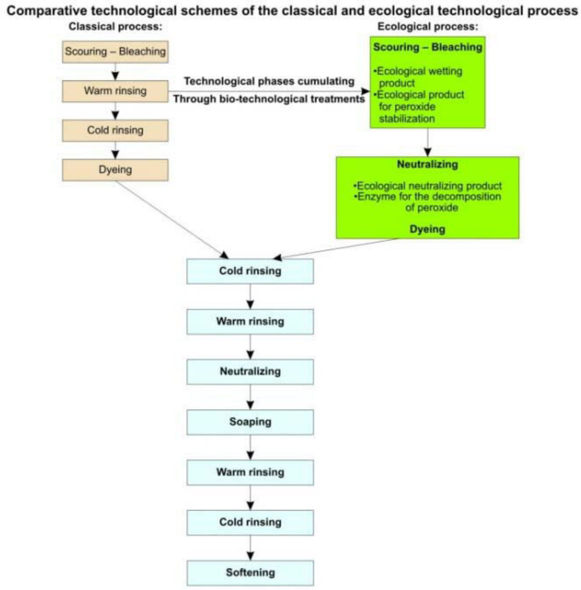

Figure 1: Comparative scheme of the classical and ecological technological process

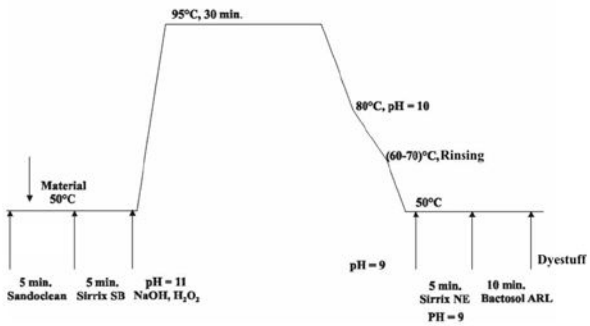

Figure 2: Ecological process diagramme

The comparative results of wastewater quality indicators for classical technologies and biotechnologies as well as pollution reduction percentage are presented in Table 1. The experimental results presented in Table 1 and are obtained at a Romanian textile factory from GNTIP. Both of the processes were tested (the classical one and the ecological process) and for them were have been taken samples from the generated wastewater. The samples were analyzed and the main quality indicators have been determined (Metcalf and Eddy, 1991). The textile factory produces denim cotton fabric. The dyes used for denim fabric are very toxic and in many countries they are forbidden to be used. That is why, this topic is very important and it was studied during several years of research. The results obtained at the Romanian textile company are very good and a significant improvement of the quality indicators can be observed (Pricop F. et all, 2012).

The new conceived technology was tested and the following socio-economical effects were obtained:

- Reduction of technological phases number (phases cumulating);
- Reduction of technological process time by 45 min;
- Reduction of technological consumptions / kg textile material by: 56 l water, 0.007 kWh power, 1.02 kg steam, 0.05 kg chemical products;
- Reduction of total costs / kg textile material (water, power, steam, chemical products) by 0.293 Euro / kg textile material;
- Dying quality enhancement (dye fastness enhancement);
- Value reduction of quality indicators for wastewaters (pH, COD, BOD, waterborne, sulphates, detergents), by 30 - 70%;
- Cost reduction for wastewaters de-pollution by 2 - 4 Euro/l wastewater

Table 1: Comparative analyses of wastewater quality indicators

Test	pH	COD mgO_2/l	BOD mgO_2/l	Suspended solids mg/l	Sulphates mg/l	Detergents mg/l	Residuum mg/l
P1 Wastewater – classical process	12,3	449,82	807,38	167	184,5	6,3	1810
P2 Wastewater – ecological process	7,6	201,9	275,8	11	92,9	5,7	1100
NTPA 002/2005	6,5-8,5	300	500	350	600	25	
Diminution of P2/P1 (%)	38,2	55,1	65,8	93,4	49,6	9,5	39,2

2.2. Wastewater monitoring

The case study presents the wastewater treatment plant in Giurgiu Nord Technological and Industrial Park. The wastewater treatment process is conducted in five circuits (figure 3), each with its own specificity: wastewater circuit; air circuit; sludge circuit; reagents circuit; wastewater circuit. Wastewater is sent with pre-pumps in the screen chambers. It is afterwards directed to an underground basin where the flow gets homogenized, still and uniform. A submersible pump directs the wastewater to the reaction chamber of the wastewater treatment plant. The following two stages are for settling solids and removing foam. Wastewater circuit continues with water passing through an underground aerated basin and finally through a settling compartment. Air circuit consists of a blower, air compressor, systems of pipes and tubes for air transport, system of diffusers and electric and control panel of the 2 pieces of equipment. Air is blown through perforated pipe type diffusers made of polyethylene within the reaction chamber and in the underground basin which follows after the stage 2 - settling. If necessary air is introduced by compressor in the basin situated after the reaction chamber.

Sludge is extracted from the 2 mechanical treatment stages. The coarse suspended solids are also retained by rare screens and removed from the wastewater mass. Sludge is discharged from wastewater treatment using pumps. Reagents circuit consists of chemical treatment plant and solution supply circuit of the reaction chamber. To discharge wastewater into the public sewerage network an upstream network manhole is provided. This is the place from where samples are taken and sent in order to be tested for the determination of water quality and the treatment degree.

Monitoring system will cover the entire process flow taking data from the existing plants and from measurement and control equipment, installed to permanently monitor the water quality. Monitoring application is a type of SCADA programs (Supervisory Control and Data Aqusition) and collects data in the field using a data acquisition system with installed flow PLC for process control and for the purchase of online analog signals.

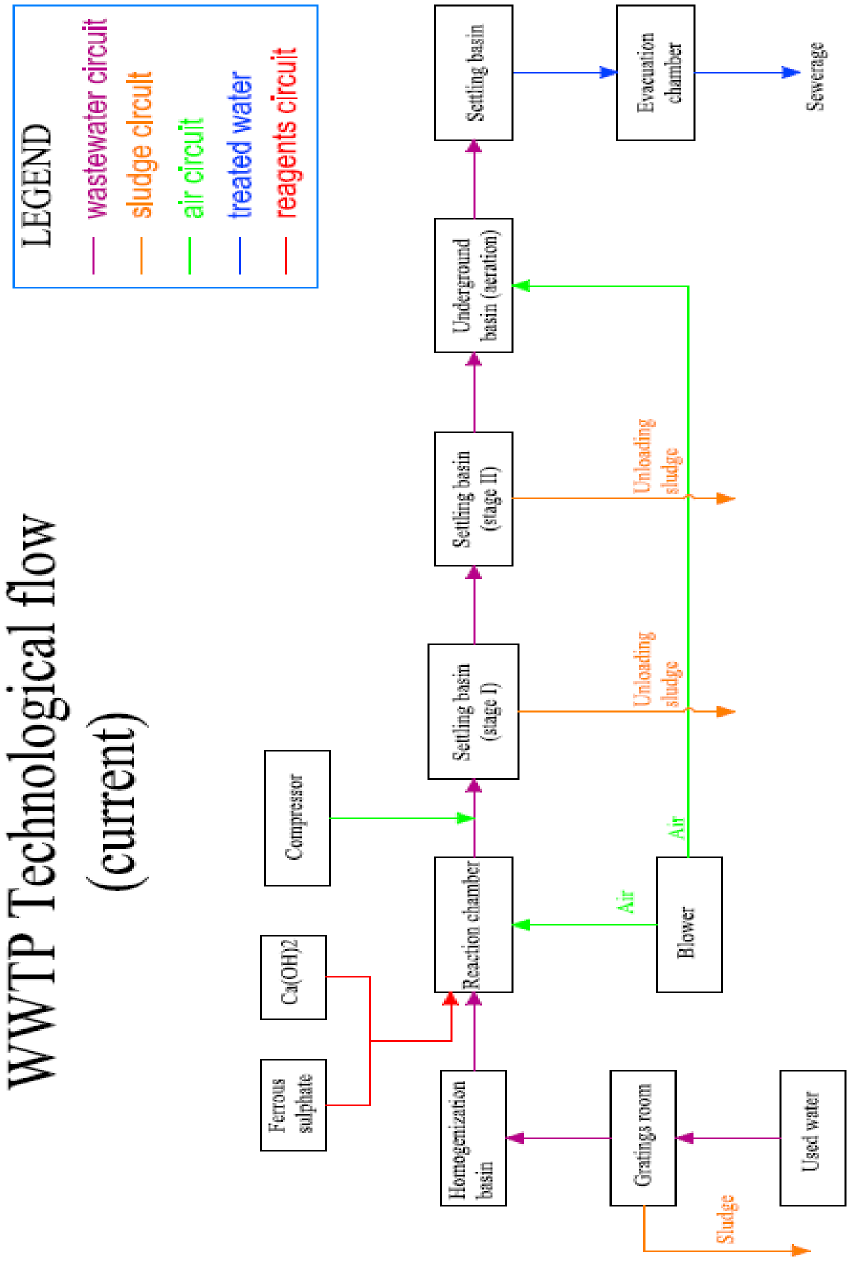

Figure 3: Existing treatment flow in Giurgiu Nord Technological and Industrial Park

2.3. Numerical simulations for the aeration processes

The numerical simulations were realized for the reaction chamber, where an aeration system is mounted (Mandis I.C., Robescu D., Pricop F., 2009). Near the reaction basin is placed the first settling basin. Here, air is introduced inside the wastewater mass with the help of an additional compressor.

The dissolved oxygen profiles are presented in figures 4 - 7. The maximum values are obtained near the diffusers. In this area it will be obtained a transfer process of high intensity, because of the renewal contact area between gas and liquid, where the gas bubble are formed and detach from the diffuser. While the gas bubbles are rising inside the water column from the biological reactor, the value of dissolved oxygen is decreasing because of: oxygen consumption needed at organic matters biochemical oxidation; the oxygen concentration from the air bubble is reduced, due to the transfer effect near the diffuser. Inside the reaction chamber the level of the dissolved oxygen is higher than the level obtained inside the clarifier. This situation is normal, because inside the reaction chamber are placed more diffusers and the basin is reduced compared to the clarifier. Because the total length of the 2 basins is very high (18 m) in figures 5 and 6 are presented to sections only for the areas with aeration systems (a zoom is realized). Here, more easily, can be observed the concentration of the oxygen profiles.

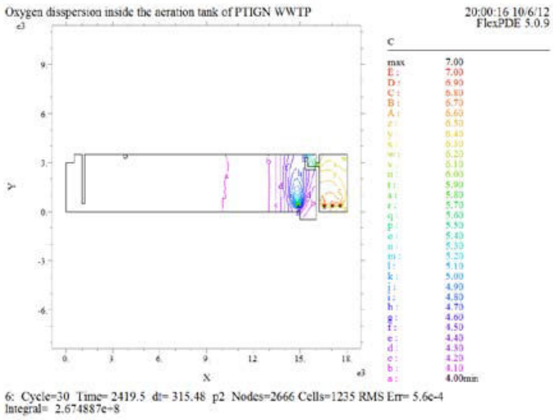

Figure 4: Dissolved oxygen profiles

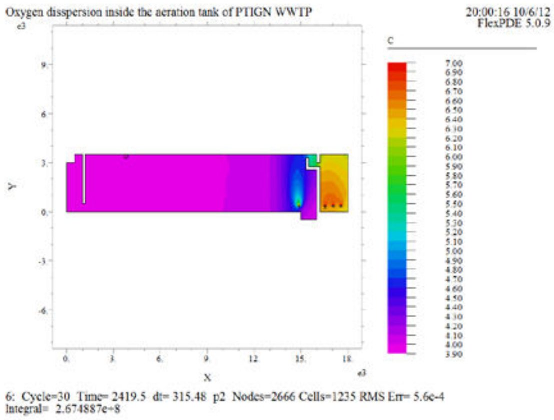

Figure 5: Dissolved oxygen dispersion

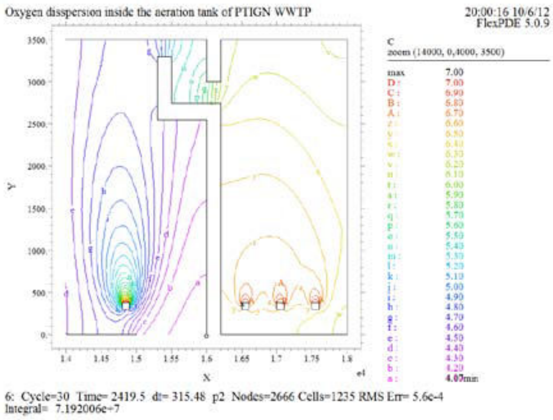

Figure 6: Dissolved oxygen profiles (zoom)

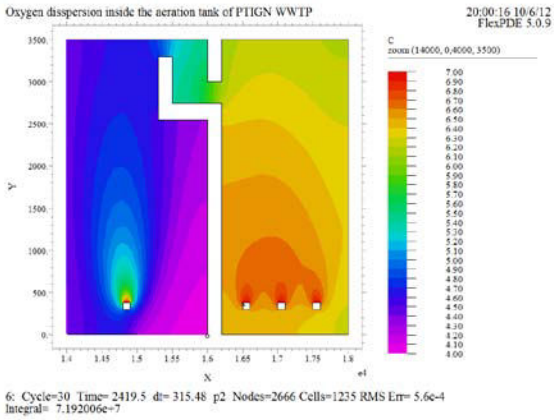

Figure 7: Dissolved oxygen dispersion (zoom)

As it was mentioned before, the air compressor is not always in function. So, for this particular situation, additional numerical simulations are realized and presented in Figures 8 and 9. Here, the values for the dissolved oxygen are lower, the fact that is explained by using a decreased number of diffusers.

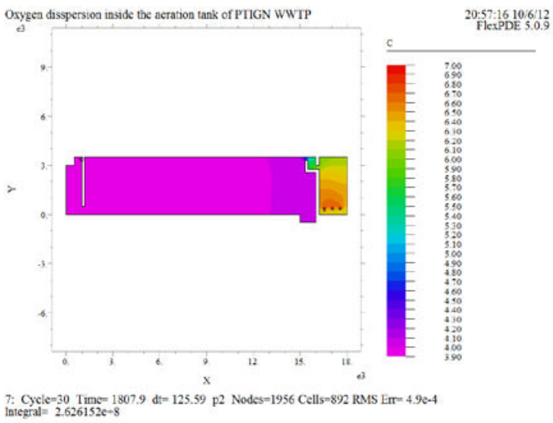

Figure 8: Dissolved oxygen dispersion (zoom)
(the air compressor is not in operation)

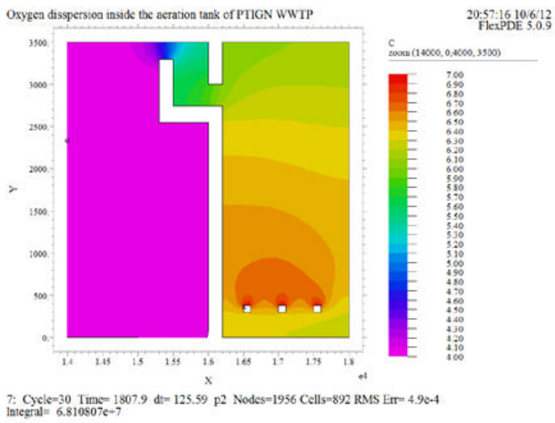

Figure 9: Dissolved oxygen dispersion (zoom)
(the air compressor is not in operation)

Depending on the wastewater characteristic, the air compressor introduce or not air inside the first part of the clarifier.

A SCADA system is proposed for the automation and monitoring of wastewater treatment plant in Giurgiu Nord Technological and Industrial Park. Selection of monitoring points takes into account significant point sources, appropriate quality monitoring points of environmental factors, (in our case: monitoring of wastewater before and after treatment) and monitoring of critical process parameters. Within the water treatment plant of the GNTIP the following sensors can be located: Dissolved oxygen sensor; 2 pH sensors; Treated water solids output signal probe; Ammonium and NO_3 sensor; CCOCr sensor; sensor for measuring the sludge level (Mitchell M., Stapp W. 2005).

The automation proposal was a result of the ENVICONTEH project, which has as the main objectives: to establish a cross border specific joint strategy on short, medium and long term for environmental protection; to develop joint systems for environmental protection monitoring and control; to develop joint information and promotion materials referring to the cross border environmental protection.

3. CONCLUSIONS

Water has always been thought of as a sufficient and cheap resource. Yet the amount of water on our planet is finite and with the ever increasing demand for it, providing water will become a problem for more and more geographical areas. It is estimated that over 50% of the textile finishing treatment plants discharge effluents with a high degree of toxicity, above the accepted standards. Water consumption in textile finishing exceeds 400 Gl/year/glob - about 150 liters of water are needed to produce 1 kg of textile product. If in the chemical industry, for example, only 20% of water is used for processing, and the rest for cooling, in the textile industry most water is used for processing, therefore the degree of contamination is high. Considering all these aspects, monitoring and automating the water treatment processes in the textile industry has become a necessity, even with the ever increasing costs of wastewater treatment.

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BEHAVIOR OF SILVER TREATED TEXTILES DURING USAGE *

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Abstract: *The antibacterial, antiviral and anti-fungicidal properties of silver have been widely used by folk, natural and general medicine, and also by the industry. In the 21st century we have rediscovered the beneficial effects of silver and more and more new products are appearing on the market that have been made of silver coated fibers. In healthcare there are more and more silver coated consumer products, for example bed linen, underwear and socks. These have a lot of advantageous properties, for example, silver prevents the spread of fungi and bacteria that are responsible for the unpleasant smell produced as feet are sweating. It has got good electrical and thermal conductivity, which reduces static charges, and it also provides an ideal environment for the joints and creates general comfort.*
The present study summarizes the advantages and the possible disadvantages of silver textiles, without attempting to be comprehensive.

Key words: *silver, nanosilver, textiles, washable*

1. HISTORICAL BACKGROUND

The antibacterial, antiviral, anti-fungicidal properties of silver have been widely used by folk, natural and general medicine, and also by the industry. Silver has been used as an antibacterial agent against infectious diseases since before the spread of antibiotics. In 200-300 BC Phoenicians stored water and wine in silver pots. Hippocrates, the founder of modern medicine used silver powder as a medicine, and Pliny, the famous Roman doctor also described the beneficial properties of silver in his encyclopedia (79 BC). Since the 19th century numerous studies have been written on silver and it has been used in several fields of medicinal research. In Germany, Carl Siegmund Credé introduced an eye prophylaxis to prevent infections of the eye, using silver nitrate at newborns. In 1920 the US Food and Drug Administration (FDA) accepted colloidal silver as an effective method of wound treatment, and in the first half of the 20th century it was used to prevent burn wounds from getting infected.

In the 21st century the beneficial effects of silver have been rediscovered, so more and more products containing silver are appearing on the consumer market such as medicines, cosmetics, electronics and a wide variety of textiles. In medical care silver treated bed linen are widely used, but we also know of socks and underwear. These products have numerous salutary effects, for example they prevent the proliferation of bacteria and fungi, they have good electrical and thermal conductivity preventing electrostatic charging, they offer an ideal environment and comfort for the joints (http://www.rezangyal.hu).

2. SILVER TREATED PRODUCTS TODAY

The development of antibiotics-resistant bacteria strains presents a grooving concern today, thus the new task of creating new antibacterial substances is given. Returning to nature and to our roots, but at the same time using the findings of modern technology can help us develop novel antibacterial surfaces.

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The antibacterial properties of silver are due to its ability to bind to the bacterial cell wall and membrane. Silver can interact with the thiol groups of bacterial proteins, inactivating them, as a result of which the cell loses its biochemical competence and eventually dies.

Nanotechnology is one of the most rapidly developing fields of science, which combines material science, biology, physics, technics, pharmacology, and medicine (Islam, N., K. Miyazaki, 2009).
Ionic silver was the first to be used, but nanosilver has opened new fields of application and brought about new opportunities.

Silver nanoparticles are potent, broad-spectrum antibacterial agents that are effective against a variety of species of both Gram-positive and Gram-negative bacteria. Their large area to surface ratio enables them to show good antibacterial properties (Kornphimol Kulthong et al., 2010).
Study groups proved that in the comparison of nanoparticles and silver ions, the latter were less effective (Sadeghi, B. et al., 2012). The activity of the nanoparticles depends on their size, shape (Fig. 1) and concentration (Pal, S. et al., 2007).

Silver treated medical equipment, bandages, catheters, implants and textiles (towels, bed linen, clothing) are well-known on the consumer market. The antibacterial properties of the silver-plated surgical thread can help in wound healing and it can lower the risk of infection. There are also cosmetics, appliances (mouse, keyboard), home textiles and toilet seats.

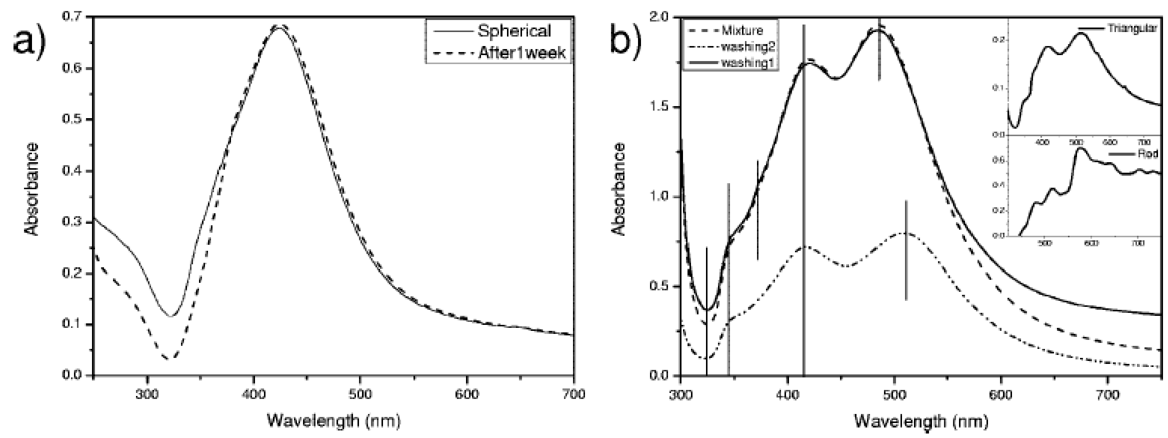

Figure. 1 *UV-VIS spectrum of nanoparticles of different shapes: a) spherical b) triangular and rod (source: Pal, S.et al., Appl. Environ.Microbiol. 73, 1712-1720, 2007)*

3. RESULTS OF THE STUDIES ON SILVER TEXTILES

The most promising field of research in textile industry is the development of intelligent and multifunctional textiles, which can satisfy the growing demand for high quality products. The development of new antimicrobial textiles is getting more financial support as there is a rising awareness in personal hygiene and a growing demand for products that can prevent the spread of infectious diseases. Until recently most commercially available antibacterial textiles were based on molecular active agents such as antibiotics, disinfectants, etc. The most important inorganic, nanoantimicrobial agents used in textile finishing processes are Ag, Cu and ZnO.
It has been proven that silver plated textiles have antibacterial properties even in low concentrations, as it is shown in Fig. 2 (Kis-Csitári, J., 2010), which is clearly beneficial in the case of textiles used in healthcare and catering industry. Besides, wearing clothes (socks, underwear, jumpers) that are made of such textiles gives a greater comfort, and they are easier to wash as less water and detergent is needed.

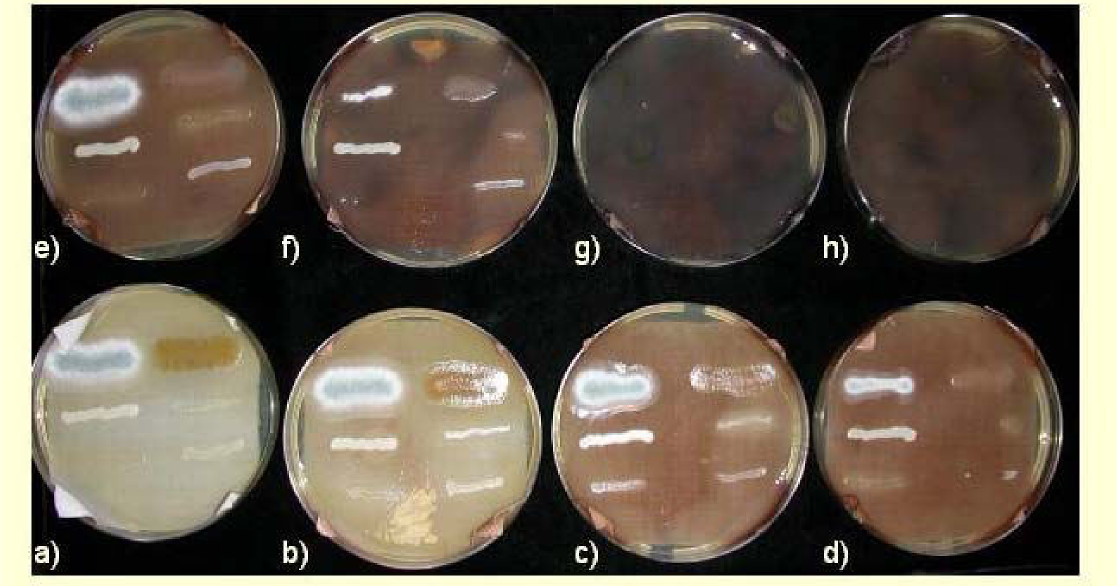

***Figure. 2** Antimicrobial test results. a) Clean, white textile b-h) AgNP plated white textile. The concentrations of the silver nitrate solution used for the preparation of colloidal silver solution are the following: b) 0,001, c) 0,005, d) 0,01, e) 0,05, f) 0,1, g) 0,5 és h) 1 mol/dm^3 (source: Kis-Csitári Judit: Antibakteriális textíliák előállítása ezüst nanorészecskék felhasználásával MAGYAR TEXTILTECHNIKA LXIII. ÉVF. 2010/1/ 2-5.)*

Antimicrobial agents are generally used to avoid some undesirable effects in textiles, for example the degradation, colouring and staining of fabrics, the production of unpleasant odour and the increase of potential health risks. Moreover, polymers and especially natural fibers are not resistant against microorganisms and their metabolites, what is more, they usually provide an excellent medium for microorganisms to accumulate and proliferate. When textiles get in contact with the human body they provide an ideal environment for the proliferation of microorganisms as they can retain oxygen, moisture, warmth, the suitable temperature and humidity and because of the exudates the nutrients are also given.

It is a major field of research therefore, to develop antibacterial finishing and desinfection techniques for all types of textiles: from hospital environment (medical clothes, protective garments, wound bandages, etc.) to everyday household and clothing (Giannossa, L. C. et al., 2013).

Researchers have also pointed out some of the adverse effects of silver. Although antibacterial substances can lead to antibiotics resistance, nanosilver can be toxic to many other types of cells apart from bacteria. Studies have shown that nanosilver can reduce the growth of sperms and in the fetus it can interfere with the development of gametes (Nyland, J. F. et al., 2010). Other research groups reported that silver nanoparticles have toxic effects on aquatic organisms by reducing the algal photosynthetic yield and inducing abnormalities is zebrafish embryos (Lee K. J. et al., 2007 and Navarro E. et al., 2008).

In the case of antibacterial clothing the human body is exposed to silver nanoparticles via skin contact. Although the human skin provides an effective barrier due to its numerous semi-permeable and impermeable layers, studies have shown that silver can penetrate through the skin (Laresse F. F. et al., 2009).

Studying the articles in this topic raises the question of the durability of the silver incorporated into textiles. It is not clear how fabrics behave under conditions relevant to washing and every day use, as there is no detailed information about the durability of silver on consumer products. According to a study silver nanoparticles are released from textiles during washing (Table 1) (Geranio, I. et al., 2009).

In this study 9 samples were used, a commercially available antibacterial sock (X-STATIC), a commercially available nanosock (AgKillBact), the other textiles were obtained directly from the manufacturers, and one was from a research project (PLASMA-NP).

Table 1 *Release of Total Ag from textiles during washing in µg/g of textile(source: I. Geranio, M. Heuberger, B. Nowack: The Behavior of Silver Nanotextiles during Washing Environ Sci. Technol. 2009.43:8113-8118)*

	1st cycle	2nd cycle	bleach cycle
X-Static	314	129	172
PLASMA-NP	67	-	-
AgCl	2.7	1.8	3.6
AgCl-BINDER	2.4	0.9	3.2
NP-PES-SURF	10.1	-	-
NP-PES	1.3	0.35	2.7
NP-PES/PA	4.3	1.6	10.2
AG KILL BACT	377	99	184

The study investigates the leaching of silver nanoparticles to water from different brands of nanosocks. The socks were immersed into tap water under shaking conditions for 1 to 24 hours. A minimum of 3 consecutive washes was conducted and the silver was size fractioned. The wash solutions were then characterized by ion selective electrode measurements for ionic Ag^+ and by TEM/DEX analysis for particulate silver. The results show that exposed to water, the textiles can release both ionic and particulate silver. In these researches the original amount of the silver applied on the fabrics is unknown, only the amount of silver leached into the water is studied. In her research, Kis-Csitári gives the concentration of the solution used for silver plating.

Depending on the extent of the original amount of silver released, the textile can even lose its antibacterial properties (Tomšič B. et al 2008). Therefore the nanosilver release from commercial products during their lifetime can endanger the ecological system.

Figure. 3 *Silver plated PA filament 36X enlargement (own photo)*

Silver can be applied to fabrics by various methods, a lot of patents are known. In fact, there are 3 basic methods by which silver-plated textiles can be manufactured:

- the silver nanoparticles are added to the melt substance during fiber formation

- the fibers are coated with silver
- silver nanoparticles are applied on the surface of the textiles

Clothes made of nanosilver-plated fibers are more and more common both in scientific and industrial fields. Fig. 4 shows a nanosilver treated dress, exhibited on SZTE (University of Szeged). It is a product of SZEFO Zrt. (Szegedi Fonalfeldolgozó Zrt.) Szeged; according to the description of the manufacturer silver nanoparticles are applied on the knitted fabric using two methods. In the first, the silver nanoparticles are created directly on the textile surface by adding silver salt solution during the phase of softener wash. In the second, nanosilver particles are incorporated by steam.

Figure. 4 *Dress made with nanosilver technology from SZEFO Szeged (Own photo: 26 March 2013, SZTE)*

A wide range of nanoparticles and nano structures are applied on fabrics, which provide new properties to the garments. These fabrics, as opposed to traditional ones, are getting greater attention as the surface of the textile fibers is treated with dirt repellent or self-cleaning coating (Kis-Csitári J., 2010).

Various procedures are used for the nanosilver modification of the fiber surfaces, a few of them are the following:

- Incorporaton of silver into polyamine-polystyrene textiles. RF plasma and vacuum UV are required to activate the fabric surface.
- The nanoparticles are incorporated into a polimer matrix. Before the particular functional group is bond to the fibers, a thin polymer layer is incorporated into the textile fibers. This is called layer-by-layer procedure.
- Nanoparticle-sized substances are created using sonochemical methods, and the solution is incorporated using ultrasound. This procedure is suitable for manufacturing nylon, polyester and cotton textiles with antibacterial properties.

The morphological features of the textile can be seen under Scanning electron microscope (SEM). Fig. 5 shows AgNP coating, Fig. 5/a on cotton, 5/b on wool. The enlarged photos, 5/b and 5/c show a more even AgNP coating of the fabric surface. On the surface of the cotton textile the size of the Ag-NP is 30-50nm, while on the wool it is 45-60 nm. The difference between the size of the particles is due to difference in the raw material content of the two fabrics (cellulose in cotton and protein in wool), which causes different electrostatic interaction between the fabric and Ag-NP (Shinde V. V. et al., 2013).

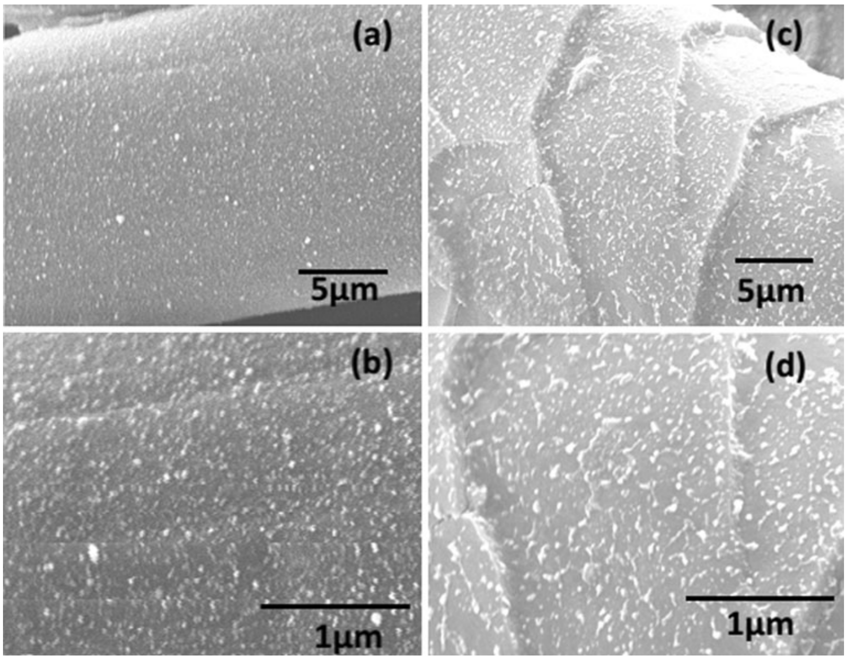

Figure. 5 *SEM photos a)Ag-NP coated cotton 5000x enlargement b) Ag-NP coated cotton 10.000x enlargement c) Ag-NP coated wool 5.000x enlargement d) Ag-NP coated wool 10.000x enlargement (source: Marina Quadros, Raymond Pierson IV, Nicolle Tulve, Robert Willis, Kim Rogers, Treye Thomas, and Linsey Chen Marr: Release of silver from nanotechnology-based consumer products for children, Environ. Sci. Technol., Just Accepted Manuscript, DOI: 10.1021/es4015844, Publication Date (Web): 03 Jul 2013 Downloaded from http://pubs.acs.org on July 11, 2013)*

Figure. 6 shows the changes in the release of silver from a baby blanket into artificial sweat over time. It can be seen that the amount of silver released reached its maximum in less than five minutes, and then remained constant.

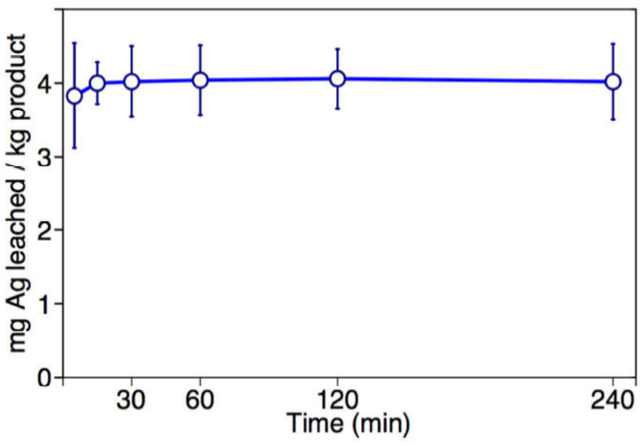

Figure. 6 *The amount of silver released reached its maximum in less than five minutes (source: Benn, T. M.; Westerhoff, P., Nanoparticle silver released into water from commercially available sock fabrics. Environ. Sci. Technol. 2008, 42 (11), 4133-4139; DOI 10.1021/es7032718)*

Exposing the blanket to artificial sweat for a longer period of time will not result in the increase of the amount of silver released. In the cycle of three consecutive exposures to artificial sweat, the blanket samples released less silver after each washing and drying. After every cycle, the silver release from the samples was 4±1, 0,39±0,02 és 0,14±0,01 mg/kg (Quadros M. et al., 2013). In contrast, in Benn and Westerhoff's research (Benn, T. M., Westerhoff, P., 2008) the socks that were washed in four 24-hour cycles released most of their silver content by the fourth cycle. The silver particles that were released from the textiles were monitored in the wash solution. The goal of this research was not to reproduce the amount of silver loss during everyday use, but to estimate the maximum possible amount of released silver.

In the case of silver treated continuous coatings the resistance of the textiles is measurable.
During everyday use, washing and abrasion the coating can be broken and the textile can lose its conductivity. We measured the resistance of silver plated fibers (Fig. 3) before and after use.

The knitted fabrics that we studied were made of 44/12 dtex PA yarn that was plated with 0.1 microne silver coating. We also recorded the changes after the use and washing of the textile. The composition of the textile was: 77% cotton, 10% PA, 3% Lycra, 10% silver PA, the weight of the fabric was 180 g/m^2.

The samples were divided into two groups. The first was studied after everyday use. The socks were worn in leather shoes, under general circumstances by men taking part in the experiment. These samples wore out and were exposed to natural human sweat. The control group was studied without being used. The two groups were washed under the same conditions. The washing was conducted in Launderometer, according to ISO 105-C01:1989E. The amount of the water was 1:50, the samples were washed on 40 ºC for 30 minutes, with 5 g/l general detergent added, rinsed in tap water and dried on room temperature. Table 2 shows the results of the study.

***Table 2** Resistance measured on different textiles after washing*

Textile (15 cm long)	Number of washes	After use Resistance (Ω)	Without use -control group- Resistance (Ω)
nanosilver treated textile	0	∞	∞
textile made of silver plated fibers	0	16,5	16,5
textile made of silver plated fibers	1	80	70
textile made of silver plated fibers	5	350	300
textile made of silver plated fibers	10	∞	∞

We can see that the resistance of the nanosilver treated textile is not measurable. In the case of the textile that was made of silver plated fibers the resistance changes after washing. After several washing cycles, between the 5-10 cycles, the silver coating on the socks was broken and the resistance could not be measured.

In the research X-ray fluorescence measurements were performed, using Strata-X-920 instrument. The measuerement surface was circular: 0.1-0.3 mm. Detecting the X-ray emitted of the samples, we can define the elements that form the pattern based on the energy of the lines, while from the intensity of the specific lines we can detect the concentration. The characteristic energy of the X-Ray can be defined to any amplitude value (identifying the elements), while the size of the peak, and the area under the peak tells us about the concentration.

The measurements were performed on textiles that were made of silver plated yarn, containing 77% cotton, 10% PA, 3% Lycra, 10% silver PA. Test measurements were performed on the instrument, and it was proved that silver could be detectable on the textile. The measurements can be refined by precise calibration and the use of known etalons.

Fig. 7 shows the energy, namely the energy of the X-ray photons to the detector on axis x (keV), and the intensity, in other words the number of X-ray photons over the second on axis Y (cps).

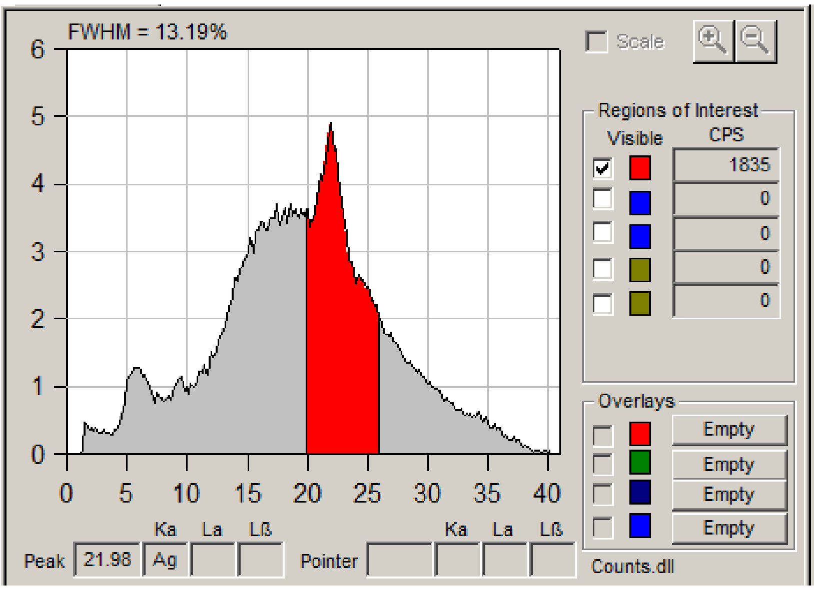

Figure. 7 *Results of the measurements performed using Strata-X-920. The XPS picture of the commercially available sock knitted of silver plated PA yarn. In the 20-26 keV region the spectrum of silver is outlined.*

In the picture silver can be clearly detected in the 20-26 region, with a pronounced peak. In our studies in the future we would like to find quantitative and qualitative correlations, and we would also like to study the changes in the amount of silver, based on conclusions drawn from the number of washing cycles and the region under the peak in the spectrum.

4. CONCLUSIONS

A wide variety of silver plated products can be found in our everyday life, in all fields. The beneficial effects are proven by studies, as these products, besides the salutary effects, are easier to handle and they are dirt repellent so they need fewer washings. The production of silver plated textiles is protected by numerous patents worldwide. These products are commercially available, and popular amongst people. Some studies have proven that the silver in or on the surface of the textiles is not detectable, and researchers measure the amount of silver released from them, to study the effects of silver on the textiles and in the washing solution.

With Strata-X-920 instrument, distributed by ATESTOR Anyagvizsgálat-Méréstechnika Kft, textiles can be studied without any damage being done, and silver can be detected even in small amounts. Calculations of the area under the peaks can tell us data about the amount of silver on the textile.

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ACETATE FIBER DYEING WITH NITRO (-NO_2) AUXOCHROME CONTAINING SYNTHESIZED NOVEL HETEROCYCLIC DISAZO DISPERSE DYES

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Abstract: *Acetate fiber fabrics, apart from being soft, have pleasing appearance, exhibit good drape qualities and provide excellent comfort features. Due to its hydrophobic nature, water soluble dyes are not suitable for acetate fibers. Therefore, non-ionic water in-soluble disperse dyes are widely used for acetate coloration. In this study, novel heterocylic disazo disperse dyes, substituted with nitro group (-NO_2) at their o-, m-, p-position, synthesized and the suitability of these novel dyestuffs on acetate dyeing was investigated. Yellow and orange shades were obtained on acetate fibers. Position of the auxochrome group affected the color properties. Heterocylic disazo disperse dye having the amino auxochrome on the para position exhibited the highest color yield among all studied dye samples. Fastness values were generally in the commercially acceptable range, with few exceptions. Overall, acetate dyeing with novel heterocylic disazo disperse dyes, substituted with nitro group (-NO_2) at their o-, m-, p-position, is applicable in terms of color yields and fastness properties.*

1. INTRODUCTION

Acetate and triacetate are produced by chemically modifying of cellulose. Triacetate is produced by acetylation (esterification) of cellulosic pulp. Triacetate is almost fully acetylated which means all hydroxyl groups of each cellulose units were replaced with acetate groups. On the other hand, regarding acetate (secondary acetate, diacetate) fibers, partial hydrolysis of fully acetylated triacetate fibers takes place and about 2.3 to 2.4 acetyl groups occur per each anhydro-glucose unit as randomly distributed (Rivlin, J.). Acetyl value is the expression for the combined acetic acid which is over 60% for triacetate whereas 54-55% for acetate (Cook, J.G., Hawkyard, C.)

Since the chemical structure is changed, acetate fibers exhibit different properties than cellulose; due to the acetylation, fiber gains hydrophobic characteristics. Acetate is less hydrophobic than triacetate since all hydroxyl groups are not replaced with acetate groups (Rivlin, J.). Due to the hydrophobic nature, water soluble dyes are not suitable for acetate fibers. Therefore, non-ionic water in-soluble disperse dyes are broadly used for acetate coloration (İngamells, W., Choi, J.H. & Towns, A.D.). According to the solid solution theory, briefly, once disperse dyes penetrate into the structure, dye molecules are solved into the fiber (Hawkyard, C.). Although, disperse dyes are by far the most preferred dye class for dyeing acetate fibers, azoic combinations and vat dyes might be chosen for particular applications (Nunn, D.M.). Color gamut and the fastness properties are two main factors which affect the choice of the dye class. Disperse dyes cover reasonably wide color gamut and provide good light fastness and moderate wet fastness properties (Nunn, D.M). Temperature is a key parameter for disperse dyeing of acetate fibers. Dyeing should be performed at the temperatures not exceeding 85^{o}C to avoid dulling effect allied to acetyl group hydrolysis on the fiber surface (Broadbent, A., Choudhury, A.K.R.). Thus, low molecular weight azo, anthraquinone and diphenylamine derivative disperse dyes are more suitable for acetate dyeing (Nunn, D.M).

Acetate fibers are soft and have pleasing appearance and also acetate fabrics are known with their good drape qualities. Moreover being not too hydrophobic (standard moisture regain 6% (Nunn, D.M).), acetate fibers provide excellent comfort features (Lewin, M.). Filament acetate fibers are used in household textiles, under wear, linings, women dresses, socks, pajamas and so on. Also, in staple form, blends of acetate fibers with many other fibers find wide range of different textile applications (Cook, J.G.).

Quite little amount of studies are available in the literature about azo disperse dyes synthesized from heterocyclic diazo compounds. Some of these studies belong to Peters and Gbadamosi (Peters A.T.& Gbadamosi, A.), Peters *et. al.* (Peters, A.T. *et. al.*), Arcoria *et.al.* (Arcoria, M.R. *et. al.*) and Towns (Towns, A.D.)

In this study, novel heterocyclic disazo disperse dyes were synthesized and the suitability of acetate dyeing with these dyestuffs was investigated. We were synthesized novel heterocylic disazo disperse dyes substituted with nitro (-NO_2) group at their o-, m-, p-position to investigate the performance of such new dyes on acetate fibers. For this purpose, color properties were determined, exhaustion yields were calculated, moreover; wash, and rub fastness performances were evaluated. High color yields and high fastness values will indicate that those dyes could be used for acetate dyeing. Since there are limitations on acetate dyes as mentioned earlier, synthesis of new disperse dyes suitable for acetate dyeing is an important point.

2. MATERIALS AND METHODS

Fabric: Acetate woven fabric which is derived from 100% secondary acetate (acetate) fiber filament yarn is used for this study.
Dyes: Four different heterocylic disazo disperse dyes, one without auxochrome group and three with –NO_2 auxochrome on para, meta and ortho positions, were synthesized. Dye synthesis is explained in detail in the results and discussions section below.
Elemental Analysis: Elemental analysis of synthesized dyes were determined using Leco CHNS-932.
Visible absorbtion spectrums: UV-visible spectrums of synthesized dyes were determined via Schimadzu UV-1601.
FT-IR Analysis: FT-IR analysis of synthesized dyes were determined via Mattson 1000 Fourier Transform-infrared.
H-NMR Analysis: ^{1}H-NMR analysis of synthesized dyes were determined using Bruker-Spectrospin Avance DPX 400 Ultra-Shield.
Dyeing Operations: Four dyes, one without auxochrome group and three with –NO_2 auxochrome on para, meta and ortho positions, were applied to acetate substrate. Dyeings were carried out at a laboratory type exhaustion dyeing machine with 2% owf dye concentration. Dyeing procedure is shown on Figure 1.

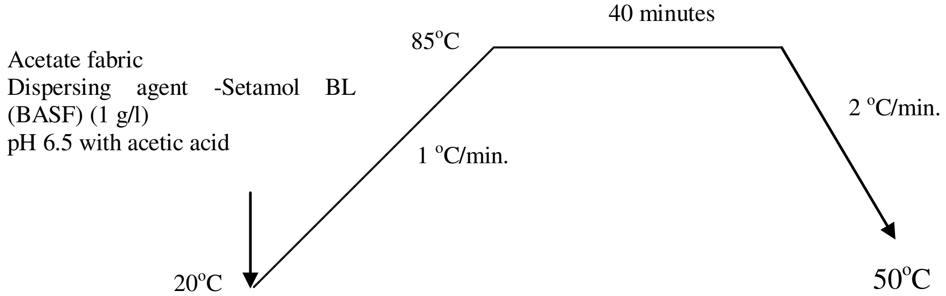


Figure 1 *Dyeing procedure of acetate fibers*

Subsequent to dyeing, reductive clearing process was carried out with 2 g/l Na_2CO_3 and 2 g/l $Na_2S_2O_4$ at 40°C for 15 minutes. Finally, cold rinsing was carried out.

Determination of Exhaustion Yields

Dye exhaustion was determined by UV spectrophotometer (Perkin Elmer) which measures the absorbance at the wavelength of maximum absorption (λ_{max}). The dye uptake was calculated by following equation:

$$\%E = ((A_o - A_1)/ A_o) \times 100$$

Where, A_o and A_1 are the absorbance values of dye liquors at λ_{max} before and after dyeing operation, respectively.

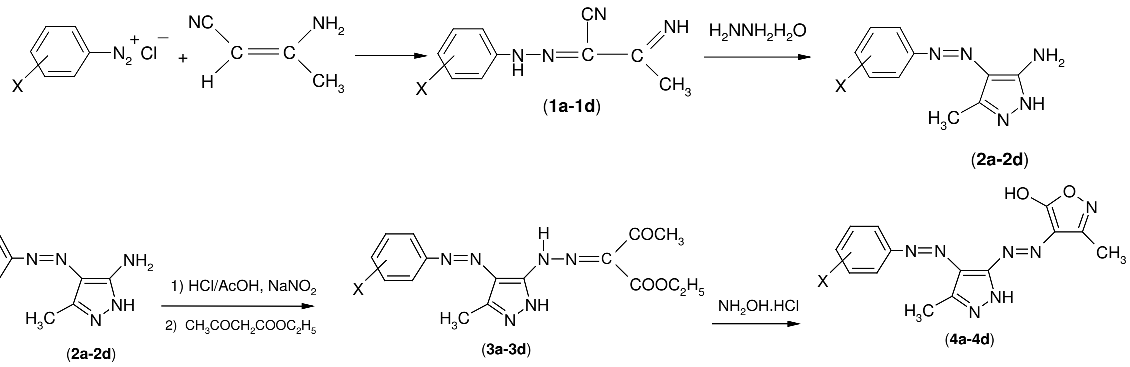
Color Properties Measurement: CIELAB color properties of the samples were determined with Datacolor 600 spectrophotometer under D65 standard day light (10^o observer). *K/S* color strength values were calculated according to Kubelka - Munk equation.

Fastness Tests: Washing, wet & dry rub fastness tests were performed according to ISO 105 C06 A2S, and ISO 105 X12 standards, respectively. Wash and rub fastnesses evaluated by standard gray scale.

3. RESULTS AND DISCUSSIONS

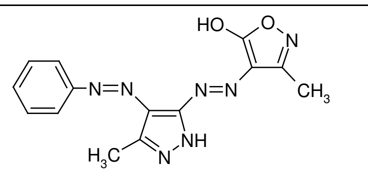
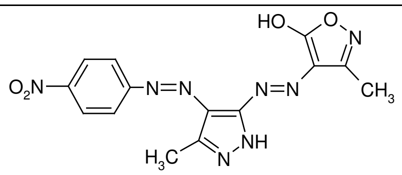
3.1. Synthesis and Characterization of Heterocyclic Disazo Dyes

Aniline and nitroaniline derivatives were diazotized and coupled with 3-aminocrotononitrile to give the corresponding 2-arylhydrazono-3-ketiminocrotononitriles (1a-1d). Cyclization of these arylhydrazono derivatives with hydrazine monohydrate afforded 5-amino-4-arylazo-3-methyl-1H-pyrazoles (2a-2d) which were subsequently diazotised and coupled with ethyl acetoacetate to yield a series of ethyl pyrazolylhydrazonoacetoacetates (3a-3d). Cyclization of these ethyl pyrazolylhydrazonoacetoacetates derivatives (3a-3d) with hydroxylamine afforded disazo dyes 4a-4d (Scheme 1 and Table 1). Synthesized these dyes were characterized by elemental analysis and spectral methods (Tables 2-4). The effect of solvent upon the absorption ability of dyes substituted with chloro group at their o-, m-, p-position was examined in detail (Table 5).



Scheme 1 Synthesis of heterocyclic disazo dyestuffs (X: $-NO_2$)

Table 1 Molecular structures of synthesized heterocyclic disperse dyes

Code	Generic name	Position of $-NO_2$ group	Molecular structure
4a	4-(4'-phenylazo-3'-methyl-1'H-pyrazole-5'-ylazo)-5-hydroxy-3-metylisoxazole	***None***	 (4a)
4b	4-[4'-(*p*-nitrophenylazo)-3'-methyl-1'H-pyrazole-5'-ylazo]-5-hydroxy-3-methylisoxazole	***Para***	 (4b)

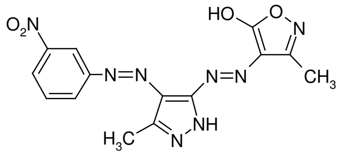
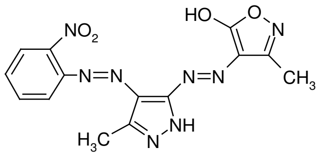
4c	4-[4'-(*m*-nitrophenylazo)-3'-methyl-1'H-pyrazole-5'yllazo]-5-hydroxy-3-methylisoxazole	***Meta***	 (**4c**)
4d	4-[4'-(*o*-nitrophenylazo)-3'-methyl-1'H-pyrazole-5'-ylazo]-5-hydroxy-3-methylisoxazole	***Ortho***	 (**4d**)

***Table 2** Elemental analyses of synthesized heterocyclic disperse dyes*

Code	**Molecular Formula**	**Molecular Weight**	**Elemental Analysis**					
			C (%)		**H (%)**		**N (%)**	
			Calculated	**Found**	**Calculated**	**Found**	**Calculated**	**Found**
4a	$C_{14}H_{13}N_7O_2$	311	54.02	54.24	4.21	4.13	31.50	31.39
4b	$C_{14}H_1N_8O_4$	356	47.19	47.33	3.39	3.42	31.45	31.28
4c	$C_{14}H_{12}N_8O_4$	356	47.19	47.11	3.39	3.42	31.45	31.38
4d	$C_{14}H_{12}N_8O_4$	356	47.19	47.07	3.39	3.44	31.45	31.52

***Table 3** FT-IR analyses of synthesized heterocyclic disperse dyes*

Code	**FT-IR (cm^{-1}, in KBr)**			
	ν_{O-H}	ν_{N-H}	ν_{Aro-H}	ν_{Alip-H}
4a	3430	3151	3076	2923
4b	-	3151	3061	2925
4c	3405	3133	3067	2926
4d	-	-	3091	2925

***Table 4** ^{1}H-NMR Analyses of synthesized heterocyclic disperse dyes*

Code	**^{1}H-NMR (δ, ppm, DMSO-d$_6$)**		
	Aromatic-H	**Aliphatic-H**	**O-H and N-H**
4a	7.36 – 8.01 (5H)	2.18-2.44 (3H, CH_3) 2.61-2.89 (3H, CH_3)	11.85 and 13.64
4b	7.47 – 9.26 (4H)	2.37-2.47 (3H, CH_3) 2.73-2.89 (3H, CH_3)	12.37 and 13.23
4c	7.40 – 8.11 (4H)	2.18-2.44 (3H, CH_3) 2.57-2.89 (3H, CH_3)	11.89 and 13.55
4d	7.44 – 8.05 (4H)	2.17-2.46 (3H, CH_3) 2.56-2.89 (3H, CH_3)	11.89 and 13.51

***Table 5** λ_{max}(nm) values of synthesized heterocyclic disperse dyes in different solvents*

Code	DMSO	DMF	Acetonitrile	Methanol	Acetic acid	Chloroform
4a	454	459	416	416	413	431
4b	474, 574 (s)	471, 573 (s)	458	457	454	461
4c	448	458	416	438	416	435
4d	444	496	430	344	424	461

s: shoulder

3.2. Color Properties and Exhaustion Yields

Colorimetric properties of the acetate samples dyed with the novel synthesized disperse dyes were shown on Table 6 and Figure 2. Since auxochromes are the electron donating groups and they extend the conjugated system leading to improvement on the light absorbtion features of a dye molecule. Therefore, as expected, the lowest color yield was observed on the sample dyed with 4a dyestuff which does not contain an amino auxochrome group. Presence of an auxochrome group resulted in bathochromic effect which leads the shift of the maximum absorption to a longer wavelength (Yadav, L.D.S.).

***Table 6** Percentage exhaustion and color properties of dyed samples*

Dyestuff	*K/S*	Exhaustion (%)	h^o	*C**	*L**
4a	3.5	38.1	86.62	58.19	85.15
4b	12.6	46.4	70.67	79.88	69.29
4c	5.7	38.4	82.09	67.75	79.41
4d	8.4	44.8	75.42	67.72	71.86

The highest color yield among all samples was attained with 4b dyestuff which contains amino group on para position, with the *K/S* value of 12.6. The color yields of 4c and 4d dyestuffs were 5.7 and 8.4, respectively. Difference between the dyes resulted from the position of the amino group which directly affects the characteristics of the dye molecule. Generally meta position has the shortest wavelength whereas para and meta positions have longer wavelengths than meta. As seen on Table 5, in different solvents, 4b (p-NO_2) dyestuff generally exhibited the highest wavelength, whereas 4c (m-NO_2) exhibited the lowest wavelength at the maximum absorption.

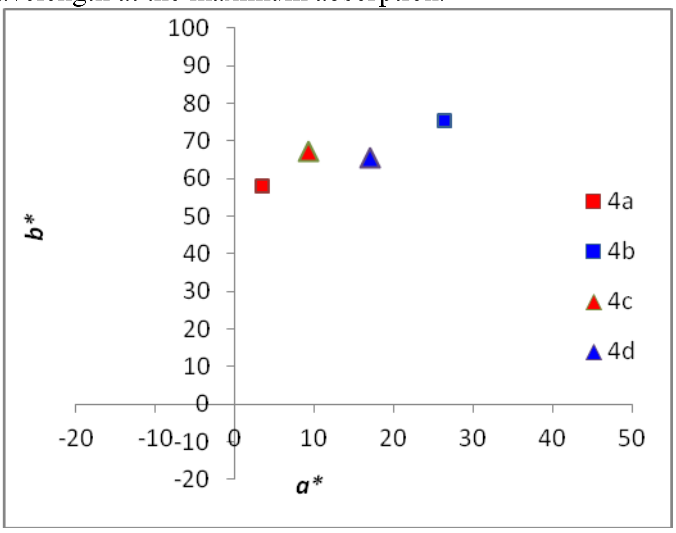


***Figure 2** a* and b* values of dyed samples*

As seen on the Table 6 and Figure 2, h^o values were below 90° for all samples, therefore; orange and yellow shades were obtained on acetate fibers by the application of 4a, 4b, 4c and 4d dyes. The sample dyed with 4b dyestuff had the most vivid and darkest appearance according to *C** (79.88) and *L**

(69.29) values, respectively. Although quite high color yields were attained with 4a, 4b, 4c and 4d dyestuffs on acetate fibers, dye exhaustions remained low (below 50% for all dyes) for 2% owf dye concentration. Meta bonding of the amino group lowered the color yield and exhaustion in comparison with para and ortho positions. The application of lower dye concentrations might be more appropriate for acetate dyeing with these novel dyes.

3.3. Fastness performance

Generally high wash fastness staining values were obtained with 4a, 4b, 4c and 4d dyestuffs on acetate fibers. Wash and rub fastness properties were shown on Table 7.

***Table 7** Wash and rub fastness staining values of acetate fibers*

Dye	ISO 105 C06 A2S Wash fastness (staining)				ISO 105 X12 Rub fastness	
	Wool	Polyamide	Cotton	Acetate	Dry	Wet
4a	5	4/5	5	4/5	4/5	4/5-5
4b	4/5	3/4	4/5	3/4	4	4/5-5
4c	5	4/5	5	5	3/4	4/5
4d	5	4/5-5	5	5	4-4/5	4/5-5

Wash fastness staining values were mostly in the commercially acceptable range which is 4 or above 4 on grey scale rating; however, 4b dyestuff exhibited 3/4 staining value on polyamide and acetate which was thought to be related with the higher color yield of the sample dyed with 4b dyestuff. Rub fastness values were in commercially acceptable range except dry rub fastness of 4c dyestuff.

4. CONCLUSIONS

Yellow and orange shades were obtained on acetate fibers by 2% application of 4a, 4b, 4c and 4d dyestuffs. 4a dyestuff exhibited the lowest color yield due to the lack of the auxochrome group. Position of the auxochrome group affected the color properties. 4b dyestuff, having the amino auxochrome on the para position, exhibited the highest color yield (12.6) among all samples. Meta bonding of the amino group lowered the color yield and exhaustion in comparison with para and ortho positions. Exhaustion yields of all dyes were less than 50%. It is thought that lower (below 2%) concentrations dyeing with these dyes are more suitable for acetate dyeing. Fastness values were generally in the commercially acceptable range, with few exceptions. Overall, acetate dyeing with 4a, 4b, 4c and 4d dyestuffs is applicable in terms of color yields and fastness properties.

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CLEATING ABILITIES OF DOMESTIC LAUNDERING DETERGENTS

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Abstracts: *To determine cleaning abilities of 5 well-known brand Arial, Tide, Persil, Bonux and Omo washing detergents, 7 tests characterizing the impact of domestic laundering process to textile products were performed. 38 widely used textile materials from natural and man-made fibres were tested with: stain removal test, fabric shrinkage test, fabric tensile strength test, fabric wrinkle test, fabric crease resistance test, seem smoothness test and colour fastness test. The test results show that the clearing abilities of the selected washing detergents are rather similar. However, the washing detergents, which remove stains better (have better cleaning abilities), work more negatively on the macrostructure of a textile material and vice versa. It was also determined that the laundering quality is less dependent on the quality of the washing detergent and more on the quality of the textile material washed.*

Key words: *domestic washing, washing detergent, stain removal, fabric shrinkage, fabric wrinkle*

1. INTRODUCTION

The quality of home textiles and clothing during exploitation period is greatly dependent on their conscientious and systematic care. Domestic laundering is a care type which we use most often. Therefore the right choice of a washing program and a washing detergent is very important. Price differences of various washing detergents make us think that their clearing abilities are not the same. Will laundering be better and cleaning results higher using more expensive washing detergents? Is the impact of a washing detergent to textiles only positive? Is the reason of quality deterioration of textiles the washing detergent used? To find out the answers to these questions the following research aim was set: to test the cleaning abilities of different, most widely used washing detergents in domestic laundering and research their impact to textile materials macrostructure.

2. WASHING DETERGENTS, EQUIPMENTS AND ITS WORK CONDITIONS, BALLAST, DRYING AND CONDITIONING CIRCUMSTANCES

10 washing detergents (5 for light cloths and 5 for coloured cloths) of 5 well-known brands: ***Ariel, Tide, Persil, Bonux*** and ***Omo*** were selected for the test. The numeral was given to every washing detergent and used during the test to raise its objectivity. Uneven numbers were given to detergents for coloured cloths and even numbers – to detergents for light cloths.
An automatic front loading A type washing machine INDESIT WG622T corresponding to ISO 6330:2012 Standard [1] was used to perform washing tests. In accordance with qualities of selected textile materials two different washing programs were used: delicate – for wool fabrics and standard program – for all other textile materials. Light colour fabric specimens were washed separately with washing detergents for light clothes and coloured – with washing detergents for coloured and dark clothes.
A ballast (loading fabric) corresponding to the requirements described in ISO 6330:2012 Standard [1] was used to adjust the load of a washing machine to the required weight.
After washing tested fabric specimens were dried on a flat surface (drying type C) in accordance with drying conditions indicated in ISO 6330:2012 Standard [1].
The fabric specimens were conditioned at a standard temperature 20°±2°C and relative humidity 65% ± 2% in accordance with requirements pointed in ISO 139:2005 Standard [2].

3. THE OBJECTIVITY OF TEST RESULTS AND EVALUATING SYSTEM

The following actions were performed to ensure objectivity of the test results:

1. Three absolutely equal specimens of the same fabric were tested during every test to avoid the influence of casual factors to the test results;
2. Visual evaluation of the fabric specimens in equal conditions was performed by 3 independent evaluators;
3. two-step evaluation system was used;
4. Maximally suitable visual evaluation conditions were used in accordance with ISO 15487:2009 Standard [3].

The evaluation of test results was done using two-step evaluation system:

1. after testing fabric specimens by one washing detergent - 3 specimens of the same textile material were put side by side and compared to determine the most characteristic, in certain test valuated, qualities;
2. after the fabric samples testing with all washing detergents was completed – the same material samples washed by different washing detergents were evaluated to arrange them in certain test valuated quality reduction sequence.

The first level evaluation was performed to increase objectivity of the test. Comparing 3 fabric specimens of the same material treated the same way it was possible to reduce the influence of casual factors (accidental deformations, wrinkles, twisting, others) on a test results. Sharply different specimens were not used in further evaluation.

The second level evaluation was used to see the dependence of evaluated qualities from washing procedure and detergent used during the certain treatment. Nine step evaluation scale with maximal number of points – 5 was used to evaluate test results.

4. THE SELECTION OF TEXTILE MATERIALS FOR TESTING

38 natural and man-made fibre fabrics well representing home textiles and clothing items were selected to perform laundering tests. *Cotton and cotton/man-made fibre fabrics* - widely used for bedclothes and clothing (woven fabrics: blouses, dresses, shirts, children garment, knit fabrics: underwear, sportswear, children garment). *Linen and linen/man-made fibre fabrics* - widely used for bedclothes, towels, tablecloths, and clothing (blouses, dresses, trousers, suits). *Wool/man-made fibre fabrics* - widely used for clothing (woven fabrics: blouses, dresses, trousers, suits, costs; knit fabrics: underwear, sportswear). *Viscose fabrics* - used for clothing (blouses, dresses, skirts). *Polyester fabrics* – very widely used for bedclothes and clothing (blouses, dress, trousers, suits and coats) and home textiles. *Polyamide fabrics* – used pure and together with natural fibres, mostly with wool to increase its strength.

5. STAIN REMOVAL TEST

Depending on the way of the contact with environment and its pollution textiles get overall and local dirt. The reason of overall dirt can be dust, filth, grime, soil. Local dirt or stains are formed in contact with different kind of liquids and hard bodies [4]. During the test washing detergent ability to remove different kind of stains was checked. 10 different stains were placed on fabric specimens: coffee, black tee, cherry juice (natural), apple juice, tomato juice, ketchup, pig blood, marker, pencil, pen. Specimens were smeared with equal concentration and quantity of above mentioned substances and left for 3 hours. Marker, pencil and pen stains were placed on light fabrics.

5.1. Fabric specimens

A specimen: size 600mm×120mm; the area for one stain 60mm×120mm; the specimen edges were neatened with 3-thread neatening chain stitch. 10 different textile material specimens were tested:

cotton bed-cloth, cotton dress fabric, cotton flannel, cotton/viscose dress fabric, linen bed-cloth, linen suit fabric, wool/polyester dress fabric, viscose dress fabric 1, viscose dress fabric 2 and polyester suit fabric. One specimen was prepared for every washing detergent. Total number of specimens - 50. Total number of tested stains - 500.

5.2. Evaluation of tested specimens

Visual evaluation of the fabric specimens was performed using nine step evaluation scale with maximal number of points – 5. To reduce the number of tables in the article (10 tables representing the removal of 10 different kinds of stains from 10 different kinds of textile materials) only the final results - showing the valuation of the cleaning abilities of 5 selected washing detergents are seen in the table 1.
The stains of black tee and cherry natural juice were the most difficult to remove. Washing with washing detergents 6, 8 and 10 pencil, marker and pen stains were not removed from all fabric specimens**.** Stains were difficult to remove from wool/polyester dress fabric. The reason could be necessity to use light washing program. Very good test results were noticed with polyester fabrics. Polyester fibres are not hygroscopic therefore all substances and stains as well are absorbed only superficially. During washing procedure they were easily removed. Different textile materials can be arranged in a conditional sequence from more difficult to easier stain removal: wool – cotton – viscose – linen – polyester. For wider research and more objective test results it should be advisable to increase stain action time – several hours, days.

6. DIMENSIONAL CHANGES/STABILITY (SHRINKAGE) TEST

Fabric shrinkage causing changes in the linear dimensions of the material could occur during fabric fusing, pressing, ironing and washing. Increased shrinkage negatively affects the qualities of textile products and change their linear dimensions and proportions. The test was performed in accordance with requirements pointed in ISO 3759:2011 Standard [3].

6.1. Fabric specimens

A specimen: size 500mm×500mm; inner square 350mm×350mm; the specimen edges were neatened with 3-thread neatening chain stitch.
Following textile materials were tested: cotton bed-cloth, cotton dress fabric 1, cotton dress fabric 2, cotton flannel, linen bed-cloth, wool/viscose/polyamide dress fabric, wool/polyester suit fabric, polyester suit fabric and polyamide/elastan underwear knit fabric. Total number of specimens -135.

6.2. Evaluation of tested specimens

The shrinkage level obtained after laundering was expressed as a percentage of the initial specimen dimensions. Grade was given to every fabric specimen: 5 points (0 – 1.4% shrinkage), 4.5 points (1.5 – 2.9%), 4 points (3 – 4.4%), 3.5 points (4.5 – 5.9%), 3 points (6 – 7.4%), 2.5 points (7,5 – 8,9%), 2 points (9 – 10.4%), 1.5 points (10.5 – 11.9%) and 1 point (12 – 13.4%). The test results of the textile materials washed with detergents for light cloths are seen in the table 2. The test results of textile materials washed with detergents for coloured cloths are seen in the table 3.
↕ the evaluation of shrinkage in warp direction for woven fabrics or in the direction of the wales for knitted fabrics.
↔ the evaluation of shrinkage in weft direction for woven fabrics or in the direction of the wales for knitted fabrics.
The shrinkage level for all tested materials was larger in direction of warp then in direction of weft. The reason could be the loss of elastic deformations obtained during fabric manufacturing process. The smallest shrinkage level of tested fabric specimens was obtained washing with the 9th detergent for coloured clothes and washing with the 4th detergent for light clothes. The biggest shrinkage level was obtained on linen bad-cloth (washing with detergent for light clothes) and wool/ viscose/

polyamide dress fabric* (washing with detergent for coloured clothes). Fabrics with polyester fibres - polyester suit fabric and wool/ polyester suit fabric* obtained the smallest shrinkage.

7. TENSILE STRENGTH (GRAB) TEST

The strength reductions of textile materials after laundering can be determined performing tensile strength test (ASTM D5034 - 09 Standard) [5] before and after washing procedure. *Tensile strength* is the resistance of a material to a force tending to tear it apart. It is measured as the maximum tension the material can withstand without tearing. Elongation is the increase in length of the sample at its break (rupture) point.

7.1. fabric specimens and equipment to perform the test

A specimen: size 100mm×200mm; for easier laundering 4 specimens of the same fabric were prepared as one common fabric sample (400×200mm). The specimens were separated after the laundering. The edges of common fabric sample were neatened with 3-thread neatening chain stitch.
Following textile materials were tested: cotton bed-cloth, cotton dress fabric 1, cotton dress fabric 2, cotton flannel, linen bed-cloth, wool/viscose/polyamide dress fabric, wool/polyester suit fabric, viscose dress fabric, polyester suit fabric.
4 specimens in warp direction and 4 specimens in weft direction of every textile material were prepared and tested. 2 of 4 specimens were tested before washing procedure but 2 others – after it. Total number of specimens – 360.
PT-250 tensile testing machine was used to determine breaking force and elongation of specimens.

7.2. Evaluation of tested specimens

As tensile strength of the tested textile materials were very different, it was not possible to use unified evaluation system giving all the tested materials certain amount of evaluation points for the same breaking force changes. Therefore conditional points (maximal number of points – 5) were given to evaluate tensile strength changes of every separate textile material after washing with all selected 5 washing detergents.
The test results of the textile materials washed with detergents for light cloths are seen in the table 4.
The test results of textile materials washed with detergents for coloured cloths are seen in the table 5.
↕ the evaluation of strength changes in warp direction
↔ the evaluation of strength changes in weft direction
The biggest strength reduction was obtained using the same brand 3rd and 4th washing detergents. Slightly larger strength reduction of specimens was observed using washing detergents for light cloths. The strength and elongation of textile materials with polyester fibers did not change after any of washing processes. Tensile strength and elongation of specimens increased if during washing procedure materials got shrank. Fabric strength changes are dependent on a material composition, its structural changes during laundering and influence of washing detergent on it.

8. FABRIC WRINKLE TEST

Wrinkles are rapid rises and falls of the surface from the initial planar status of the fabric those are caused in wear and care procedures. Drying wrinkles of textiles obtained after laundering were evaluated during the test in accordance with ISO 15487:2009 Standard [5].

8.1. Fabric specimens

A specimen: size 200mm×200mm; the edges were neatened with 3-thread neatening chain stitch.
Following textile materials were tested: cotton dress fabric, linen bed-cloth, viscose dress fabric, polyester lining, polyester suit fabric, wool/polyester dress fabric, wool/ polyacryl/nitrile dress fabric, wool/viscose/polyamide dress fabric, polyamide/ polyurethane/elastan underwear knit fabric. Total number of specimens – 141.

8.2. Evaluation of tested specimens

Visual evaluation of the fabric specimens was performed using nine step evaluation scale with maximal number of points – 5. The test results of the textile materials washed with detergents for light cloths are seen in the table 6. The test results of textile materials washed with detergents for coloured cloths are seen in the table 7.
Wrinkle level difference of the same fabric specimens after washing with different washing detergents was small. After washing with 3rd and 9th detergent wrinkle level of fabric specimens was the smallest. After washing with 1st detergent wrinkle level of fabric specimens was the largest. There was not any surface smoothness difference on polyamide/polyurethane/elastan underwear knit fabric after washing procedure with all washing detergents. Linen and viscose specimens washed by detergents for light clothes obtained the largest wrinkle level. After laundering the wrinkle level of linen and woollen fabrics increased, but the wrinkle level of viscose fabrics – decreased. The reason of these changes could be the decrease of fabric finishing effects. The test results shows that the fabric wrinkle after laundering is more dependent on properties and quality of the material and less dependent on washing procedure and detergents used.

9. THE RETENTION OF PRESSED-IN CREASE TEST (CREASE RESISTANCE TEST)

Pressed-in creases are often used in garments. They are performed pressing or ironing textile material. During the test visual evaluation of the retention of pressed-in creases was performed in accordance with ISO 15487:2009 Standard [6]. Pressing parameters – temperature, pressure, time and moisture were chosen for every material in accordance with its composition and qualities. Pressing was done by a domestic iron.

9.1. Fabric specimens

A specimen: size 200mm×200mm; the edges were neatened with 3-thread neatening chain stitch seam; one crease pressed in warp direction; the deepness of the crease (a fold) 4cm; along one side of the specimen the crease was fixed with 2-thread lockstitch seam;
Following textile materials were tested: cotton bed-cloth, cotton dress fabric, linen bed-cloth, linen/polyester suit fabric, wool/polyester suit fabric, wool/viscose/polyamide dress fabric, polyester suit fabric. Total number of specimens – 105.

9.2. Evaluation of tested specimens

Visual evaluation of the fabric specimens was performed using nine step evaluation scale with maximal number of points – 5. The test results of the textile materials washed with detergents for light cloths are seen in the table 8. The test results of textile materials washed with detergents for coloured cloths are seen in the table 9.
The creases in linen/polyester suit fabric and polyester suit fabric specimens had remained in the best condition. The sharpness of a crease of linen/polyester suit fabric specimens reduced after washing with 6th detergent. The crease sharpness of polyester suit fabric samples after washing with 4th and 8th detergent even increased. A crease of wool/ viscose/ polyamide dress fabric* fully disappeared after washing procedure with all detergents. The retention of pressed-in creases test shows well the influence of washing procedure and washing detergent to fabric macrostructure and finishing.

10. THE TEST OF SMOOTHNESS APPEARANCE OF SEAMS

Smoothness of seam characterizes smoothness of one or more joined material lays along the seam. *Seam pucker* is a wrinkled appearance along the seam, which influences the appearance to a considerable degree. Causes of seam pucker can be: structural jamming of fabric yarns during sewing, differential feed of sewing machine feed dog, very high thread tension, unequal length fabric components are joined together, sewing thread or fabric shrinkage [8]. The smoothness of seems after washing procedure was evaluated visually in accordance with ISO 15487:2009 Standard [6].

10.1. Fabric specimens

A specimen: size 100mm×200mm; 2-thread lockstitch seam was performed in a middle of the specimen (in warp direction); the edges were neatened with 3-thread neatening chain stitch seam.
Following fabric samples were used: cotton dress fabric, linen bed-cloth, linen/polyester suit fabric, wool/polyester suit fabric, wool/viscose/polyamide dress fabric, viscose dress fabric, polyester lining, polyester suit fabric, polyamide/acetate dress fabric.
The seams were performed with 120 number 100% polyester sewing threads. 3 equal specimens for every textile material were tested with 6 washing detergents. The total number of specimens – 171.

10.2. Evaluation of tested specimens

Visual evaluation of the fabric specimens was performed using nine step evaluation scale with maximal number of points – 5. The test results of the textile materials washed with detergents for light cloths are seen in the table 10. The test results of textile materials washed with detergents for coloured cloths are seen in the table 11.
The changes of seam smoothness after washing procedure were not significant. Comparing seam smoothness of cotton and linen specimens before and after washing it was seen that seam pucker was bigger before washing then after it. The reason of it could be the shrinkage of these fabrics during washing. After laundering the threads of seams on wool/viscose/polyamide dress fabric specimens became very loose. The reason could be fabric shrinkage. The same seam smoothness was seen on polyester, linen/polyester, wool/polyester suit fabric specimens before and after washing. The seam smoothness test can be used to recognize washing shrinkage of the fabric.

11. COLOUR FASTNESS TEST

Color fastness refers to the resistance of color to fade or bleed of a dyed or printed textile materials to various types of influences e.g. water, light, rubbing, washing, perspiration etc. to which they are normally exposed in textile manufacturing and in daily use. Textile material colour fastness after washing procedure was evaluated during the test in accordance with ISO 105-C06:2010 Standard [7]. Washing detergents for coloured cloths were used in the washing procedures.

11.1. Fabric specimens

A specimen: size 120mm×70mm. Every coloured fabric specimen was put in between two white colour cotton fabric samples and stitched together with 3-thread neatening chain stitch seam. Sandwich type specimens were washed, after it dried and unstitched. The change in colour and staining of adjacent white fabric specimens were evaluated to determine colour fastness of the main coloured fabric specimen. 32 different coloured textile materials were tested. Total number of specimens – 480.

11.2. Evaluation of tested specimens

After washing it was seen that some textile materials had lost their colour more, some – less. However, it was not possible to perform objective evaluation of colour fade as colour changes were small and visually weakly expressed. To objectively evaluate test results it is necessary to perform multi-fold washing of fabric specimens. The test results shows that the colour fastness of textile materials during laundering is more depended on their dyeing quality and less on washing detergents used.

12. CONCLUSION

The stain removal test shows the main quality indicator of a washing detergent - ability to remove dirt. The final results of the stain removal test are seen in table 12.
The fabric shrinkage test, tensile strength test, fabric wrinkle test, the retention of pressed-in creases test, the test of the smoothness appearance of seams and colour fastness test show the impact of laundering process and its detergent to textile material macrostructure and finishing. The final results of these tests are seen in table 13.
Analyzing the final results of the test it is observed that the clearing abilities of the selected 5 brands of domestic washing detergents are rather similar. It can not be pointed nether the best nor the worst detergent. The same time the test results showed following regularities:

1. Washing detergents, which remove stains better (have better cleaning abilities), work more actively on the macrostructure of a textile product and vice versa.
2. Washing detergents, which work on the macrostructure of a textile product more actively, increase fabric shrinkage and wrinkle, decrease material strength and pressed-in crease sharpness.
3. The laundering quality is more dependent on the quality of the textile material, less - on the quality of the washing detergent used.

Because of limitations in time and finances repeated washing procedures were not realized for any of described tests. To obtain more objective test results and widen research, multi-fold laundering procedures of specimens should be performed for fabric shrinkage test, tensile strength test and colour fastness test.

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THE INVESTIGATION OF WARP KNITTED FABRIC WITH ELASTOMERIC THREAD

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Abstract: *An expansion and improvement of the textile's assortment is received special attention in the face of rapid scientific and technological progress, which is a part of the human society evolution. Therefore, the development of new knits for the prevention and recovery of an anatomical form and a function of the human body is an important issue. To this end, the possibilities of the knitted fabric's manufacture for special purposes, as prevention bandage, are studying. A selection of raw materials is due to the using conditions and to the product properties. The nylon threads are most used for the manufacture of special knitted fabrics. Form stability and extensibility of fabrics is ensured by the introduction into the knitted structure elastomeric threads. They are needed to be securely fastened in the structure without contact with the external layers. In addition the surface of knit fabric should be smooth to avoid any uneven compression of the skin.*

Warp knitted fabrics, which were made on warp knitting crochet machine, have been selected as the subject of studies. Four guide bars are using for producing the samples. One is for chain loops from nylon treads. Second is paving the elastomeric longitudinal thread with a preliminary elongation. Elastomeric longwise threads are providing the necessary strain of knitted fabric. Two other guide bars are laying transverse weft from nylon treads too. They cross-connect the single chains into a fabric and create a smooth surface in addition. The authors have researched the structure parameters and properties of warp knitted fabric. The influence of elastomeric thread on physical and mechanical properties has been established.

Key words: *warp knitted fabric, chain, longitudinal thread, elastomeric thread, structure parameter, strain*

1. INTRODUCTION

An expansion and improvement of the textiles assortment is received special attention in the face of rapid scientific and technological progress, which is a part of the human society evolution. In the modern world it is possible to observe the use of knitted fabrics in almost every area of human life: in engineering, building, automotive, ship and aircraft industry, space technology, medicine, etc.

The use of knitted fabrics in the medical field is steadily expanding. The formation of new knitted materials for using in the bandage for the reconstruction of anatomic form and function of internal organs is an especially actual now. Bandage is a special medical product, which is put on the body for its stabilization, unloading or correction of pathological deformation and is used to restore the body after treatment and during sports for prevention a possible injury. Such product can be further strengthened by additional elastic bands at the front or the back surface depending on the design. Depending on the purpose bandages have a different design to ensure compliance form prophylactic articles of anatomy and function of the human body [1]. Bandages are usually differ by raw materials composition, by color, by degree of hardness, which are not only depend on the constructional features but and on the amount of insertions and on the corset's height.

2. THEORY

Modern market of raw materials, especially polymeric and synthetic fibers, can help meet the growing demand for materials with specific properties. The use an elastomeric yarn, which is capable after charge-discharge cycle to recover its original size and having a breaking elongation more than 100%, in knitted fabric is leading to the establishment of new types of textile fabrics. They have got a feature of extensibility, elasticity, compressive capability for use in a stretched condition. Fabrics containing elastomeric yarn are very stretchable (an elongation of more than 200%) and these properties are preserved during exploitation. [2]. For the consumer the use of elastomeric threads in the knitwear means an article is a good fit, has dimensional stability and comfort.

The modern market of elastomeric yarn presents the filaments and reinforced threads, which are produced by wrapping an elastomeric core by threads and fibers of different origin [3]. From an economic point of view it is advisable to use elastic monofilaments in knitted fabric, but it is difficult because of their low knit ability, namely the occurrence of considerable friction in feeder and in knitting systems, which may lead to thread breakage [4].

It is known that the elastomeric yarn can be fixed in knit structure as filling or in-laid yarn or can be knitted into a loop [5]. The choosing of a fixing method of the elastomeric yarn is depend on requirements that apply to the preventive goods: the stable fixing, the structures uniformity and the fabric elasticity. Besides, the elastomeric yarn should be positioned inside of the knit structure, in order to avoid its contact with the human body.

The filling yarns are positioned in the structure as additional yarns. When used as such an elastomeric yarns, the elastic properties of the basic interlooping are increase in in-laying direction [6]. It is known that elastic properties of elastomeric yarn are exhibited better when it is inserted into weft knitted fabric. The using of elastomeric yarn as in-lay lets create a fabric with a lower consumption of materials compared to other ways of its fixing.

The stable fixing of elastomeric yarn in the structure is due to the presence of the contact points with the filaments which are forming the basic interlooping. When weft knit structure are used as a basic intelooping it is possible presence of such a defect as a "runaway" of elastomeric yarn in the case of its breaking during the manufacturing of the knitwear. The use warp knit structure as a basic interlooping provides reliable wrapping an elastic thread by loops. Furthermore, the drop of stitch in such structure is smaller than in weft fabric. Most of warp knit structures can not be de-knitted. The necessary flexibility and extensibility of knitted fabrics are caused by the pre-stretching of elastomeric yarns and their relaxation after the removal of the draw-off force.

3. METHODS

The main purpose of this work is to investigate the influence of elastomeric yarn on the structures parameters and properties of warp fabrics. To achieve this purpose warp knit fabric with various conditions of elastomeric yarn in-laying were produced; the structure parameters and the deformation properties of warp knitted fabrics have been investigated.
The standard tests methods were used for experimental research of the properties of elastic warp knit fabrics.

4. RESULTS AND DISCUSSION

Warp knitted fabrics, which are used for the manufacture of medical bandages, have been produced. Taking into account the special requirements four guide bars of 15 gauge Crochet knitting machine have been used. The chain with closed loop is used as the basic interlooping with full drawing of guide-bar. Elastomeric yarn is laid in a walewise direction and is feeding with the extension to ensure the elastic properties of knitted fabrics. Wales of chain loop are connected into the fabric by weft yarns, which are laid on the entire width of the fabric at the different sides of fabric in order to full cover the elastomeric yarn. The linear density of weft yarn is exceeding the linear density of ground yarn for chain in order to create a dense lay which prevents the output of the elastomeric yarns on the surface of the fabric (table 1). In-layed yarn and weft yarns are positioned between the underlap and overlap of chain loop, which is dense wrapped around them and holds them in the structure. Such warp knit structure has high dimensional stability and provides comfort, because elastomeric yarn is located inside of the knitted fabric and has not negative influence on human skin.
It can be assumed that the change in pre-stretching the elastomeric yarn will also change the parameters of the structure and properties of the jersey. In this regard the samples were manufactured warp knitted fabric in which the thread length loop of longitudinal weft was varied on three different

levels (see Table 1) by changing its tension than with a linear density of thread is not changed. It can be assumed that the changes in pre-stretching of the elastomeric yarn will also inflow on the structure parameters and the properties of the knit fabric. In order to study this influence the warp knit fabric has been manufactured with variation of elastomeric yarn feeding tension on three different levels. Linear density of elastomeric yarn is constant. Therefore three variants of warp knit fabric (see Table 1) have different length of elastomeric yarn per course. It can be seen, the length of weft yarn per wale is constant because the weft yarn is laid over the entire width and is uniformly distributed in the fabric structure. The loop length of the chain is changed by 14%: an increase in pre-tension of elastomeric yarn promotes increased consumption of ground yarn.

Table 1: Producing data

Fabric	Linear density, tex			Diameter of in-lay elastomeric thread, mm	Length of yarn per unit, мм			
	Chain	Weft yarn 1	Weft yarn 2		Chain loop	Weft 1 per wale	Weft 2 per wale	In-lay per course
1	18 Nylon	34 x 6 Nylon	34 x 6 Nylon	0,6	7,22	1,68	1,68	0,80
2	18 Nylon	34 x 6 Nylon	34 x 6 Nylon	0,6	7,48	1,68	1,68	0,70
3	18 Nylon	34 x 6 Nylon	34 x 6 Nylon	0,6	8,41	1,68	1,68	0,64

It is can predict that the pre-tension of the elastomeric yarn will change the structures parameters of the warp knitted fabric (see table 2). The loop step is the exception because this parameter depends on gauge of knitting machine first of all. Thus increasing of the elastomeric yarns length promotes an increase of the course height and correspondingly decreases the number of courses per 100 mm, which is 20% in this experiment. At same time the thickness of warp knit fabric decreases that can be explained by a lower degree of the elastomeric yarns relaxation. The chain loop prevents such process. Besides the chain loop moves in structure horizontally under the elastomeric yarns pressure. Decrease in the elastomeric yarn length per course leads to an increase of basic weight.

Table 2: The structure parameters of knitted fabrics

Fabric	Thickness, mm	Number of wale per 100 mm	Number of courses per 100 mm	Loop step, mm	Course height, mm	Basic weight, g/m^2
1	1,58	58	122	1,72	0,82	652,3
2	1,68	58	142	1,72	0,73	709,1
3	1,83	58	151	1,72	0,66	799,8

Feature of the use of such warp knit fabrics is the need to support tensile loads. The processes with an alternation of loading, unloading and rest affect the structure of fabric, which is being deformed and changes the original shape and size. Therefore of considerable interest is to study the mechanical characteristics of the fabrics in a cycle of "tension-discharge-rest". The results of this research are presented at table 3.

Table 3: Deformation properties of knitted fabrics

Fabric	Full stretch	Parts of full stretch, %			Parts' quota		
		elastic	plastic	residual	elastic	plastic	residual
	ε, %	ε_1, %	ε_2, %	ε_3, %	$\varepsilon_1/\varepsilon$	$\varepsilon_2/\varepsilon$	$\varepsilon_3/\varepsilon$
1	85,8	82,9	0,9	2,0	0,97	0,01	0,02
2	114,8	112,7	0,7	1,4	0,98	0,01	0,01
3	115,8	112,7	0,6	2,5	0,97	0,01	0,02

The full stretch of warp knitted fabrics is 85.8 - 115.8%, while the elastic part of it is constitute 97-98%. This means that almost all samples at 2-5 seconds restore its original size and shape. Residual part of full stretch is less than 2.5%. It should be noted, that the change of the elastomeric yarns pre-tension significantly (up to 25%) affects the deformation properties of warp knitted fabric. Reducing the value of full stretch with increasing of elastomeric yarn length is due to more oriented position of chain loop to walewise direction. As result low-extensible interlooping chain prevents the appearance of the deformation properties of elastomeric yarn.

5. CONCLUSION

The use of elastic warp knitted fabrics for the manufacture of bandage products is promising way. Investigations of warp knitted fabric with elastomeric thread showed that the pre-stretching of an elastomeric yarn during the knitting greatly affects the structure parameters and properties of knit fabric. Thus the loop length is reduced with increasing stretching of the elastomeric thread, which leads to an increase of thickness, of loop length of chain and of basis weight. The loops in such structure less oriented in walewise direction therefore the full streight of warp knit fabric increases. It's observed, that the use of an elastomeric yarn in structure provides good formstability of warp knit fabric.

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POROSITY KNITTED SPATIAL STRUCTURE, AND FUTURE TRENDS

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Abstract: *Spatial knitting different types with similar structures are produced on machines Shima Seiki fineness 7. In order to achieve different porosity knitting, capillary radii and angle of capillaries on a horizontal surface were changed to a different number of space between two rows of yarn single jersey knitting, as well as varying the space between two consecutive rows trap. Capillary radii were calculated using the model and porosity based on the weight of the sample knitting, thickness and surface area 50.26 cm^2. Vertical absorption tests were performed on eleven samples using a knitting machine for testing the absorption of records found. The rate of absorption and total absorption was compared with the theoretical parameters of twists and apsorpcijom.Samples knitting with higher porosity have higher total absorption in contrast to the samples with lower porosity and lower overall ability absorption. However, knitting patterns with lower capillary radius and high capillary angle (sin φ) on the horizon absorption.Total show lower rates of absorption per unit area seems to vary with the thickness of knitting, knitting thicker higher overall absorption per unit area. Total absorption varies from 800% to 1 500% and that the rate of absorption of some structures is very high in comparison with other structures. The future of the textile structures can be produced in water in geo-textiles, agro-textiles and clothing materials under different conditions in agriculture drop by drop.*

Key words: *knitted structure, porosity, structure, absorption, corner of capillaries, capillary radii, geo-textiles, agro textiles.*

1. INTRODUCTION

In the process of wearing garments made of knitted and transverse spatial Basics of knitted knittig is one of the key factors that influence the physiological wear comfort is the transfer of liquids or moisture in the knitting.Knittig to quickly transfer moisture / liquid away from the skin surface carriers feel more comfortable and keep the skin dry. At high levels of physical activity, such as athletes , when there is an extensive body perspiration , it is not only desirable for the knittig next to the skin to absorb liquid faster, but that has been passed down through the mesh immediately in order to avoid the nuisance of knitting that sticks to the skin. To avoid this unpleasant occurrence, comfort of the knittig can be improved by understanding the mechanism of liquid transfer.

Mathematical modeling of surface tension transmission flow in the yarn and knitting can provide a way to develop such an understanding. In capillary flow through knitting, yarn and its composition are responsible for the major part of the liquid stocks (Hollies et al. , 1956, 1957).

For these above reasons Vresna are many researches to study the behavior of the liquid in the spatial structure of the knit. This also applies to the basics and simple cross woven knittig. Among the extensive research in this area, the yarn is treated as a porous media (Amico, 2000, 2002), or as a transfer fluid that can be described by Darcy's law (Rahl et al. , 1997, Chatterjee, 1985), or as a capillary tube (id Kamath, 199. Nioni, 2006 Pervelz et a., 2000, 2001 and Washburn,1921) through which the liquid can model - Lucas - Washburn kinetics (Washburn , 1921). In the first case , however, the characteristic parameters, such as permeability are difficult to quantify and are always obtained empirically (Benltoufa et al. , 2007).In another, somewhat similar, the effective radius of the capillary tube, the effective contact angle, etc. , are also determined by placing the experimental data. An extensive review of the literature in this area shows that, although widely to the research in this area, a comprehensive model to simulate capillary flow through the fabric of the structural parameters is still missing.

2. THE CURRENT TRANSPORT PROPETRIES

Transfer the liquid through the knitwear is usually in two stages. First, wet the surface of the liquid absorbed in knitwear and yarns by capillary attraction and also in the structure of the fiber in the case of hydrophilic polymers. Second, the fluid moves through the structure of a combination of diffusion and capillary movement of liquid. In the case of material produced from hydrophilic fibers , such as cotton or wool , the initial wetting liquid molecules allows for access to the fiber surface and then efficiently move " the solution " to the structure of the polymer while the polymer becomes saturated . The liquid then enters the capillary spaces between fibers and runs or wicks to move away from the structure of the reservoir fluid. Distance traveled depends on the contact angle between the liquid and the polymer, and the physical dimensions of the capillary space. The fluid that enters the solution within the fiber is effectively trapped and prevented from moving away from the source.Of course , hydrophobic polymers prevent the liquid solution enters the fiber and thus prevent capture of moisture. With time fluid has traveled along the capillary cross will evaporate, and then diffused into vazdužni space knitting. If there is a pressure gradient across the air molecules knitting fluid will be transferred to the air space and the knitting. Higher air flow will be determined by the pressure gradient, and thus a higher gear fluid. When you make a comparison between the fabric and knitted kntting made from the same polymer combination / fiber / yarn then capillary wick and the liquid in a polymer solution, of course, be similar. The main difference will be in the flow of air through the fabric and knotted knitting to be more porous and thus the transmission fluid level will be higher.

3. COMFORT

Comfort knitting is a very complex issue and the complexity of the variables involved. For example, the knitwear that is comfortable in cool dry environment can be uncomfortable to wear in hot humid climates. In order to have a meaningful discussion should state the following:
• environmental conditions , including temperature , humidity , wind speed and precipitation ;
• the level of activities of ;
• function of clothing, such as underwear, outerwear, jackets (rowboat) , trim , etc. ;
• fitting clothing.
The perception of comfort is carried out through a number of physiological interaction of textiles and the wearer:
• mechanical interaction between the surface of the skin and fibers and yarns. This includes the roughness or smoothness, as well as pressure, shear and tear.
• humidity as the holder of sweating or urination rain in the outer layer.
• Temperature condition in the body generates heat through exercise or penetration of heat to the surface from the outside.

Against this complex background knitwear offer benefits in three major areas.First,the strength properties of knitwear offer better compliance and preventing the excess of pressure and / or the development of shear between the garment and the body surface. This is especially important for underwear , as well as for active sportswear and swimwear to the extent that the vast majority of these goods are made of knitwear . Second, as already mentioned, knitwear offer substantial advantages over the fabric in terms of isolation, especially when they are protected from the wind.Third, knitwear behave well when there is a need for the transfer of sweat from the skin surface. These features increase the advantage of the natural extension of active sports applications.Conversely, knitwear does not provide good protection from the wind and cold and must be used in such circumstances under knitwear inserted podstavna tkanina.Slično are difficult to effectively waterproof.

4. CAPILLARY RISE OF MODELING 3D WOVEN STRUCTURES

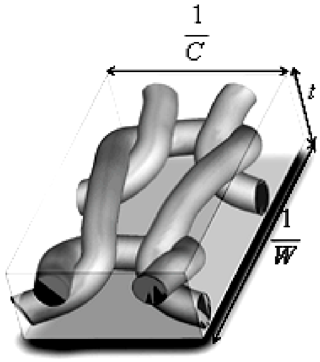
4.1. Macro-and micro-porosity

It was developed for capillary rise Savka channel model. Porous medium knitwear contains pores that are filled with fluid. Pores can communicate and exchange matter and energy. Hard part is called "matrix" can be deformed, but he must have cohesion (Okarango, 2004).

The phenomena occurring in porous depend on the geometry of the solid matrix, which may be consolidated or porosity (ε) is characterized by a particular form of average, geometric or static size and usually capillary rise modeling is defined as the ratio of pore volume to total volume available (Bories and Pratt : Techniques de l'Ingenieur (8A 250)):

$$\varepsilon(\%) = \frac{V_a}{V_T} \qquad (1)$$

where Va - The volume of available pore through which the fluid runoff occurs, V_T-total volume of the sample.
Braided structures (Figure 1 and 2) is a porous medium that offers several advantages.Physically it is a comfort feature, such as high elasticity, comfort in shape, softer touch and better feel fresh, and more.Porosity is one of the important physical properties, which affects the comfort aspect and use.



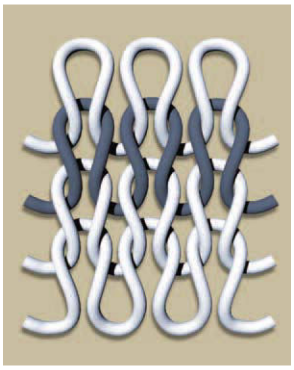
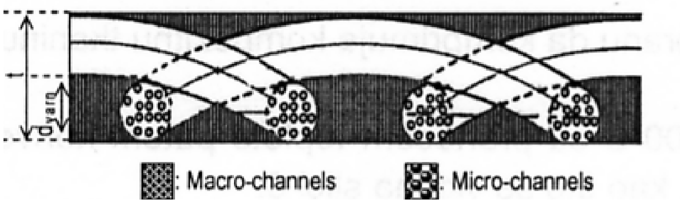



Figure 1.Three dimensional elementary Jersey loop shape. *Figure 2.Ribbed interlacement 1+1.*

Analyzing the knitted structure (Figure 3), we observe two porous scales: macro pores - vacuum between the yarn structure and micro-pores a vacuum between the fibers into yarn.



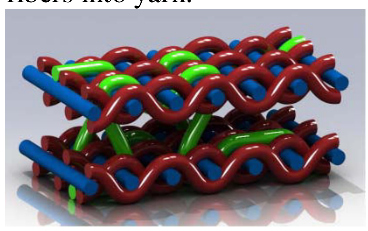


Figure 3. Side view of Jersey loops (macro and micro-channels), Right geometric design of the unit cell 3D knitwear.

Macro-porosity
In a study (Benltoufa and others., 2007), macro porosity channels is determined as follows:

$$\varepsilon_{macro} = 1 - \frac{\pi d^2 \ell C W}{2t} \qquad (2)$$

where t- is the thickness of the sample, ℓ – the length of the yarn in the loop (mm), d-diameter of yarn, C-number rows of loops, W-series of loops.

Micro-porosity
Porosity of yarn is defined as:

$$\varepsilon_{micro} = 1 - \frac{V_{of\ n_s}\ fibers\ \text{in yarn}}{\text{V}_{\text{Yarn}}} \qquad (3)$$

As pointed Norvick (Suh, 1967), there is a wide range of cross-section yarn in woven structures. So they need some simplification in an attempt to develop a theoretical model geometry. In the modeling we assume [2, 3, 4] that the yarn has a circular cross section and uniform diameter, which in reality it is not.

So:

$$V_{zarn}) \frac{\pi d_{zarn}^{2} L_{loop}}{4} \tag{4}$$

where L_{loop} elementary length of the yarn loops. As can be seen from Figure 3 the diameter of the yarn d_{yarn} = t/2, where t is the thickness of the knitwear.Then:

$$V_{zarn} = \frac{\pi t^{2} L_{loop}}{16}$$

(5)

Also, the volume n_s fiber in the yarn cross-section is:

$$V_{n_s fibers} = n_s \pi \frac{d_{fibers}^{2}}{4} L_{loop} \tag{6}$$

Substituting (5) and (6) into (3) yields:

$$\varepsilon_{micro} = 1 - \frac{4 n_s d_{fiber}^{2}}{t^{2}}$$

(7)

In fact, capillary progression between the knitting yarn can simulate the flow between two parallel plates distant (capillary length) (Figure 4). While, on the scale of the cross (between fibers) can be analyzed as a flow in the capillary tube radius R_{mi} (Figure 5).

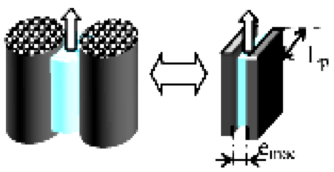
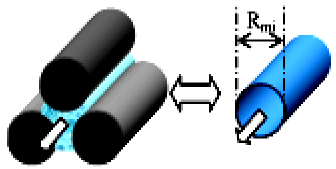


Figure 4. Capillary progression between yarns (macro channels)

Figure 5. Capillary progression between fibers (micro channels)



5. MODEL ORDINARY SINGLE JERSY KNITTED KNITTING AS POROUS

The unit cell of a regular Single jersey knitted structure (Figure 6) is a loop, which is created by the abstraction between the yarn loops. The loops are arranged in rows and rows, where you can see the empty space of the unit cell is almost the same cylinder, which limited the scope of yarn loops created. Since there is a uniform distribution of loops that make up the knitting, there is a unique array of circular cylinders in a unit area, while knitting usually can be modeled as a layer with identical cylindrical pores perpendicular to the surface.

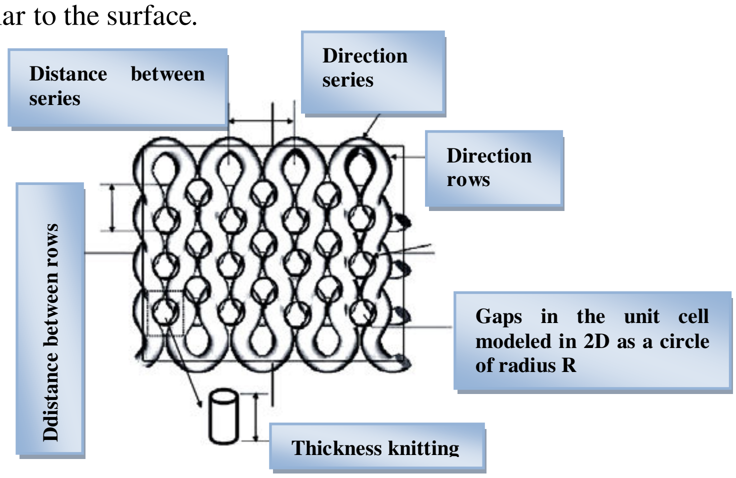


Figure 6. Right-ordinary person Single Jersey knitted structure (Dias Monaragala, 2006).

6. THE EXPERIMENTAL PART

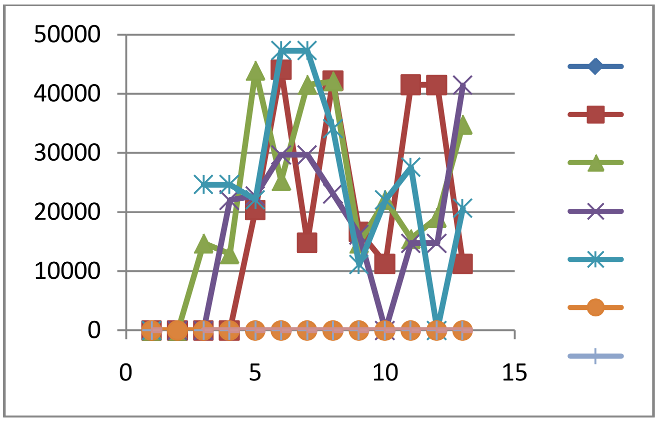
For the experimental investigation of absorption capacity, are woven of different patterns of spatial structure similar knitted knitting machines Shima Seiki to finesse 7 [11]. In order to achieve different porosity, capillary radii and angle on surface capillaries was changed to different numbers of spatial yarn between two knitted rows with varying number of space between two consecutive rows traps. Table 1 [11, 3] shows the specification of different knitting polyester spatial structures used in the experimental and theoretical works. It also shows the capillary radiuses, which are calculated by the model and the porosity of the fabric sample weight, thickness and surface area of 50.26 cm^2. Capillary radii given in Table 1 are calculated using jednadžine (Delkumburewatte, 2007):

$$r = \sqrt{\frac{t \cdot \frac{1}{w} \cdot S - \left[rows \cdot c \sqrt{\left(t^2 + \frac{S}{w^2} \right)} \cdot 1/(1 - crimp) \right] / 10^5 \cdot T / \rho_f}{170 \cdot rows \cdot c \cdot \sqrt{\left(t^2 + \frac{S}{w^2} \right)} \cdot \pi}}, \qquad (8)$$

where t is the thickness of knitting, w is a series of loops per cm, c the number of rows per cm, S is the number of needle space needle between two traps, 'rows' is the number of spatial yarn in one repeat, T is the number of spatial yarn and ρ_f is fiber density.

Table 1 Specification ofknitting, porosity, capillary radii and its spatial patterns [11], with the diagram shown below [3].

Sample	Spatial	Thickness (mm)	Weight (gr)	Series per cm	Rows per cm	Loops per cm²	Capillary radius (μm)	Porosity
Spatial 21	9	13.20	5.40	5.00	6.67	33.35	60.94	0.960
Spatial 22	10	13.35	5.35	4.60	6.67	30.68	55.63	0.960
Spatial 23	6	9.55	4.20	4.62	6.60	30.50	59.09	0.9607
Spatial 24	7	10.20	4.69	4.81	6.29	30.30	56.69	0.957
Spatial 25	8	10.40	5.09	4.81	6.29	30.30	53.20	0.953
Spatial 26	9	10.15	5.15	4.63	5.93	17.50	51.64	0.952
Spatial 27	10	10.45	5.40	4.44	6.30	28.00	48.14	0.944
Spatial 7	12	10.30	6.60	5.00	5.60	28.00	48.86	0.931
Spatial 8	8	11.10	5.42	4.40	6.75	29.70	63.30	0.959
Spatial10	6	9.10	4.52	4.40	7.00	30.20	58.12	0.957
Spatial 11	7	10.30	4.95	4.06	7.56	30.70	56.66	0.958



7. THE EXPERIMENTAL RESULTS

Figure 7 shows the experimental absorption grams per 100 grams of knitting [11], while Figure 8 shows the absorption of water in grams per 50 cm2 [11]. In the case of materials for clothing, it is important to know the capacity of absorption per square unit of area, and percentage.

Figure 7 shows that samples knitting with higher porosity have higher total absorption. For example, the pattern SP-21 with a porosity of 0.960 and a sample SP-8 with a porosity of 0.959 higher overall absorption capacity (absorption) around 1200%. Also, knitting patterns less porosity, SP-7 with porosity of 0.931 and SP-27 with a porosity of 0.944, with lower overall absorption capacity (absorption;) of 900%. The total absorption of other knitting patterns have a similar sequence according to their porosity variations as given in Table 1.

Figure 7 shows that the samples knitting SP-21, SP-22, SP-26 and SP-8 have a higher absorption rate and consistent from beginning to saturation with respect to other structures in tabeli.To also shows that the rate of absorption between saturation and 400% absorption, similar to most structures. However, knitting patterns with lower capillary radius and high capillary angle (sin φ) on the horizon showed a lower rate of absorption.

Figure 8 shows the absorption per unit area of knitting patterns followed a similar pattern in terms of percentage of absorption. However, the total absorption per unit area seems to vary with the thickness of knitting, knitting thicker higher overall absorption per unit area.

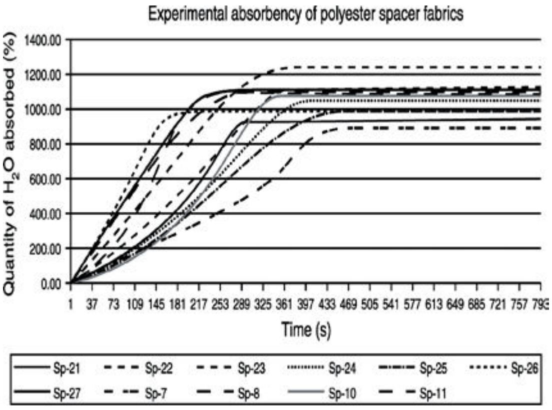


Figure 7. The experimental absorption rate spatial twists given in Table 1 as a percentage [11].

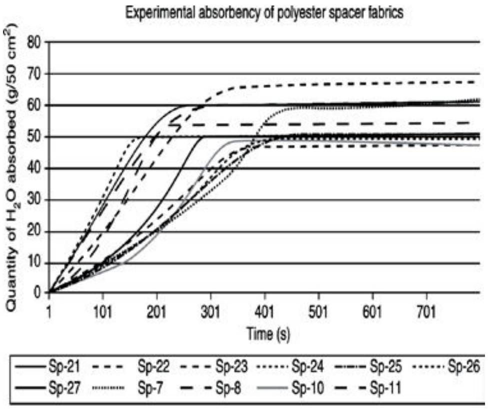


Figure 8. Absorption spatial knittig listed in Table 1 (50 grams per cm^2) [11].

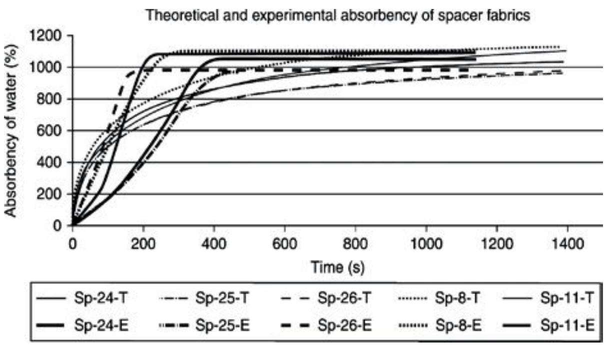


Figure 9. Theoretical and experimental absorption selected spatial structure [11].

Figure 9 shows the comparison of theoretical and experimental absorption five chosen space. T and E indicate the theoretical (continuous) and experimental (dots) absorption of selected samples of SP-24, SP-25, SP-26, SP-8 and SP-11th.

It shows that the theoretical and experimental total absorption is almost the same with the given structures.When the experimental values are compared with the theoretical rate raise upwards of liquid, the sample is almost the same, although there are some differences. In the initial stages of the theoretical absorption rate is higher than the experimental, because we took the average constant contact angle of 75 ° (cos75 = 0.2588), which is lower than the actual dynamic contact angle. At the beginning of the dynamic contact angle is closer to 90 ° (Heinrich and al. , 2006) and thus provides a closer cos 90 0 Thus , the value of ℓ (t) jednadžini 2 will be lower until it reaches the dynamic contact angle of 75 °. After that, the dynamic contact angle will be less than 75 ° , which leads to higher values of ℓ (t) jednadžini 2 So the theoretical absorption rate will be lower than at the start date to the theoretical value of the dynamic contact angle of 75 ° . Similarly, after reaching a dynamic contact angle of 75 ° the actual theoretical absorption rate must be higher than the theoretical value given to excess.

Figure 9 shows that the time required for saturation of the theoretical and experimental varies between 6 and 10 minutes for a given structure. The theoretical time required for saturation is greater than the experimental time for the same explanation given as to the rate of absorption after the dynamic contact angle of 75 ° .

The models were developed to predict the absorption of knitted spatial structures can be used directly for the planned total absorption in knitted spatial structures made of monofilament yarn texturing . The model can be used to predict the absorption rate and the time required for saturation. However, if the dynamic contact angle is considered in formula, shape , and absorption saturation time can be predicted accurately.

8. FUTURE TRENDS

Textile structures can be produced in water in geo-textiles, agro-textiles and clothing materials under different conditions.Special woven structures can be produced as a liquid batteries for medical and technical textiles. Kapilarnni effects and gravity can be used to 'pump' ground water for agricultural purposes in the area, drop by drop, if properly designed.

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APPLICATION OF ARTIFICIAL NEURAL NETWORKS FOR PREDICTING THERMAL RESISTANCE OF KNITTED BLANKETS

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Abstract:*Artificial neural networks (ANN) is a powerful tool used in complex problems and procedures of the system identification and prediction modeling applications, recognition and classification and grouping of data.This paper is designed ANN model to predict the thermal resistance of knitted blankets puncture needle.To predict the thermal resistance stab knitting needles as input parameters are taken parallel and cross-laying, fiber fineness, fiber cavity level, the weight of knitting, needle puncture depth, density and impact stab needles.The relative contribution of each parameter in predicting the overall thermal resistance of a set of tests has been studied conducting sensitivity analysis of data.The results of the sensitivity analysis showed that the most important input parameters in parallel and cross-connection in the process of forming knitting, followed by the other above mentioned parameters. Artificial neural networks have only one non-linear and stochastic model that has the capability to organize its structural constituents,known as "neurons" to perform certain calculations (patterns, knitting mistakes, knitting and other wrinkles) much faster than the best computer.*

Key words: *Artificial Neural Networks, ANN model, knitting, thermal resistance, puncture needles, parallel and cross-laying, stitch density, sensitivity analysis.*

1. INTRODUCTION

One of the most important aspects of the thermal comfort properties of knitting . It is known that non-woven knitting have better heat resistance compared to woven kniting and knitting with a similar surface mass of 1m^2. Properties stitch knitting depend on the nature of fiber components and the ways in which the fibers are arranged in the structure.Properties fibers (such as dimensions, mechanical and surface), along with a variety of machines and web (parallel and cross- laying) parameters contribute to the structure resulting from needle operations (Midha snd Mukhopadhaya, 2005). For knitting design is very important to properly understand the impact of various parameters on the thermal resistance of the covers. Midha , Alagirisamy and Kothari (2004) examined the effect of fiber and process parameters on the thermal resistance puncture needle cover using statistical models. However , the relative importance of each parameter in influencing the thermal resistance puncture needle cover is still unknown. By researchers developed mathematical models have shown that the thermal conductivity of porous substance has a nonlinear relationship with the thermo -physical parameters (Fay, Alibi, Benltoufa and Jemni, 2008). In addition, the physical properties of knitted blankets puncture needle, such as thickness and weight , affecting the thermal resistance , are derived from primary fibers and process these circumstances the parameter using neural network model is a better alternative statistical models to predict the thermal resistance (Chattopadhyay & Guha, 2004). in various studies (Debnath , Madhusoothanan and Srinivasamoorthy 2000; Ureyan & Gurkan, 2008a, 2008b), it was reported that the model of artificial neural networks (ANN) are better in their predictions compared to the statistical models.Neural networks are trained to predict the output of the various input parameters also include knowledge about the relative importance of the input parameters, which can be very useful in process control and design of the final product.Several attempts were made to extract such information neural network model.Jaiadeva,Guha and Chattopadhiai (2003) determined the most important parameters affecting fiber yarn properties using a model of neural networks. Midha, Kothari, Chattopadhiai and Mukhopadhiai (2010) estimate the relative importance of process and machine parameters that affect the power loss during cross stitching. In this paper,the ANN model is used to predict the thermal resistance of the blanket puncture needle when the fiber and process parameters given as input.

The relative importance of fiber and process parameters is also analyzed using a sensitivity analysi.

2. ANN APPLICATIONS IN TEXTILE ENGINEERING

Basically since 1990 VNM application in Textile Engineering is becoming more and more popular gradually been proven that they can successfully solved complex engineering problems.Many researchers have turned VNM when they were in front of multiparameter and nonlinear problems, with no clear or simple analytical solutions. Established a method for selection of cotton bales based on certain criteria (Majumdar and others., 2004). In the case of synthetic fibers, VNM was supported by the identification of parameters to control output (Allan et al., 2001) and predict the properties of melt spinning yarn (Kuo, 2004). VNM used in conjunction with NIR spectroscopy for identification of textile fibers (Jasper and Smith 1994). Has also developed a system to optimize the production of yarn. Spinning process and its role in predicting the properties of cotton - polyester yarn was tested using VNM (Lu et al, 2007;.Methods based on a combination of genetic algorithms and neural networks used to predict and optimize the performance of yarn (Subramanian et al., 2007).

3. ARTIFICIAL NEURAL NETWORKS

3.1. The functionality of the interest of Textile Engineering

Artificial neural networks (ANN) are algorithmic structure derived from a simplified concept of human brain structures. They belong to the family of Soft Computing methods, along with fuzzy logic / phase control algorithms and genetic algorithms (Zadeh, 1994).They are iterative, non-linear search for the optimal or sub-optimal solutions of the problems, without assuming any kind of model for a basic system or process,(Keeler, 1992).The problem of predicting thermal resistance covers (blankets) quilting needle-puncture of fiber and process parameters can be seen as a function approximation. Thermal resistance is a function of knitting fibers and process parameters, and the goal is to make this function from a set of measurements. Power-forward neural network (Figure 1) are six nodes in the input layer (equal to the number of input parameters), two hidden layers and one node in the output layer (corresponding to the output and heat resistance) is used for the study.Power-forward network receives data from the previous layer, ie, an output layer is the input to the next layer and no feedback from output to input. Number of hidden layers and number of neurons in the hidden layer have been optimized for the proper training of the network. Guha received a report that one or two hidden layers are able to map the response to a reasonably good prediction accuracy and performance of the network can not be significantly improved by increasing the number of hidden layers.The starting point for the number of neurons in the hidden layer is chosen by the rule of thumb (Guha, 2002);

$$n_{hidden} \succ 2 \cdot [\max(input\ neurons, output\ neurons)] \quad (1)$$

where msw Mean square weight, given by equation (3), γ is the performance ratio (default 0.5).

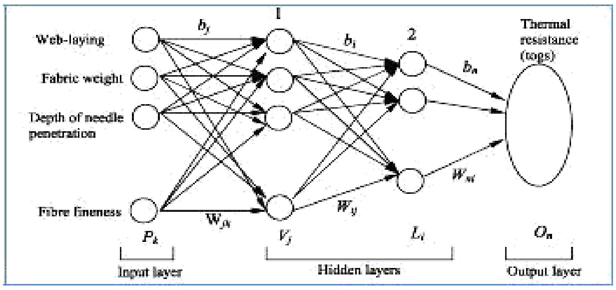

Figure 1. Three layered architecture of the neural network used to predict the thermal resistance of non-woven blankets (shield) penetrating needles. W_{Jk} is the mass matrix, b_J bias, and V_j and L_i are the number of nodes in the hidden installation.

Too few neurons starved network resources,complexity of the model is not able to extract a deterministic relationship between the input and output variables.The training is increased and this can cause a problem called overfitting (over fitting). Errors on training set is driven to a very small value, but when new data is presented to the network for testing, it is determined that the error is very large.The network is able to plan the training set, but this can not be generalized to new situations. Thus, some of the points test data provide very high error.Several methods are used to improve network generalization (Bhattacharjee and Kothari, 2007).In this study, the regulation done by changing the performance mode mean square error or "mse" in "msereg";

msereg = γ mse + (1- γ) msw (2)

where msw Mean square weight, given by equation (3), γ is the performance ratio (default 0.5).

$$skw = \frac{1}{n}\sum_{j=1}^{n} w_j^2 \qquad (3)$$

where n is the number of neurons in the layer, ie the weight matrix. Value "msereg" becomes smaller than the "mse", so the total error is reduced.
Round - spreading,iterative gradient descent algorithm is used for training the network (Bhattacharjee & Kothari , 2007 ; Cheng and Adams , 1995).The network begins with a random set of weights that are adjusted after training with each pair of input - output.The training is conducted in two phases known as the passage forward and back passage.In the passage above, the network is presented with training with weights and input are activated units in the hidden layers, which are calculated from the sigmoid function. Outputs are calculated from the weight of the second layer.During the backward pass,the network output is compared to that target output and error estimates output units are calculated.Weight attached to the output units are then adapted to reduce errors. Estimates of errors in the output layer are used for the performance evaluation of errors in the hidden layer units.Finally, errors are propagated back to the connections stemming from the input units.This is an iterative process until the weight of the links adjusted so that the error in the target output is compared with the actual output converges to an acceptable level (Ramesh, Rajamanickam,and Jayaraman , 1995). Total of 39 samples were taken for the study,of whom 27 (70 %) samples using the training and 12 for testing the network.The prediction performance of neural networks is evaluated with 12 test data sets that were not used during training, in order to reduce the dependency of the results to a specific distribution of data in the training and test sets was carried out, three-way cross- validation tests , ie , complete data were divided into training and testing set in three different ways.When the neural network trained by training set, the thermal resistance is predicted for the training and test sets.Since the error of each test data set were calculated and the mean square error MSE.The estimated thermal resistance is correlated with the experimental heat resistance and coefficient of correlation obtained between the actual and predicted thermal resistance.The relative contribution of each parameter in predicting the overall thermal resistance is studied through sensitivity analysis of a set of test data. Each input parameter is eliminated while the individual provides thermal resistance and MSE for the test data set is calculated.The ratio test is calculated as the ratio of MSE for testing data set before and after the removal of input parameters.Higher ratio test, the greater the sensitivity of the output parameter.Input parameters are ranked according to their importance for all three partitions. Compatibility coefficient and significance test is conducted to know the degree of consensus among the ranks obtained in three different partitions.

3.2. Prediction performance

Table 3 shows the prediction of network performance for the three-way cross-check the data. MSEs in the training set varies from 0.0010 to 0.0016 in all compartments. The maximum and minimum errors in the basic set were 12.26% and 0.0%, respectively. The coefficient of determination is 1 for all partitions. The test set (set) data, mse ranges from 0.017 to 0.082, and the maximum and minimum errors were 36.45% and 0.07%, respectively.The coefficient of determination 19 (R^2) in the test data set for the three compartments was 0.95, 0.93 and 0.97, respectively.The values of the correlation coefficient (r) for the three compartments were 0.96, 0.95 and 0.98, respectively. The good correlation between the experimental and predicted thermal resistance shows that the model can predict the thermal resistance covers puncture needle with good precision.

Table 1. Specifications set of data [1].

S. no.	Fibre fineness (denier)	Fibre degree of hollowness (%)	Web-laying	Fabric weight (g/m^2)	Depth of needle penetration (mm)	Needle punch density (punches/cm^2)	Thermal resistance (togs)
1	6.75	10	Parallel-laid	800	9	50	0.588
2	6.75	10	Parallel-laid	800	3	50	0.979
3	6.75	10	Parallel-laid	400	9	50	0.457
4	6.75	10	Parallel-laid	400	3	50	0.849
5	6.75	10	Parallel-laid	800	6	70	0.588
6	6.75	10	Parallel-laid	800	6	30	0.849
7	6.75	10	Parallel-laid	400	6	70	0.522
8	6.75	10	Parallel-laid	400	6	30	0.718
9	6.75	10	Parallel-laid	600	9	70	0.457
10	6.75	10	Parallel-laid	600	9	30	0.588
11	6.75	10	Parallel-laid	600	3	70	0.849
12	6.75	10	Parallel-laid	600	3	30	0.979
13	6.75	10	Parallel-laid	600	6	50	0.588
14	6.75	10	Cross-laid	800	9	50	1.371
15	6.75	10	Cross-laid	800	3	50	2.806
16	6.75	10	Cross-laid	400	9	50	1.632
17	6.75	10	Cross-laid	400	3	50	1.893
18	6.75	10	Cross-laid	800	6	70	2.023
19	6.75	10	Cross-laid	800	6	30	1.893
20	6.75	10	Cross-laid	400	6	70	1.175
21	6.75	10	Cross-laid	400	6	30	2.023
22	6.75	10	Cross-laid	600	9	70	1.11
23	6.75	10	Cross-laid	600	9	30	1.501
24	6.75	10	Cross-laid	600	3	70	2.349
25	6.75	10	Cross-laid	600	3	30	2.545
26	6.75	10	Cross-laid	600	6	50	1.501
27	14.5	15	Cross-laid	800	9	50	1.501
28	14.5	15	Cross-laid	800	3	50	2.545
29	14.5	15	Cross-laid	400	9	50	1.501
30	14.5	15	Cross-laid	400	3	50	2.023
31	14.5	15	Cross-laid	800	6	70	1.89
32	14.5	15	Cross-laid	800	6	30	2.023
33	14.5	15	Cross-laid	400	6	70	1.762
34	14.5	15	Cross-laid	400	6	30	1.892
35	14.5	15	Cross-laid	600	9	70	1.37
36	14.5	15	Cross-laid	600	9	30	1.501
37	14.5	15	Cross-laid	600	3	70	1.892
38	14.5	15	Cross-laid	600	3	30	2.154
39	14.5	15	Cross-laid	600	6	50	1.631

4. RESULTS AND DISCUSSION

Web-laying (parallel and crossed-laying), fiber fineness, fiber cavity level, weight knitting, needle puncture depth and puncture needle density are considered input parameters to predict the thermal resistance of 18 puncture needle-punched blankets. Table 2 shows the error (%) of data sets for three different partitions of data. Estimated (projected) value of the surveyed data set are very close to the set of experimental data for all three compartments (Figure 2). Proposed neural network approximates the thermal resistance values with very low error, regardless of the particular partition data into training and test sets.

Table 2.The experimental and predicted thermal resistance of test data stored in a variety of existing partitions [1].

S No	Exper.	Plan	Error (%)	S. No.	Exper.	Plan	Error (%)	S. No.	Exper.	Plan	Error (%)
1	0.588	0.5112	13.06	2	0.979	1.0045	-2.60	4	0.849	0.7280	14.25
8	0.718	0.8197	-14.16	3	0.457	0.4784	-4.68	5	0.588	0.7403	-25.99
11	0.849	0.6666	21.48	6	0.849	0.8325	1.94	7	0.522	0.5272	-1.00
13	0.588	0.6259	-6.45	10	0.588	0.5319	9.54	9	0.457	0.4825	-5.58
15	2.806	3.1653	-12.80	17	1.893	2.5830	-36.45	14	1.371	1.2192	11.07
16	1.632	1.4120	13.48	18	2.023	2.0104	0.62	21	2.023	1.8103	10.51
19	1.893	2.3151	-22.30	23	1.501	1.8965	-26.35	24	2.349	2.5885	-10.20
23	1.501	1.6373	-9.08	25	2.545	2.8871	-13.44	26	1.501	1.4605	2.70
30	2.023	2.0245	-0.07	27	1.501	1.6613	-10.68	28	2.545	2.5315	0.53
31	1.890	1.6893	10.62	34	1.892	1.8342	3.05	29	1.501	1.4734	1.84
36	1.501	1.6882	-12.47	37	1.892	2.2654	-19.74	32	2.023	2.1302	-5.30
38	2.154	2.4139	-12.07	39	1.631	1.8981	-16.38	35	1.37	1.5470	-12.92

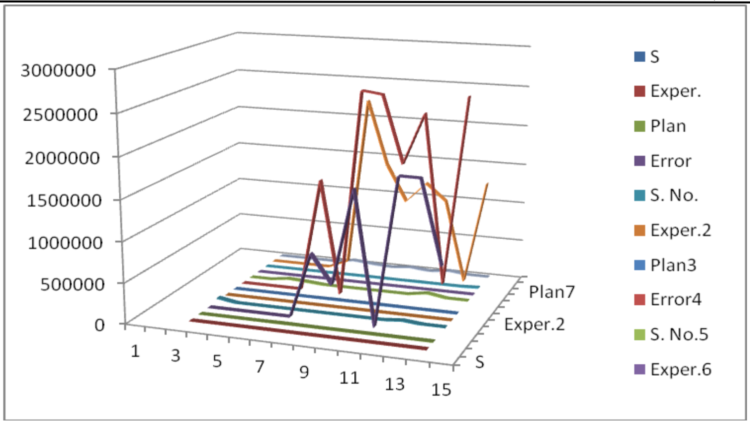

Figure 2. Experimental and predicted values of thermal resistance of test data

Table 3. Performance parameters of the neural network [1].

	Partition 1	Partition 2	Partition 3
Network architecture	**6-12-10-1**	**6-8-6-1**	**6-10-7-1**
Performance goal	**0.01**	**0.01**	**0.01**
Epochs	**61**	**48**	**63**
Performance ratio	**0.95**	**0.95**	**0.95**
Training set			
Mean square error (MSE)	**0.047**	**0.082**	**0.017**
Maximum error (%)	**22.30**	**36.45**	**25.90**
Minimum error (%)	**0.07**	**0.62**	**0.53**
Coefficient of determination (R^2)	**1**	**1**	**1**
Test set			
Mean square error (MSE)	**0.047**	**0.082**	**0.017**
Maximum error (%)	**22.30**	**36.45**	**25.90**
Minimum error (%)	**0.07**	**0.62**	**0.53**
Coefficient of determination (R^2)	**0.95**	**0.93**	**0.97**

4.1. Sensitivity analysis

Sensitivity analysis is a way of analyzing changes in network performance p rediction for a particular change in a parrticular input parameter.The main measure of s ensitivity is the ratio of MSEs when implemented changes in one parameter. A higher ratio of err ors, it is more critical parameter. Input parameters are ranked according to the relative MSE of the test set data after eliminating one input parameter at the time.Table 4 shows the results of the sensitivity analysis ANN model.The parame ters are ranked according to their relative sensitiv ity to all three compartments. Coefficient of com pliance among the three compartments was 0.84 and 0.84 and $F_{calculated}$ = 9.82 >F_{table} = 7.0 9., at 99 % confidence level, which means t hat there i real agreement among obtained in various partitions . On this basis, we calculated the total rows, as shown in Table 4. It is observed th at the web taking the most critical input parameter for determining the thermal blanket (blanket) puncture needle , followed by a deep puncture needles, k nitting weight, degree of fiber cavities, puncture n eedle density and fineness of the fiber. Parameters f ibers (fineness and degree of cavity) have the lea st impact on the heat resistance blanket puncture n eedle. Process parameters, which are mainly resp onsible for the structure covers puncture needles have a bigger impact on the heat resistance blank et puncture needle. The results were confirmed by previous studies by different authors. It is the fineness of the fiber has a relatively small effect o n the thermal resistance of studies based on statis tical models (Midha et al., 2004).Thermal insulation knitting a certain amount of air trapped within the structure. Knitti ng with thicker catch more air, resulting in greate r heat resistance (Smith, 1972). Simultaneously l aying the Web leads to greater consolidation of t he web in relation to taking the web.Thus, the thi ckness and the amount of air trapped in parallel casual knitting is lower, which leads to lower therm al resistance . Due to stitch density or increasing the depth of puncture needles, more traps in the k nitting increase compactness and knitting materials enabling it to hold less air, which leads to a reduction in thermal resistance covers puncture needle.The depth of puncture needle has a larger impact on the density of needle puncture, which was confirmed in previous studies.It was found that the reduction in thermal resistance increased with increasing depth of penetration but with increasing in punch density (Midha et al, 2004).Thermal resistance increases with weight yarn, and because the thick ness of the air trapped in the structure increases.

Table 4. Sensitivity analysis of the neural network model[1] .

		Knitwear - Laying	Fiber fineness (den)	Degree of Swelling of fibers (%)	Weight knitting (gr/m^2)	Depth of the needle	Density needle Puncture (Puncture/cm)
Partition 1	Ratio test	4.64	1.06	1.02	1.40	3.10	1.14
	Position	1	5	6	3	2	4
Partition 2	Ratio test	3.58	1.38	1.63	1.68	2.15	1.27
	Position	1	5	4	3	2	6
Partition 3	Ratio test	6.83	1.92	3.26	2.66	5.42	2.49
	Position	1	6	3	4	2	5
	Total position	1	6	4	3	2	5

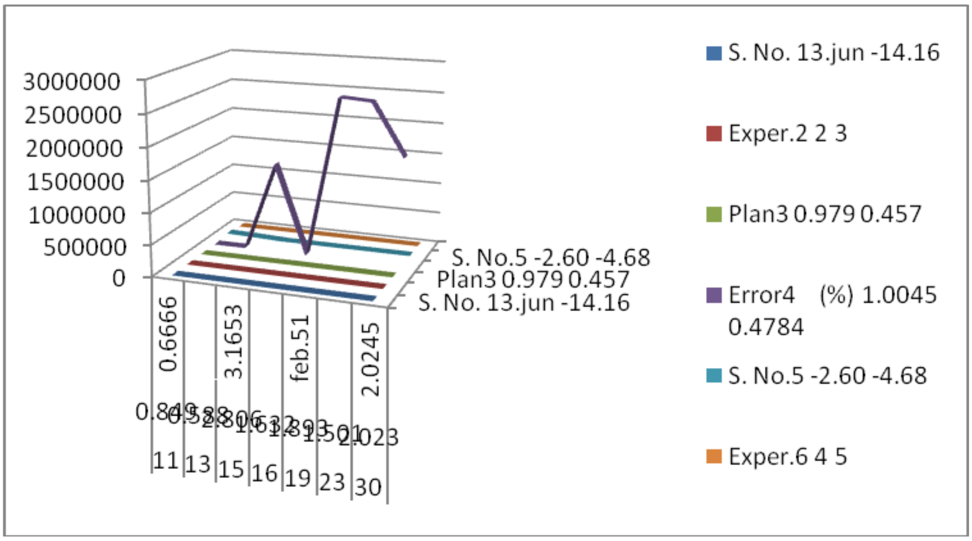

Figure 3. Sensitivity analysis of the neural network model

5. CONCLUSION

ANN model is used to predict the thermal resistance covers puncture needle. Six input parameters were used, web laying, fiber finen ess, fiber cavity level, weight knitting, needle puncture depth and density puncture needles. The results show that the neural network model provide s an effective method for predicting thermal resistance covers puncture needle. The performance of the proposed neural networks are tested on experimental data and cross-validation.The data is performed by dividing he training and test data in three different ways. Re asonably good correlation was obtained between the experimental and predicted thermal resistance. The relative importance of the input parameters of regards of thermal resistance covers puncture n eedle was also investigated using sensitivity analysis. It is noted that the web taking the most i mportant input parameter for determining the heat resistance blanket puncture needle, then the depth of penetration of the needle, fabric weight, the degre e of cavity fiber density puncture needle and fiber fi neness.

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STUDY OF THE PRESSER FOOT DISPLACEMENT IN A LOCKSTITCH SEWING MACHINE

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Abstract: *Wool and wool blended fabrics for men's tailored clothing having variations in structure were sewn using two sewing speeds on a lockstitch sewing machine. The sewing machine, stitch type 301, was equipped with encoder for monitoring presser foot displacement. The information of presser foot displacement was collected and stored on a pc and analyzed using specially developed program.*
It was shown that increasing of the sewing speed results in increasing of presser foot displacement. It was also shown, that the variation of the fabric structure affects presser foot displacement, while the effect varies depending on the type of variation.

Key words:*sewing dinamics, presser foot displacement, sewing machine monitoring*

1. INTRODUCTION

Market requirement for high quality products of increasing variety of materials and small-batch orders, stresses the need for flexible and reconfigurable machines, off quick set-up and self-adjusted setup. This is especially true for the garment and leather industries in European countries. To fulfill these needs, new control devices and process-engineering tools for sewing machines are required.
The sewing process, namely needle penetration, stitch formation and fabrics feeding dynamics, have been studied using a "sewability" tester mounted on a industrial overlock sewing machine, where the performance of needle penetration, fabric feeding and stitch formation were assessed during sewing. Eventually the authors (Carvalho M., at al., 1996, Carvalho H., at al., 2000, Silva L. F., at al., 2002) and other instrumented this machine with miniature piezoelectric force transducers on the presser foot and needle bars and encoders and semiconductor strain gauge transducers on a threads' path. Also, signal acquisition and analysis equipment was also developed for measuring 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. A linear variable differential transformer 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. The "*critical*" points in the stitch cycle that greatly influence the quality of the produced seams were identified and correspond to the contact losses occurring between the presser foot and the fabric plies. 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. Later the contribution towards the development of a new generation of sewing equipment was made (Silva L.F., at al., 2004) by integrating auxiliary add-on kits to improve performance and flexibility in the production of high quality garments.
The current paper presents the development of stitch formation monitoring methods relying on the measurement of presser foot displacement investigating the influence of the variation of the fabric structure and sewing speed on foot displacement.

2. EXPERIMENTAL

There are two distinctive pairs of fabrics in the whole 4 fabrics investigated. The fabrics A and A1 differ in weft density, while all other parameters are the same.

Fabrics B and B1 differ only in weft yarn count. The fabric thickness of A and A1 is 0.36 and 0.41 respectively, and between B and B1 is 0.29 and 0.34. The other details of investigated fabric structure are shown in Table 1.

Table 1: Details of investigated fabrics

Fabric	A	A1	B	B1
Fiber composition	98% wool 2% lycra	98% wool 2% lycra	100% wool	100% wool
Yarn count, warp, tex	17x2	17x2	15x2	15x2
Yarn count, weft, tex	17x2	17x2	24	15x2
Warp density, cm^{-1}	32	32	31.2	27.6
Weft density, cm^{-1}	24.80	26.2	31.2	28
Fabric thickness, mm	0.36	0.41	0.29	0.34
Weave	2x1 twill	2x1 twill	2x1 twill	2x1 twill

A lockstitch sewing machine was equipped with several devices in order to acquire, store and analyse data reflecting the behaviour of the most important parameters involved in the formation of the stitch type 301. The system consists of data collection devices (sensors - cantilever beams strain gauges, encoders, LVDT (Linear Variable Differential Transformer) and hardware for signal conditioning and processing). These devices are connected to a data acquisition board installed in a PC.
There is also a program (developed in *LABVIEW*), which allows the calibration of the devices, the on-line graphical display and signal processing functions. The program includes also basic statistical tools, in order to shorten the evaluation of the results.
The table 2 describes positions of the needle and the presser foot during one sewing cycle of 360 degree rotation of the main shaft. In a stitch cycle, the feed dog is at the throat plate level, during its rising movement, at approximately 80 degrees. The presser foot will reach its maximum rising 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

3. RESULTS AND DISCUSSION

It can be seen (figure 1 and figure 2) that there is increasing of the amount of presser foot displacement with increasing sewing speed for fabrics A and A1 in warp direction. For sample A tested in warp direction, the maximum height of displacement at 3000min^{-1} and 4000min^{-1} is 1.806mm and 1.864mm (fig. 1). For sample A1, the maximum height of displacement at 3000min^{-1} and 4000min^{-1} is 1.824mm and 1.884mm respectively (fig. 2). For the samples tested in weft direction there is also difference in maximum presser foot displacement for fabrics A and A1. The same applies for fabrics B and B1: with increasing sewing speed, the height of presser foot displacement increases in both fabrics (fig. 3 and 4).

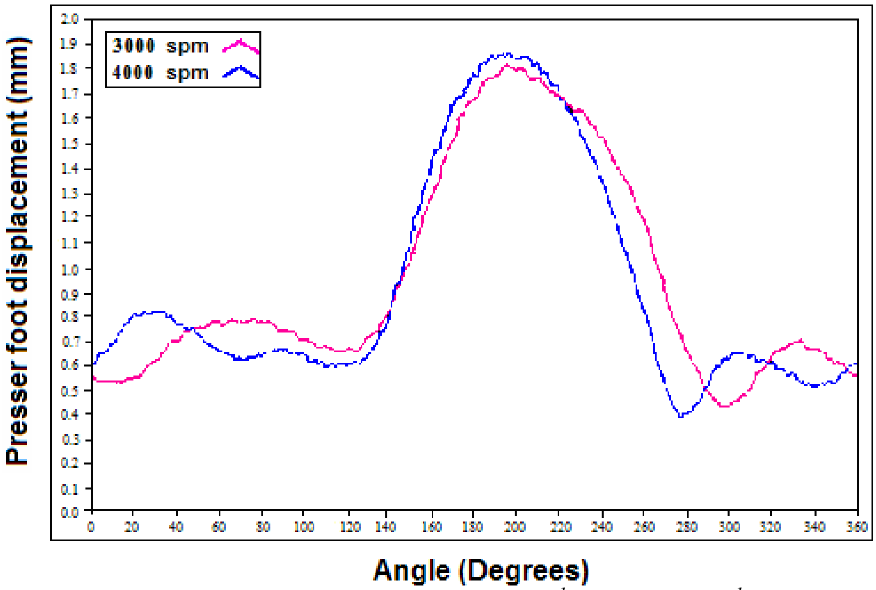

Figure 1: Displacement of the presser foot at speed 3000min^{-1} and 4000min^{-1} on fabric A, for seams in warp direction

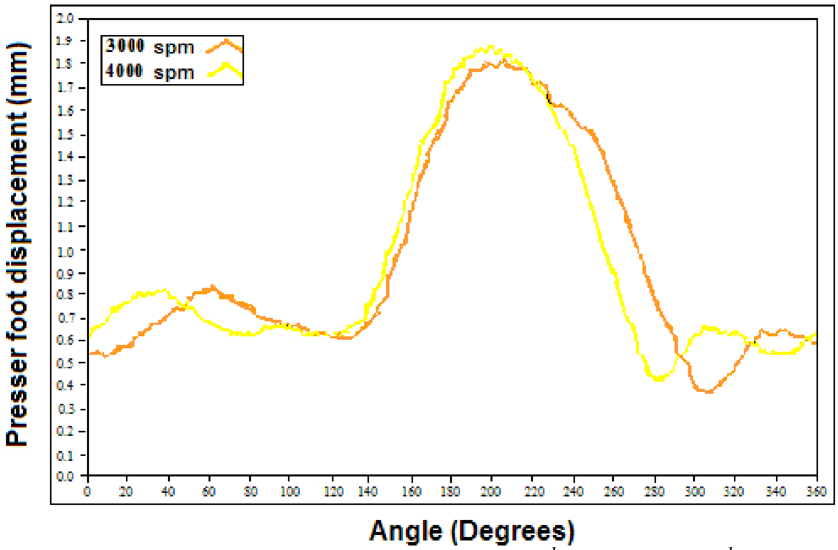

Figure 2: Displacement of the presser foot at speed 3000min^{-1} and 4000min^{-1} on fabric A1, for seams in warp direction

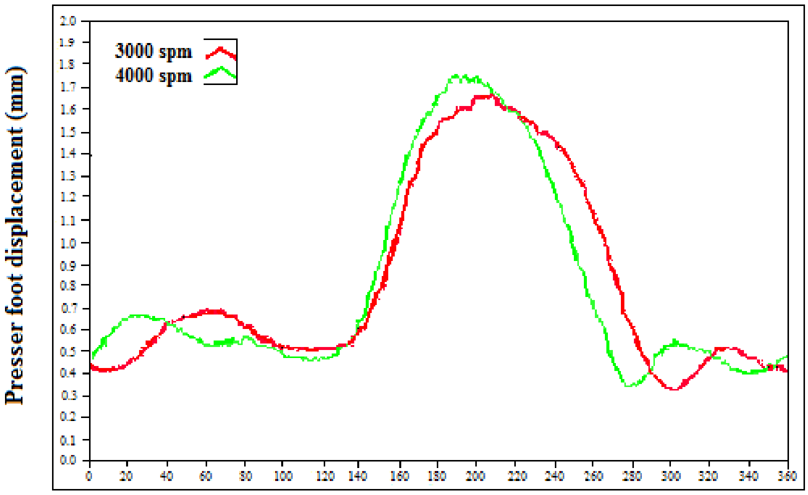

Figure 3: Displacement of the presser foot at speed 3000min^{-1} and 4000min^{-1} on fabric B, for seams in warp direction

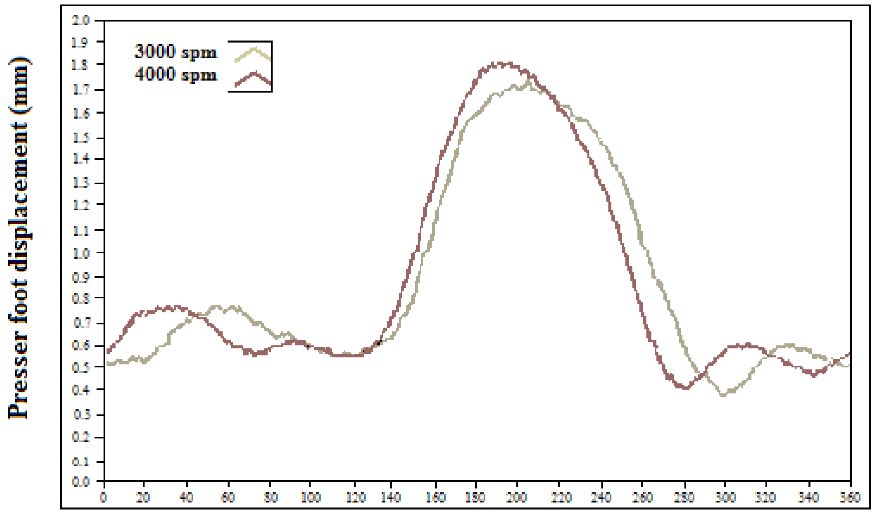

Figure 4: Displacement of the presser foot at speed 3000min^{-1} and 4000min^{-1} on fabric B1, for seams in warp direction

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 direction at speed 3000 and 4000min^{-1}

Samples	Max. presser foot displacement (mm) Sewing speed, min^{-1}		Increase of max. Foot displacement, % (3000 to 4000 min^{-1})
	3000	4000	
A	1.806	1.864	3.2
A1	1.824	1.884	3.3
Increase of max. foot displacement, % (A to A1)	1.0	1.1	
B	1.664	1.741	4.6
B1	1.704	1.785	4.8
Increase of max. foot displacement, % (B to B1)	2.4	2.5	

The difference in thickness between fabrics A and A1 is 0.05mm, which represents an increasing of thickness for 14%. Accordingly the difference in thickness between fabrics B and B1 is also 0.05mm, representing increase in thickness for 17%.
We see that the increase in presser foot displacement for fabric A when increasing the speed from 3000 to 4000 min^{-1} is 3.2% and for fabric A1 is 3.3%. The difference in presser foot displacement between fabric A and A1 for sewing speed of 3000min^{-1} is 1.0% and for speed 4000min^{-1} it is 1.1%. So, the increase of presser foot maximal height displacement is greater when increasing the speed than when increasing the fabric thickness.
For the fabric B, the increasing of sewing speed from 3000 to 4000min^{-1} results in increasing the presser foot maximal height displacement of 4.6%. For sample B1 the increasing of speed results in increasing of the presser foot displacement for 4.8%. Again if we analyze the difference in presser foot displacement between fabrics B and B1 we finds that at lower speed (3000min^{-1}) the difference is 2.4%, and at greater speed (4000min^{-1}), the difference is 2.5%.
In both cases we find that the difference in presser foot displacement is higher when increasing the sewing speed, than when increasing fabric thickness. It is noticeable that the difference in increasing presser foot displacement is higher for the second pair of fabric (B and B1). This can be attributed to difference in ingerent compression properties of the fabrics and to differences in structural changes between the fabric A and A1 (increasing weft density) and between B and B1 (changing weft yarn count and structure).

4. CONCLUSION

The influences of sewing speed and fabric structure variation on presser foot displacement has been investigated on a lockstitch sewing machine, stitch type 301. The obtained results show that the increasing of sewing speed and fabric structure variations has influence on maximal height displacement of the presser foot.
The increase of the sewing speed results in higher increase of the presser foot height displacement than the increase of the fabric thickness.

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INFLUENCING TAILORABILITY AND MECHANICAL PROPERTIES OF WOOL FABRICS FOR TAILORED GARMENTS

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Abstract:*The distinguish characteristic of the textile industry is that it is subjected to seasonal variations and dealing with wide range of materials. To survive and compete usefully in today's globalized market, apparel companies must design high quality and high performance apparel products. The quality of the garment to a great extent depends on fabric mechanical properties under low loads.*
The paper investigates the effect of woven fabrics structure variations on a fabric mechanical behavior and garment quality. Worsted fabrics for men's tailored garments were tested on a KES-F system for fabric objective evaluation. It was shown, that depending on the type of fabric structure variation, the various effects on a fabric mechanical behavior, that influence fabric hand and garment appearance could be achieved.

Key words*:KESF, tailorability, fabric objetive evaluation*

Influencing tailorability and mechanical properties of wool fabrics for tailored garments

1. INTRODUCTION

Fabric characteristics are usually dictated by apparel design and specification of use. Understanding the relationship between fabric end use and fabric properties becomes fundamental point for product development. During wear, fabrics deteriorate in their mechanical properties and handle, even though they may not have suffered physical breakdown. Although many textile fabrics are suitable as clothing materials, there is always challenge to seek better or more comfortable fabrics. The fabric hand is a most important quality characteristic of fabrics as clothing material. From the mechanical comfort viewpoint, textile producers and consumers have evaluated this kind of fabric performance by a subjective method, called handle judgment. The beginning of investigation of fabric hand started by Pierce in 1930, where he suggested correlation between fabric hand and its mechanical properties, and eventually initiated the measurement of the bending stiffness of fabrics (Pierce F.T., 1930). The investigations have carried on by Lindberg, who introduced term formability as ability of fabric to convert into 3-d garment (Lindberg J, Waesterberg L, Svenson R. 1960). Then, in 1970`s the Hand Evaluation and Standardization Committee (HESC) having realized the importance of routine fabric measurement, developed the KESF instruments which opened possibilities of objective evaluation of fabric hand and gave answer to questions opened by Pierce (Kawabata S., at al., 1982. This objective method is based on the measurement of the low load mechanical properties and they are transformed into the primary hand and total hand value (THV) (Kawabata S., Niwa M., 1989) Applications of objective measurements for fabric quality evaluation, fabric manufacturing, quality assurance in garment making and product design were suggested by Postle, Kawabata and other researchers (Postle R., Mahar T.J., 1982, Postle R. at al. 1983). Further investigations (Geršak J., 2003), were directed towards clarifying the impact of fabric mechanical behavior on form changes, as well as on the quality of garment appearance. Results suggested that garment appearance quality was strongly affected by three components: formability, elastic potential and draping. Investigations of (Vassilliadis S.G. at al., 2005) provided a mathematical tool for a parametric study and definition of the quantities, which have to change, in order to maximize the THV of the fabric. As well as, objective and subjective test result, a new total hand value was calculated for this purpose. (Sülar V., Okur A., 2008). Ciesielska-Wrobel I.L, Langenhove L.V., 2012) gives a review of the international literature from 1930 to 2010 concerning the hand of textiles and other related subjects like skin physiology, perception though the skin, and biomechanical aspects of the skin. (Tsucada M., at al. 2013) shown that the changes in tensile, shearing, bending and compression behavior of grafted wool fabrics are due to the reduction of the free internal volumes of the fabrics, leading to a tightening of its texture.
The paper investigates the influence of variation of fabric structural parameters variation on primary and total hand of the fabrics for outerwear clothing.

2. EXPERIMENTAL

For investigation purposes, 100% worsted wool fabrics for men and ladies tailored garments were produced. The fabrics designated C21YL and C21YH, have all structure parameters identical and differ only in weft yarn count. The first fabric C21YL, has single ply weft yarn of lower count, while, the second fabric C21YH, has double ply weft yarn making total higher weft count.
The particulars of fabric structure parameters are shown in Table 1.

Table 1: Investigated fabric particulars

Fabric	Fiber composition	Yarn count, warp [tex]	Yarn count, weft [tex]	Warp density [cm^{-1}]	Weft density [cm^{-1}]	Weave
C21YL	100% wool	15x2	24	31.2	27.6	2x1 twill
C21YH	100% wool	15x2	15x2	31.2	28	2x1 twill

The fabrics are tested KES-FB system for mechanical properties under low load. The system and consists of four instruments: KES-F1 for tensile and shearing testing [11], KES-F2 for bending testing [12], KES-F3 for compression testing [13], and KES-F4 for investigating surface friction [14]. A total of 16 parameters are measured, all at low loads intending to imitate fabric deformations during wearing. All samples were conditioned under standard atmospherics conditions, 20±2ºC and 65±2% relative humidity.

3. RESULTS AND DISCUSSION

The results of mechanical properties of the investigated fabrics C21YL and C21YH testing on KES-FB instruments are presented in Table 2 and Table 3.

Table 2: Mechanical properties of testing fabrics C21YL on KESF

C21YL	***Warp***	***Weft***	***Average***
Tensile			
EM [%]	2.9680	8.3620	5.6650
LT [-]	0.7950	0.6910	0.7430
WT [$cN\cdot cm/cm^2$]	5.9100	14.4200	10.1650
RT [%]	65.5000	57.5500	61.5250
Bending			
B[$cN\cdot cm^{2/}cm$]	0.0567	0.0995	0.0781
2HB [cN·cm/cm]	0.0136	0.0294	0.0215
Shearing			
G[$cN/(cm^0)^1$]	0.5802	0.6860	0.6331
2HG [cN/cm]	0.4969	0.4949	0.4959
2HG5 [cN/cm]	1.1700	1.3600	1.2650
Surface			
MIU [-]	0.1291	0.1038	0.1164
MMD [-]	0.0241	0.0204	0.0223
SMD [µm]	5.6640	5.9830	5.8235
Compression			
LC [-]	0.3040	-	-
WC [$cN\cdot cm/cm^2$]	0.0920	-	-
RC [%]	62.6291	-	-
Thickness			
T [mm]	0.2900	-	-

Table 3: Mechanical properties of testing fabrics C21YH on KESF

C21YL	***Warp***	***Weft***	***Average***
Tensile			
EM [%]	3.1720	5.8680	4.5200
LT [-]	0.8220	0.7260	0.7740
WT [cN·cm/cm^2]	6.5300	10.6500	8.5900
RT [%]	64.9700	63.2000	64.0850
Bending			
B[cN·cm$^{2/}$cm]	0.0881	0.1056	0.0968
2HB [cN·cm/cm]	0.0257	0.0359	0.0308
Shearing			
G[cN/(cm^0)^1]	0.9178	0.9854	0.9516
2HG [cN/cm]	0.6556	0.6331	0.6443
2HG5 [cN/cm]	2.0100	2.0000	2.0050
Surface			
MIU [-]	0.0932	0.1063	0.0998
MMD [-]	0.0190	0.0224	0.0207
SMD [µm]	5.6420	6.7930	6.2175
Compression			
LC [-]	0.3388	-	-
WC [cN·cm/cm^2]	0.0841	-	-
RC [%]	68.8976	-	-
Thickness			
T [mm]	0.3400	-	-

Comparison of tensile properties of fabrics C21YL and C21YH shows that extension in warp direction is almost the same for both fabrics, while there is a significant difference of extension in weft direction. The fabric C21YL has the weft extension of 8.4%, and the fabric C21YH has 5.9% (fig 1 and 2). So, the introduction of thicker double plied weft yarn affected drop of extensibility and also the tensile energy from 14.4 to 10.6 cN cm/cm^2. On the opposite, tensile resilience (RT) in weft direction increases from 57.5 to 63.2%, while linearity also increases from 0.69 to 0.73.

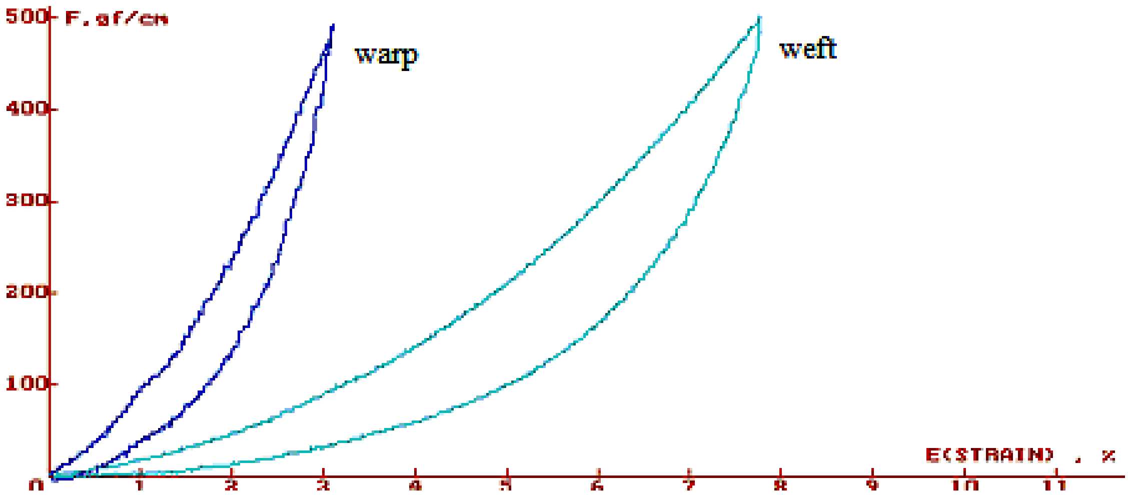


Figure 1: Tensile properties of fabric C21YL, by warp and weft

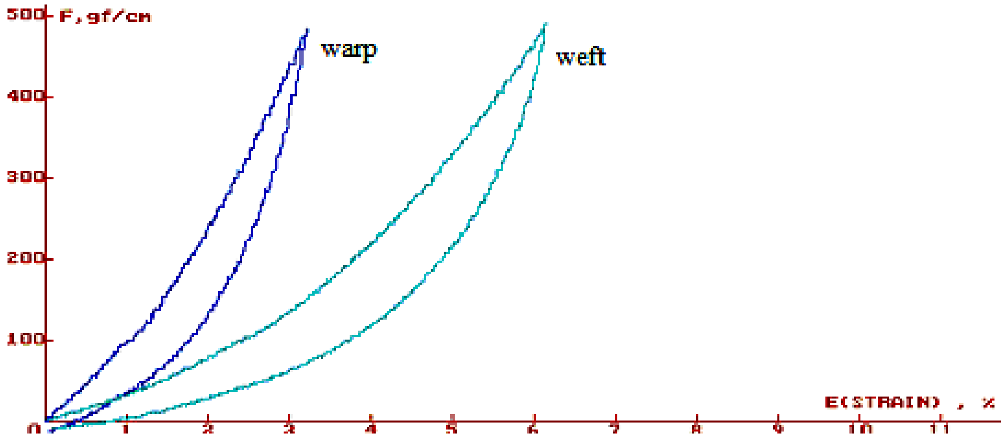


Figure 2: Tensile properties of fabric C21YH, by warp and weft

Regarding bending properties (B, 2HB), we can see that introduction of thicker double played yarn in sample C21YH results in adequate changes in bending stiffness. It is interesting that the more significant change occurs in warp direction. Bending rigidity (B) and hysteresis of bending moment (2HB) increased at sample C21YH for 52% and 88% respectively (table 1 and 2). Although the changes between two fabrics is in weft direction, in this particular direction there is lesser increasing of bending rigidity and hysteresis than in warp direction. Namely, bending rigidity in weft direction increases only 6% and hysteresis 22%. As a result of changes of bending properties in both directions, the sample C21YH obtains higher average bending rigidity 0.0968 cN cm2/cm compared to sample C21YL which have 0.0781 cN cm2/cm (24% increasing) (figure 3 and figure 4). It is interesting that the effect of introduction double ply yarn has greater effect of increasing bending properties in warp direction that in weft direction.

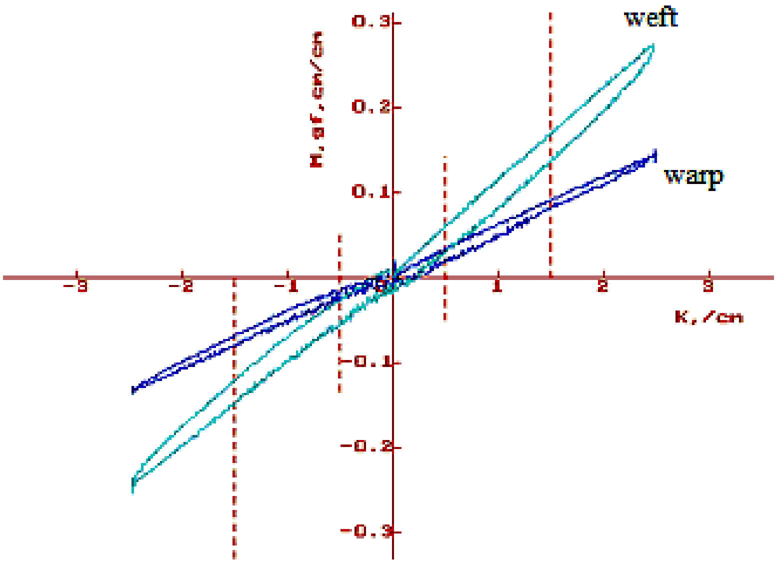


Figure 3: Bending properties of fabric C21YL, by warp and weft

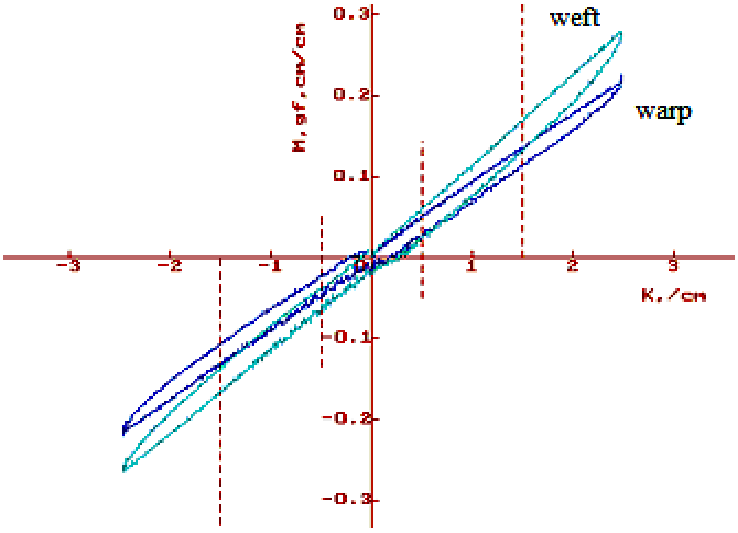


Figure 4: Bending properties of fabric C21YH, by warp and weft

Analysis of the shear properties shows that the fabric C21YH has a significantly higher values of shear stiffness. The sample of single ply weft yarn obtains shear rigidity G of 0.6331 cN/(cm^0)^1 while sample with double ply yarn 0.9516 cN/(cm^0)^1, (table 2 and 3). This means that introduction of double ply yarn of higher count increases shear rigidity for 50%. The same applies to the value of hysteresis of shear force of 0.5º, 2HG and hysteresis of shear force 5º, 2HG5. Increase of hysteresis of shear force 5º by warp is 72% and by weft is 47% (figure 5 and figure 6). The parameters of shear rigidity are important for successful conversion of 2D structures into 3D shapes.

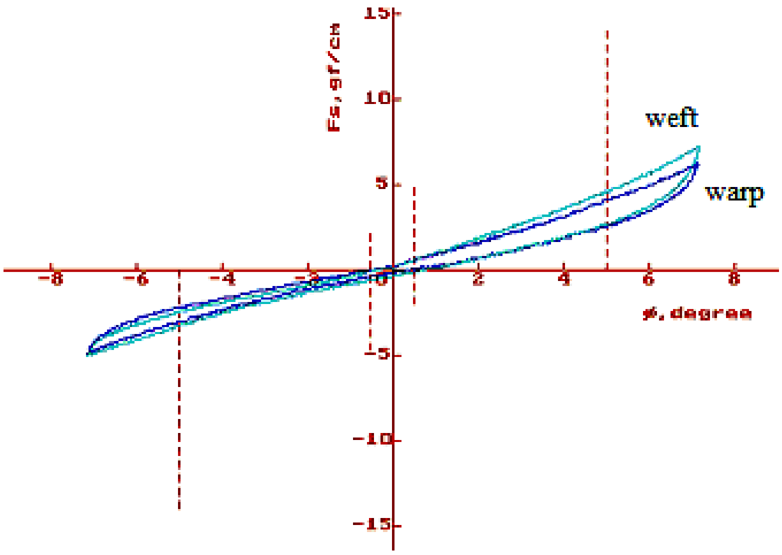


Figure 5: Shear properties of fabric C21YL, by warp and weft

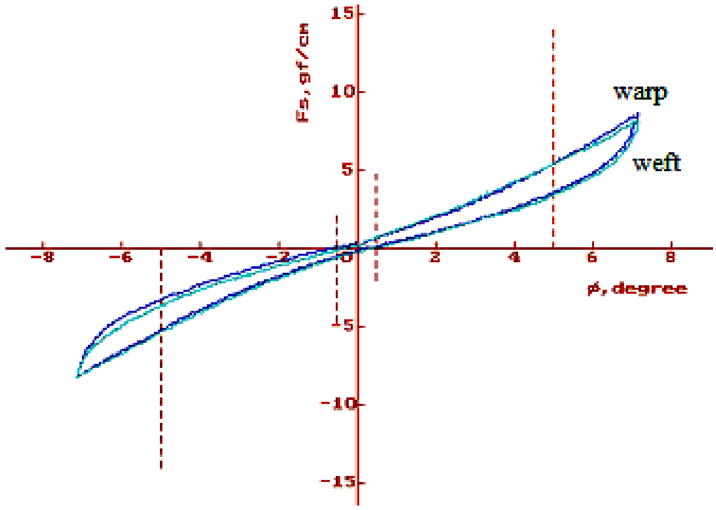
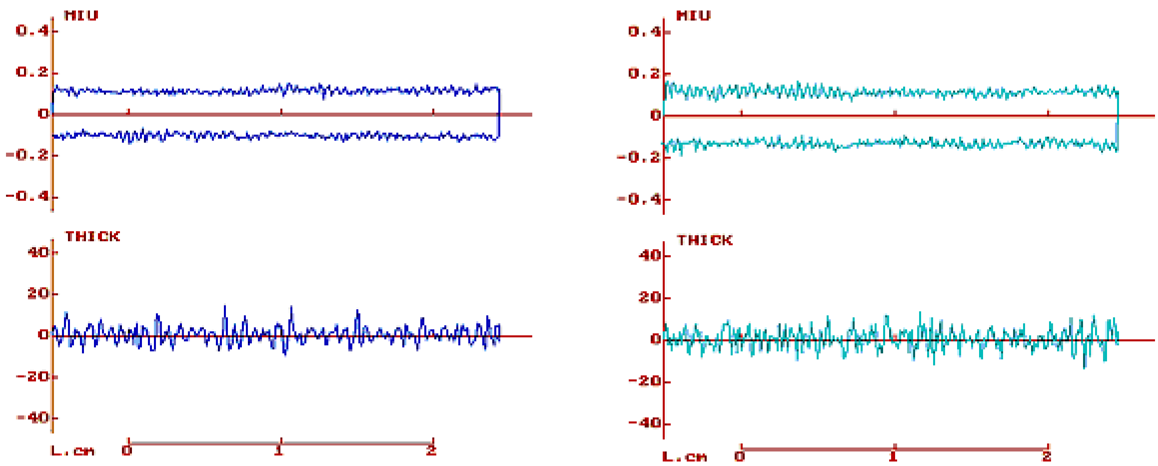


Figure 6: Shear properties of fabric C21YH, by warp and weft

The results of compression properties show that sample C21YH obtains higher compression linearity, lower value of compression energy and higher values of compression resilience. So the introduction of double ply yarn of higher count results in increased linearity of the compression curve and in increased resilience of compression.

Graphs fig. 7 and 8 show coefficient of friction-MIU and geometrical roughness-SMD for samples C21YL and C21YH. The sample C21YH has a lower average coefficient of friction (MIU), lower mean deviation of coefficient of friction MMD, but higher geometrical roughness, SMD (table 2 and 3). The samples have similar values of geometrical roughness in warp direction and different in weft direction. C21YL has geometrical roughness average of 5.98, and fabric C21YH is 6.79. Ti is obvious that introduction of double ply weft yarn resulted in more coarse fabric surface.



a) b)

Figure 7: Coefficient of friction MIU and geometrical roughness SMD in a) warp direction and b) weft direction for fabric C21YL

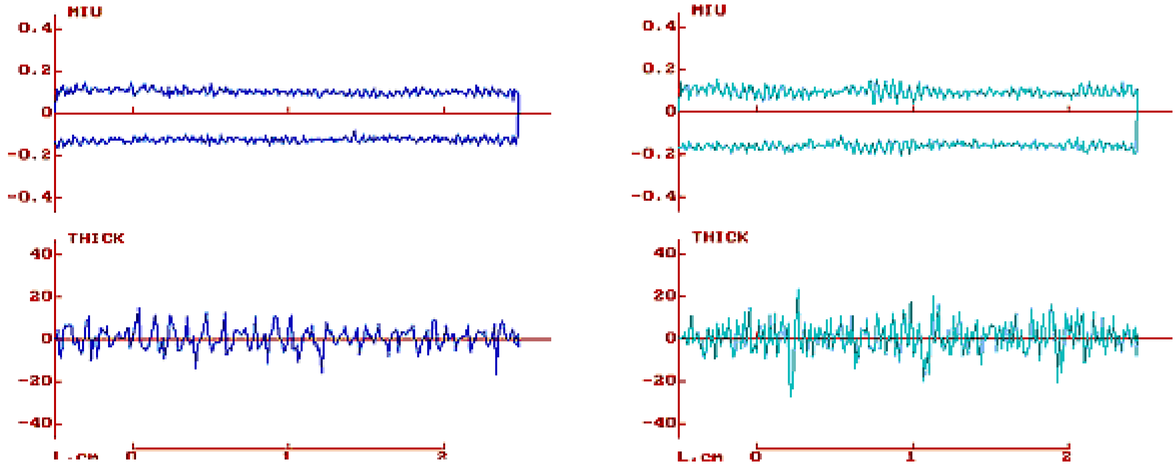


Figure 8: Coefficient of friction MIU and geometrical roughness SMD in a) warp direction and b) weft direction for fabric C21YH

Fig. 9 and 10 represents *tailorability* charts for fabrics C21YL and C21YH respectively. In both fabrics parameter LT is out of the control zone. This particularly applies to the fabric C21YH which has a value of 0774. Higher values of LT mean that both fabrics can expect difficulties in sewing. In fabrics C21YL value EM_1 is out of the control zone with a value of under 3%, which again indicates a problems with sewing when adding allowance. For the fabric C21YH as a result of increased shear stiffness, the parameter G is a little bit out of the control zone again predicting problems when sewing with adding allowance.

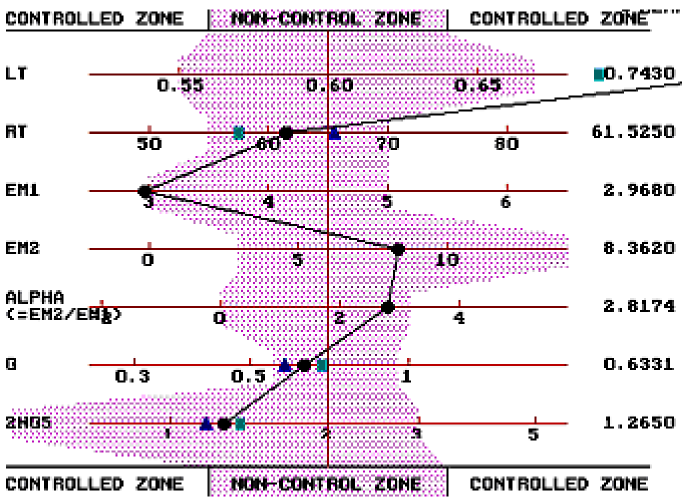


Figure 9: Control chart for inspecting properties of fabric C21YL

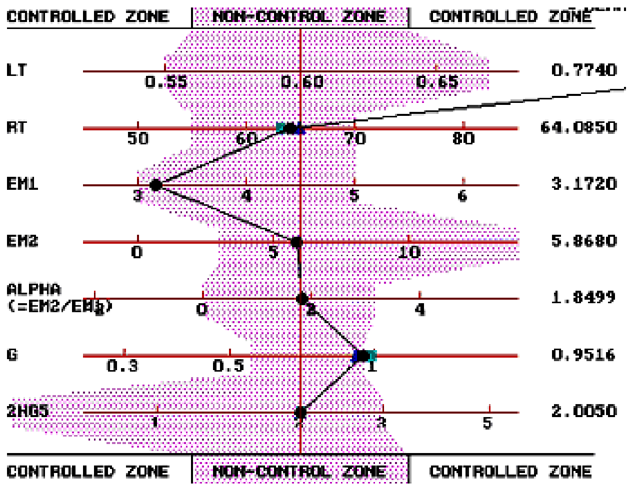


Figure 10: Control chart for inspecting properties of fabric C21YH

4. CONCLUSION

The mechanical properties under low loads and taliorability of 100% wool worsted fabrics were investigated on a KEFS-B system for objective evaluation. The fabrics differ in only one structural parameter, which is the structure and count of the weft yarn. It was obtained that introduction of double ply yarn of higher total count has influence on fabric mechanical properties as well as on tailiorability.

The weft yarn on higher count affected increase of fabric bending stiffness in both directions. However, the increasing of the bending stiffness is much more significant in warp direction. Introduction of double ply yarn increases shear rigidity for 50% as well as hysteresis 5º by warp for 72% and by weft for 47%.

The geometrical roughness of the fabrics was similar in warp direction and different in weft direction. Introduction of double ply weft yarn resulted in more coarse fabric surface.

The mechanical properties of both fabrics fall mostly in safe non control tailorabolity zone. The sample of single ply weft yarn has value EM_1 is out of the control zone which indicates problems with sewing when adding allowance. For the sample of double ply yarn the parameter G is out of the control zone which also indicates sewing problems.

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RESEARCH REGARDING KNITTED STRUCTURES ACCOMPLISHING MEANT FOR ESD PROTECTIVE GARMENTS

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Abstract: *This work presents a new ESD garments accomplishing concept, considering that the existing protection equipments do not solve integrally the problem of accidental electrostatic discharge. Accordingly, starting from the objectives of the research, initially has been established a matrix comprising the available existing types of conductive yarns, the proper knitted structures, various methods of electrical or evaluation, etc. The experiments included different knitted structures made on electronic flatbed knitting machines, using a mixture of conductive yarns. Thus, these knitted panels has been evaluated from electrical point of view.*
Based on the results obtained in the evaluation stage of the electrical insulation efficiency of the test panels, has been considered that the knitted panels made in two layers with different electrostatic behaviour allow to solve problems that cannot be solved by using a single layer. Also, 4 types of conductive yarns (yarns covered with conductive substances and yarns with carbon trilobate core) has been selected for the next step of the research: one for the internal layer and 3 types for external layer.

Key words*: ESD garments, conductive yarns, electrostatic behaviour, knitted structures*

1. INTRODUCTION

The technical evolution in the electronic industry led to increasingly more advanced electronic devices that can fulfil various operations at higher speeds and with a higher precision. This increase in performance triggered an increase of these devices' sensitivity to electromagnetic disturbances. Electrostatic discharges are caused when a sufficiently amount of charge accumulated through different mechanisms (friction, induction or corona charging) [1-3] is suddenly released on a nearby object.

When human operators are met on the production line of devices sensible to electrostatic discharge, a different protection measure is taken into consideration, namely ESD garments, which reduce the risk of an ESD from the operator's normal clothing to the sensitive device. ESD garments on the market don't solve all the problems raised by accidental electrostatic discharges. This is because the fabric, from which the garment is made, must fulfil at the same time two contradictory conditions: high resistivity, to limit the charging process and energy transfer in case of an eventual discharge, and high conductivity, to facilitate the dissipation process of charges, thus limiting the accumulation of charge on the fabric [4]. The protective garments must also have shielding properties, to prevent the electrostatic fields generated under the garment to induce charge to nearby objects [5], and good anti-static properties, so that they won't generate electric charge when making contact with other materials [6].

Presently, the ESD garments are realized of conductive composite textiles by combining conventional textile yarns with the composite conductive ones. The manufacturing technology is similar to the one used for standard clothing, the panels being knitted or woven and their connection made by sewing.

2. THEORY

Starting from the main objectives of the research, which are:
- new solutions for societal problems related to public health and occupational safety;
- high integrated, efficient and complete ESD knitted garments design;

- manufacturing of novel, versatile and multi-sectorial products as ESD protective solutions - complying with EC directives,

initially has been established a matrix comprising the following:

- evaluation of composite conductive yarns available on the market;
- electrical and micromechanical simulations;
- test panels knitting;
- determination of electrical impedance of the test panels at various frequencies;
- thermally Stimulated Discharge Currents (TSDC) measurements;
- evaluation of the electrical insulation efficiency of the knitted test panels;
- analysis of the discharge time of the electrically charged panels;
- investigation of the shielding efficiency of the panels;
- results analysis and interpretation.

The research methodology for developing the final structure is encompassing specialised electromagnetic simulation of conductive yarns in predefined spatial architectures, ESD measurements, and equipment and textile technology design and testing for integral knitting.

3. TEST MATERIALS, METHODS AND FINDINGS

The samples were knitted using the following assortments of yarns:

- yarns covered with conductive substances;
- yarns with carbon trilobate core.

The following knitting structures were chosen for knitting: plain jersey, plated plain jersey, rib, plated rib (Figure 1) or sandwich. The knitting technology has presumed a flatbed knitting machine. Due to the particularities of the conductive yarns that are displaying high stiffness and less elasticity than regular yarns, slow speed during the knitting process was used.

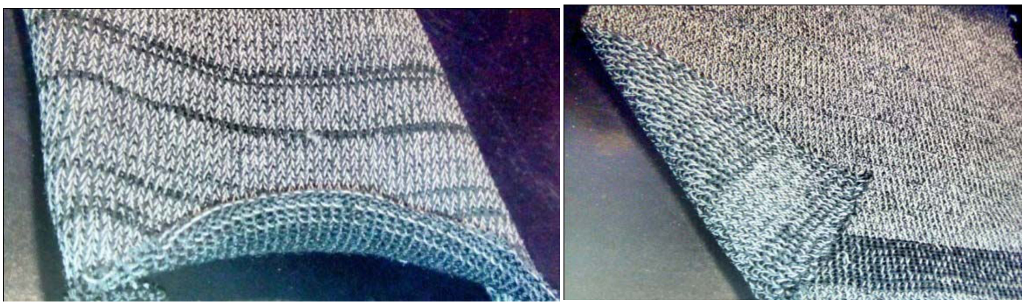

Figure 1 - Plated plain jersey (a) and plated rib (b) structures

To evaluate the samples' ESD properties the following characteristics were analyzed: surface and volume resistivity and charge decay time. Electrical resistivity measurement is important for determining certain properties of insulating materials. It can provide estimates regarding the ability to dissipate accumulated charge on the dielectric's surface or the discharge current's amplitude during an electrostatic discharge. For rezistivity measurements has been used the electrometer Keithley 6417A and the rezistiviity testing chamber Keithley Model 8009, according to the proper ASTM standard.
Charge decay time analysis was made using the testing stand developed within ESDGarm CrossTexNet 7-058 (2012) project. The following parameters has been determined:

- $t_{1/2}$ representing the time after which the 5 kV voltage, at which the samples were initially charged, decreases by half as a result to the discharge stage;
- $t_{1/e}$ representing the time after which the 5 kV voltage, at which the samples were initially charged, decreases to 1/e (37%) as a result to the discharge stage;
- U_{125} representing the voltage recorded at 125 ms after the discharge stage was initiated (residual voltage after 125 ms);

• r_{125} representing the ratio in percentage between U_{125} and the initial 5 kV voltage.
The surface resistivity and charge decay parameters were measured and can be observed in Table 1, for 8 samples. In Figure 2 (a-h) the discharge signals for the tested samples can be observed. A good ESD garment must fulfil at the same time two contradictory requirements:
• high resistivity/resistance to prevent fast dissipation (electrostatic discharge) and limit the energy transfer during a discharge;
• high conductivity/conductance (low resistivity) to facilitate the dissipation of charge and to avoid charge accumulation.

Table 1 – Resistivity and charge decay figures

Sample no.	Type of yarn	t1/2 [s]	t1/e [s]	U125 [V]	r_{125} [%]	Resistivity of the conductive textile layer [Ω]
1.	Cotton fibres (75%) + Epitropic fibres (25% - polyester covered with Carbon)	0.0224	0.0325	40	0.8	$< 2 \times 10^5$
2.	Polyester filament with trilobate Carbon core	0.0348	0.0536	960	19.2	2.8×10^8
3.	Polyester filament with internal trilobate Carbon core	0.0651	-	2040	40.8	7.82×10^{11}
4.	Nylon filaments superficially saturated with Carbon particles	0.0386	0.0643	1320	25.98	5.11×10^{11}
5.	Polyester (65%) and cotton (35%) yarns + nylon filaments with trilobate Carbon core	0.0384	0.0575	960	19.05	3.1×10^9
6.	Polyester filaments + nylon filaments covered with Carbon	0.0886	-	2280	45.97	8.1×10^{11}
7.	Polyester (64.4%) + cotton (35%) + nylon fibres with Carbon core (0.6%)	-	-	3880	79.51	4.7×10^{11}
8.	Polyester covered with bamboo charcoal	-	-	4920	98.4	9.5×10^{11}

4. DISCUSSION

As it can be observed in Table 1, the sample no. 8, although has fibres coated with bamboo charcoal which were believed to be electrical conductive in some extent, presents the highest resistivity value. The next samples in a descending order of the resistivity are: sample 6, 3, 4, 7, 5, 2 and 1. As expected, high values of resistivity present the samples with core conductive fibres.
Taking into account ability to dissipate the charge, represented by the charge decay times, the best results are shown by the first sample. It is followed at a short distance by samples 2, 5 and 4 with similar values.

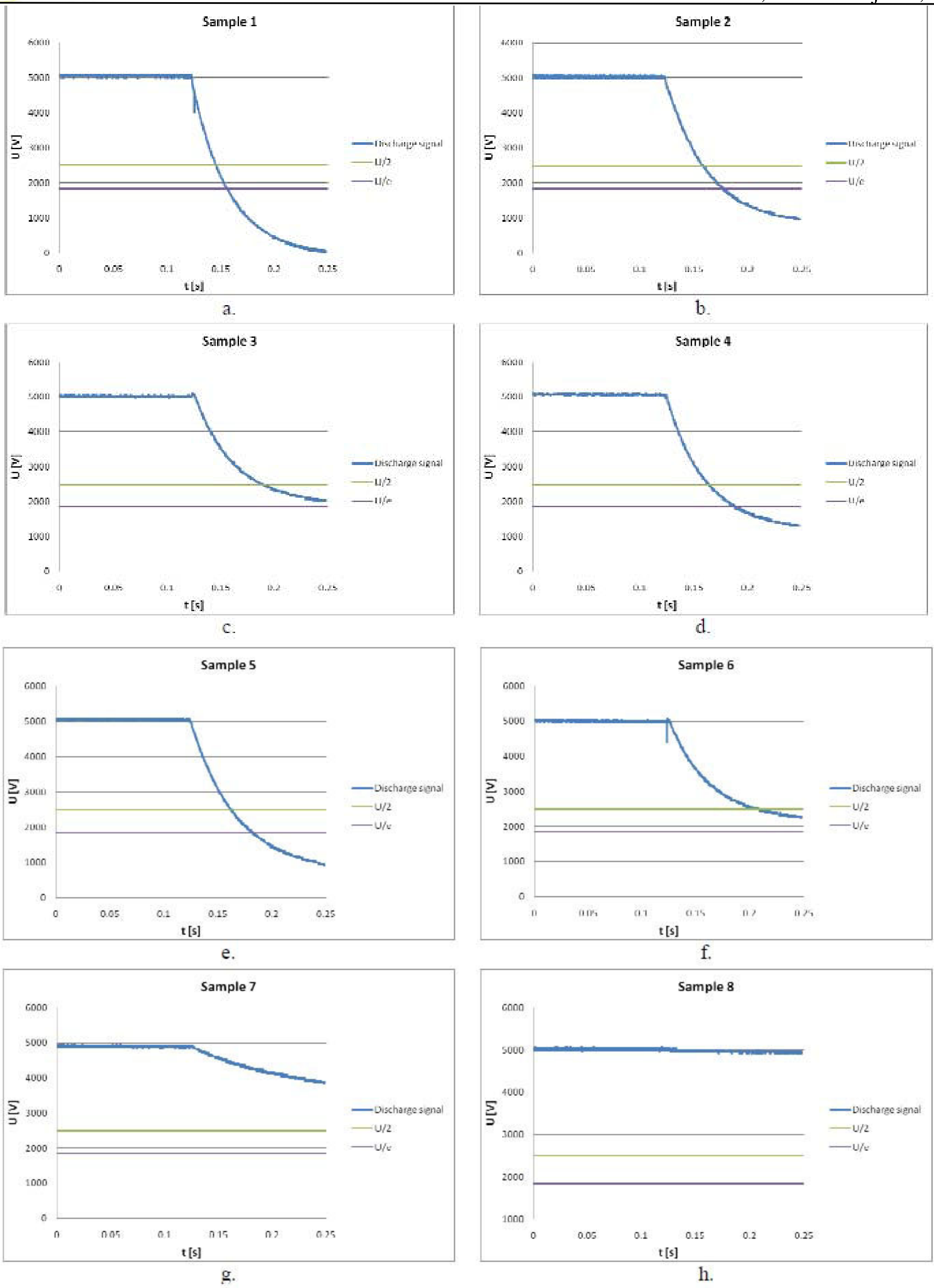

Figure 2 - Discharge signals for the tested samples

Out of these two with core conductive fibres and one with surface conductive fibres can be observed. In the case of the surface conductive fibre the short time was expected, while in the core conductive fibres it was due to the fact that the core reaches to the surface of the fibre, which facilitates the dissipation of charge.These samples are followed at a larger distance by samples 3 and 6. These samples have higher times given to the fact that one contains fibres with buried conductive core (sample 3) and the other one has a small percentage of carbon coated filaments. The last 2 samples don't present a charge decay times because, as it can be seen in Figure 2 (g-h), they have a reduced capacity to dissipate the charge. For the seventh sample a slight dissipation of charge can be observed, due to the carbon coated filaments, but not that great because of the small 0.6 percentage of conductive fibre. The eighth sample, as seen in the resistivity column, it doesn't have good conductive properties, thus it can't dissipate the charge in a timely manner. Analysing the column with the voltage values obtained after 125 ms, it can be observed a correspondence with the *t*1/2 time.

5. CONCLUSIONS

Within this paper, eight samples with carbon based fibres were analysed for their ESD properties. Surface resistivity and charge decay time were measured and analysed to detect which sample are presented better in terms of ESD protection. These must have at the same time a high resistivity and good charge dissipation ability.

Based on the results of the measurements for the samples, the most appropriate to be used in ESD applications were identified and proposed for a two-layer structure. This structure must have an external layer with high electrical resistivity, to reduce the risk of an electrostatic discharge, and an internal layer with high conductivity, to quickly dissipate the charge accumulated on the first layer.
The configuration for these two layers will be following (for future research):
• internal layer: sample 1 (best charge dissipation properties)
• external layer: sample 2, 4 and 5 (good charge dissipation properties and high surface resistivity).

ACKNOWLEDGEMENT

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3D IN APPAREL DESIGN: A REVOLUTION IN THE INDUSTRY

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Abstract: *Three decades ago, three-dimensional (3D) technology use in the fashion industry was limited to a few adventurous manufacturers and was largely dismissed by the apparel sector. Today, pressure in the apparel market to produce more collections under shorter lead times has led to a veritable 3D revolution affecting the industry as a whole. Cost reduction, enhanced creativity, and improved communication are only the beginning of what 3D technology has to offer this complex and dynamic market.*

Key words*: 3D technology, apparel, design*

1. A SLOW START

By 1990, 3D design technology was commonly used in aeronautics, furniture, and many other industries—but still not in fashion. The number of apparel companies willing to experiment with 3D fashion technology were few. In addition, because of the complexity of the original 3D programs, fashion designers who found the technology too difficult resisted adopting it. Only in the last decade has 3D technology made its revolution and gained acceptance as both a design and a merchandising tool in the apparel industry. It is now recognized for its effectiveness in streamlining product development and is applied throughout the supply chain.

2. 3D TECHNOLOGY EVOLVES

Initially, 3D technology was used only to visualize styles. With the early systems, designs viewed on an avatar had little correlation to the actual fit of a model. The technology was simply not advanced enough to be used to check the fit of a garment. Now, however, improved 3D technology includes tools that respond to the specific fit challenges encountered by fashion companies worldwide. This technology is not only economically advantageous, but it can also be a priceless competitive advantage in a fashion environment. Advances in computer speed and performance over the past thirty years have made digital communication much more practical.

3D technology has benefited from these developments in three main aspects:

•Computer power
Initially, 3D design required very powerful supercomputers, such as Cray, Sun, and similar systems. Today's laptops are as fast as or faster and have more storage. Furthermore, the cost per station is a fraction of the investment made in earlier models. In addition, greater power coupled with advances in software techniques allows designers to create life-like avatars with fabric draping.

•Graphic technology
Pixelization in early 3D technology resulted in jagged line quality and drawings that simply did not look clean. With today's vector-based technology, drawings are even clearer than the artists' hand sketches.

•Ease of use
Early 3D technology was designed for engineers and scientists. When applications were first developed for the apparel and footwear industries, the users were designers and merchandisers. These are the "artists" of the industry, and they felt the technology drained their creativity. It had to become easier to use. In fashion, trends change quickly and time is essential; 3D applications for apparel have consequently been greatly simplified, without sacrificing power. Today, users can begin creating within days or even hours.

3. APPLYING TECHNOLOGY

One of the major challenges for any fashion company is ensuring that the fit of a garment is as close as possible to its target customer. In most cases, this implies providing a sample, which means patterns need to be made, fabric cut, pieces sewn together, and products then shipped to the client for a fit session. Some retailers and brands still fly human fit models to Asia or other contractor locations for on-site fit sessions. This is an expensive and lengthy process, which may require several iterations before the garment is fit-approved or eventually rejected from the line. 3D technology at the design stage can help reduce cost and time-to-market, contributing to a more efficient and profitable process by reducing the number of samples required and their associated costs.

3.1. Making prototyping cost-effective

How often a company introduces new styles is an important cost factor in development and manufacturing. Some fashion companies have an adoption rate as low as 25%. A single prototype can cost anywhere from $250 to $1,000— and much more when design and development costs are factored in. One fashion company in Germany studied the average cost of dropped styles and reported that each rejection cost more than €1,200. So eliminating the need for thousands of physical prototypes per year and the related shipping charges adds up to very significant savings. Since companies can now decide whether or not to take a product to market using 3D technology without a physical prototype, or fewer prototypes, the cost of rejecting a style (in terms of material, labor, and time) is significantly lowered.

3.2. Fabric

Until recently it has proven very difficult to predict fabric properties accurately and to view the effect of fabric on the body. Today, textile manufacturers test fabrics to gather their physical attributes, such as the bending of the fabric due to its own weight, the friction of the cloth against the body, and stretch in the x and y directions. Shading, transparency, and sheerness of fabrics, and the ability to import trims into the application, also add to the realism of garment simulation. In addition, it is necessary to be able to see the pressure points or stress points where the fabric might be too tight against the body. This information allows a much more realistic drape during the rendering of the finished garment. The subtle differences in various fabrics are immediately apparent and designers can even test new textiles still under development. This facilitates and accelerates the decision-making process, even before a garment sample is manufactured or a strike-off or handloom produced.

3.3. Better pattern modeling

The most advanced 3D applications available today combine patterns with particular fabric properties and stitching lines to simulate how the fabric will fall or drape. 3D body scanning machines take all the millions of points of a company's fit model to create an avatar of the same body, which can then be used to accurately predict the ease and tightness of a garment. The user can then adjust the pattern pieces in the 2D pattern-making application and view them in the 3D application to re-simulate and once again check the fit. These rough modifications are easily transferred to paper patterns for fine-tuning. In the past, work done on paper patterns required a multitude of tedious manual adjustments. Fit-checking was a very time-consuming task that would have taken hours, or even days. Today's 3D applications include automatic functions specifically designed to reduce repetitive tasks and allow trained technical designers to adjust patterns in a matter of minutes.

Figure 1. An avatar showing garment print design in Lectra's 3D apparel prototyping software

3.4. One size doesn't fit all

Virtual fit checking has proven to be an efficient way of improving fit quality across the board. Some forward thinking companies are going a step further by checking the fit of complete size sets virtually. Companies rarely have the time and resources to physically check all the different sizes of a garment during the product development process, and so they frequently skip this important step. Without 3D technology, they often simply check a pattern in a basic size and sometimes in the smallest and largest sizes. This does not always translate into good fit across the board. Checking patterns in all sizes is crucial, as it has a direct bearing on the fit and quality of the garment, and consequently the consumer's perception of the brand. This is especially true for childrenswear, as patterns usually have to be altered in the smallest sizes by adding or removing pieces to accommodate the different morphologies of each age group. Designers in all markets, whether childrenswear, menswear, womenswear, sportswear, or any other kind of apparel, are under the same pressure to produce high-quality products in a limited amount of time. 3D technology offers a realistic, easily accessible solution to the historically arduous task of full-sizerange fit checking.

3.5. Bridging the gap between design and development

Improved communication between internal and external merchandising, design, technical design, sourcing, vendors, and customers can significantly reduce overall product development time. Many designers are now comfortable enough with 3D apparel technology to make quick design decisions on how a garment looks in different colors, with different sizes of motifs and logos, and in different fabrics. This technology allows the designer to communicate changes quickly to the pattern maker and see the results within hours, instead of days or weeks.

Figure 2. An avatar showing pattern construction control in Lectra's 3D apparel prototyping software

In turn, the ability to produce close to the market instead of having to plan far in advance allows companies to avoid getting locked into poor designs or create illfitting garments. In the same way, today's 3D applications can be used to create virtual lines or ranges of garments for review and discussion over the Internet by design teams across the globe.

3.6. Increased speed-to-market, increased profits

In the quest for an ever-shorter product development cycle, "speed-to-market" is key. Within a lengthy product development process, it is difficult for companies to "chase" fast-selling items with updated variants and complementary items. However, with 3D technology, companies can tweak their designs and approve them digitally, with minimal sample making. This gets the designs into the stores much faster than in the past, enabling companies to capture continuing sales.

3.7. The green dimension

3D fit technology combined with computer-aided design (CAD) pattern-making may also significantly reduce a company's carbon footprint. With some companies checking the complete size range of a garment virtually, fewer prototypes have to be cut and sewn. Reducing the millions of prototypes companies manufacture to check fit, color, and the overall look of a garment reduces the energy used for shipping and transport as well as the amount of chemicals used for preparing, washing, dying, and treating fabric, and results in less waste from each operation in that process.

4. 3D:THE APPAREL MARKET'S BEST STRATEGIC ADVANTAGE

Today's fashion 3D technology has surpassed expectations, becoming easier to use and learn and adapting completely to the specificities of designing apparel. Getting the right design with the perfect fit to market on time is now more crucial than ever. Development costs are increasing, shipping charges are going up, and mistakes are something that most companies cannot afford. Products have to get to market faster, and they must be products that will sell. With that in mind, regular use of 3D technology in the apparel market is an essential competitive advantage for retailers, brands, and manufacturers alike.

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www.**lectra**.com/

A STATISTICAL MODEL FOR DEVELOPING BODY SIZE CHARTS FOR WOMEN'S GARMENT

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Abstract: *This essay overviews the results of measuring of the key body dimensions of female population between the age of 28 and 40. By using the method of regressive and correlational analysis, the analysis of main components and proportional interval between sizes, the proposal of a size chart has been made for the examined female population.*

Key words: *size charts, custom-sizing standards, modified standards, main measurements, measurements relation*

1. INTRODUCTION

The problem of sizes and human body proportions raised interest throughout the history. For centuries, people tried to find correlations that would correctly describe the size and proportions of different body parts, for example relating to age. This was connected to the use of anthropometric techniques. According to this data, the dimensions of human body were created, as a basis for creating and designing clothes. For garments, that are most closely connected to anthropometric dimensions, it is necessary to define data for dimensions that would determine their sizes.

In the second half of the last century, the proportions and shapes of female bodies have drastically changed. People are not only taller, but their body proportions have changed, creating a problem in clothes fitting. More and more women are having difficulties in finding the optimal garment sizes while shopping for clothes. Changes in female bodies are mainly consequences of a healthier life style, nutrition and diet, medical care, demographic changes, etc. For this reason, the data that was used for creating current standards has become obsolete and unrepresentative, so many confection industries choose to modify them and create their own size charts with dimensions based on their target customers. Hudson and McVery (1,2) are pointing out that most companies don't have a systematic approach to developing size charts or determining garment size intervals.
Given the evident changes in body dimensions and shapes that are noticeable in today's generations, it is necessary to redesign current standards.

Focus of this essay is to highlight the changes in body dimensions of the target group of female population. The need for this research comes also from JUS (Yugoslav standard) which is used by the current MKS (Macedonian standard) being outdated, because the data based on the anthropometric measuring was obtained during seventies of the last century in Vojvodina, which is making difficulties for textile confection production. For winning the market, data on demographic structure of population is needed, since each area has specific characteristics in body types and anatomy.
In this essay the methodology for developing a size chart system is shown, following several subsequent phases.

2. GARMENT CHART SYSTEM

System of garment sizes presents the basis for determining of correct sizes and fitting for the consumers (3). Dimensions measured on specific parts of the body determine sizes of clothes, so the clothes fit perfectly the person with similar body dimensions. (4). Sizing system classifies specific population in homogenous sub-groups based on the key dimensions of the body (5). Members of those sub-groups are similar to each other in sizes and body types. The fitting of clothes depends on relations between garment dimensions and measures of the human body. For creating confection

garments, it is very important that shapes and dimensions of clothes fit perfectly to different body types.
Main factors that determine the sizing system and accordingly the fitting are body dimensions of the population, design characteristics (clothes construction), and fitting characteristics (fitting quality management), as well as correlation between sizes and fitting (marking of the sizes).
Body type and shape is the factor that affects all other components in one way or another. Body measurements measured in specific way are facilitating the classification of body types and are an exact reflection of the three-dimensional garment characteristics. Clothes design depends on body shape (three-dimensional characteristics), which has to be defined in order to create a pattern for good fitting clothes. Evaluation of clothes fitting (fitting quality management) has to be precisely defined with relating methods of analysis and modeled according to body types of targeted population. Measurements and body types determine the marking of sizes.

The basis for developing a sizing system is anthropometric data for dimensions of certain body parts. Using of unified methodology for dimension measurements and strict following of measurement techniques is extremely important.

Types of body shapes given in anthropometric standards are grouped according to body height and build. These standards show the values of characteristic dimensions and their variations in certain groups. Population classification into homogenous groups according to body size and shape is a complex problem, because there is a great variation in dimension and proportion of certain body parts.
In the last decade, there is a great number of research papers on developing of size charts (6). Different methods have been applied for classification and separation of population into groups according to body shape and size. Gupta & Gangadhar, Veicht (7, 8) have used the analysis of main components for identifying the key measures of the body, and according to it they classified the population into groups of certain body shapes, while Chung and others developed the system of sizes by using two-stage cluster analysis. Salusso and others (9) used the method of main components (principal components analysis). They concluded that this methodology is mathematically capable of classifying 95% of target population. Hsu and Wang (10) have applied the tree technique for determining the sizes of military pants. Hsu suggests the relation of bust width and waist width for identifying the female body shape. By using the factual analysis, waist girth for width measures and body height for length measures have been determined as having the highest correlation to other measurements and their ratio (height – waist girth) has been transformed to a target variable in the tree method and in cluster analysis. Population has been divided into three groups (small, medium, large) having significant difference in waist girth, hips and height.

By using the method of multiple dimensions (11), such as system based on relation between height and weight, the creating of body size chart is determined by several body measurements. The main example of this system is the pants sizing system, and it is feasible because the elastic materials frequently used today for making of pants can be adjusted to different body types. Also, because the elastic materials allow for the interval between sizes to be bigger and in this way, only few sizes can accommodate a large circle of customers. This system is not adjusted for complicated patterns or styles. This is why the method of multiple measures is used more rarely than the methods based on proportional order of sizes and main component analysis.

The biggest number of sizing systems used today is based on the ‘ideal’ western figure with ideal body proportions. Current and fresh data on dimensions that characterize specific body parts are vital for every state in order to minimize the problem of fitting of garments. Usually, the body height and the difference between hip girth and waist girth are the two main characteristics in defining the body type.
Hohenstein Institute (Germany) takes chest girth as the main measurement, based on which they revise other size dimensions. Virtual human bodies are classified into groups (clusters) based on chest girth. Simmons and Istook (12) identified 16 body measurements form experts and from the literature, that they consider being critical in constructing basic clothes patterns.

Linear structure is used the most in applied sizing systems. Most often, one width measure can be chosen for predicting other width measures. When one measure has been determined as a basic sizing measurement, other sizes are determined by addition or deduction with increment, and this process is called grading. This way we can get series of proportional fixed increments between sizes. Proportional arranging of sizes comes from the fact that the interval between sizes is created based on the proportional grading of the general size or model (9). This system has the advantage of easy grading and size marking. But, its disadvantage is in the fact that structural limitations of the created system can result in lesser fitting quality.
There are many techniques for determining body shapes and taking of measurements, from manual measuring with sewing meter, anthropometric measuring, newest non-contact technology of body 3D scanning, to the computer software, for example FFIT for Apparel software – Visual Basic Pro version 6. This enables classification of people in one of 9 body types, by only using six body measurements (chest girth, waist girth, hip girth, and upper hip girth (10cm under the waist), stomach and abdomen girth.

3. EXPERIMENTAL WORK

This essay examines the female population between the age of 28 and 40, because of their clothes shopping capabilities, being mostly employed which demands looking smart and having good fitting clothes.
Anthropometric research has been conducted by measuring the main dimensions needed for construction of confection garments. Research has been done on the sample of 100 women. With the lack of modern measuring equipment, measuring has been done within the accuracy of 1mm on persons wearing only underwear, on the specific body areas defined according to ISO MKS.
Using regression analysis, key body dimensions are determined, and these dimensions are the most critical for functioning and fitting of clothes, and at the same time they statistically correlate with other dimensions important for clothes sizes. Value of these other dimensions is obtained by using regression analysis by applying adequate body measurements as an independent variable. Inputting key dimensions into coordinate diagram defines conventional sizes within those two dimensions. This system is different from the proportional system of clothes sizes.

4. RESULTS AND DISCUSSION

4.1. Division of basic measurements dimensions

Based on obtained data taken from recording the female population, the mean value and variation coefficient of the basic measurements needed for construction of clothes has been calculated (table 1). Waist girth determines body type, and hips girth is the important measurement for size and fitting, especially for lower body. Upper hip girth (10 cm below waistline) is the measurement that enables better shaping of the curve from waistline to hipline, which provides a good fitting of clothes, especially pants and skirts, while the upper arm girth is an important measure for sleeve construction.

Table 1 – mean value and coefficient of variation of determined size values

Measurement	Mean value (cm)	Maximal value (cm)	Minimal value (cm)	Variation coefficient , Cv(%)	5 % percentile	95 % percentile
Body height Bh	166,2	152,0	180,0	3,9	156,0	176,0
Bust girth Bg	91,96	78,0	114,0	8,6	80,0	106,0
Waist girth Wg	76,5	62,0	103,0	9,5	66,0	93,0
Upper waist girth Uwg	95,2	84,0	119,0	8,9	85,0	112,0
Hip girth Hg	100,2	85,0	120,0	8,1	88,0	115,0
Upper arm girth Uag	28,6	22,0	35,0	11,4	23,0	32,0

Examined group of female population has an average height of 166, 2 cm, or 55% of females has a high of 160 to 170cm. If compared to current MKS standard, this group fits to medium and high women. Bust girth is from 80 to 106cm, with the average value of 91, 9 cm. Mostly the value is between 80 and 100 cm (80%) which is in accordance with the current MKS standard for sizes between 36-44.

Biggest percent (70%) of examined women has waist girth from 60 to 80 cm, which according to standard fits in sizes from 36-46 for slim physique. Division leans to lower values from the average. Biggest percent (80%) has a hip girth from 80,0 to 100,0 cm.

4.2. Creating a sizing system for the examined group of female population

Creating of sizing system has been done in this order:

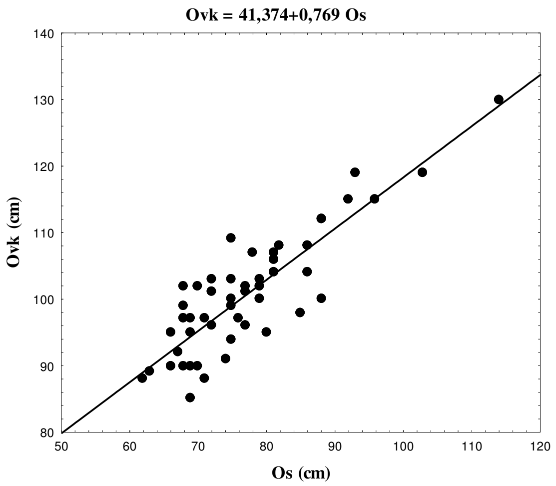
1. Determining body type
2. Choosing the main measurement
3. Choosing the interval between main measurements
4. Comparing the current standard with the obtained results
5. Proposing a redesigned system of sizes for female population.

- Determining body type

First step in creating a sizing chart is determining the body type of the examined group. Based on determined regression equation between hip girth and waist girth (figure 1a), the two measures considered main measures in current standard, or:

$$Hg = 41,374 + 0,769\ Wg \qquad (1)$$

t
he value of hip girth is determined, taking the waist girth value according to existing standard depending on body type (slim, normal and fuller) (table 2).



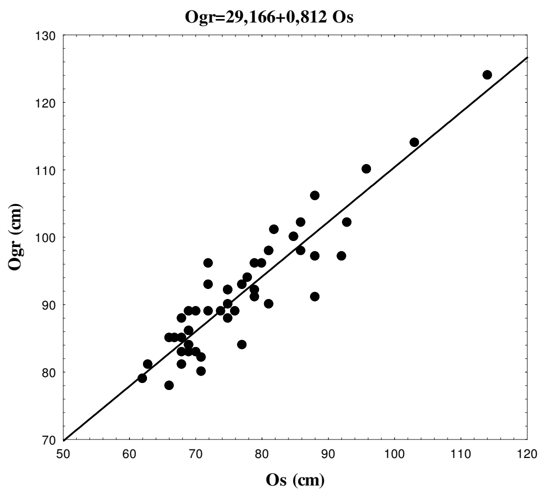


Figure 1. Relation between waist girth (Os) and a) hip girth (Ovk) b) bust girth (Ogr)

Table 2 – Calculated values of hip girth using regression equation (1) for waist girth values for slim, normal and fuller figure according to current standard

Size		Waist girth according to MKS (cm)	Calculated hip girth (cm	Hip girth according to MKS for	
Slim figure	Normal figure			Slim figure	Normal figure
7-36	-	60		88	-
7-38	36	62	89,05	90	92
7-40	38	66	92,13	94	96
7-42	40	70	95,20	98	100
7-44	42	74	98,28	102	104
-	44	78	101,36	-	108
7-46	-	80	102,90	106	-
-	-	82	104,43	-	-
-	46	84	105,97	-	112
7-48	-	86	107,51	110	-
-	48	90	110,58	-	116
7-50	-	92	112,12	116	-
-	50	96	115,20	-	122
-	-	98	116,74	-	-
-	52	104	121,35		128
-	-	106	122,89		-
-	54	112	127,50		134

Based on determined regression equation between bust girth and waist girth (figure 1b), or:
Bg = 29,166 + 0,812 Wg (2)
the value of bust girth is calculated taking the values for waist girth according to current standard, grouped based on body type (slim, normal and fuller figure) (table 3).

Table 3 – Calculated values of bust girth using the regression equation (2) for waist girth values for slim, normal and fuller figure according to existing standard

Size		Waist girth according to MKS (cm)	Calculated bust girth (cm)	Bust girth according to MKS (cm) for	
Slim figure	Normal figure			Slim figure	Normal figure
7-36		60	77,91	84	
7-38	36	62	79,53	88	84
7-40	38	66	82,78	92	88
7-42	40	70	86,02	96	92
7-44	42	74	89,28	100	96
-	44	78	92,53	-	100
7-46	-	80	94,15	104	-
-	-	82	95,78	-	-
-	46	84	97,41	-	104
7-48	-	86	99,03	110	-
7-	48	90	102,30	-	110
7-50	-	92	103,98	116	-
-	50	96	107,15	-	116
-	-	98	108,88	-	-
-	52	104	113,65	-	122
-	-	106	115,27	-	-
-	54	112	120,15	-	128

From tables 3 and 4 we can learn that obtained values for hip girth are closer to values for slim figure, while bust girth values are closer to fuller figure values. It can be concluded that the examined group of female population fits in different type according to figure. By using the regression and correlation analysis, the dependence between other measures has been determined (Figure 2 and 3). Dependence between these measures is statistically important. by increasing the waist girth, hip girth is increased as well as bust girth, upper hip girth and upper arm girth.

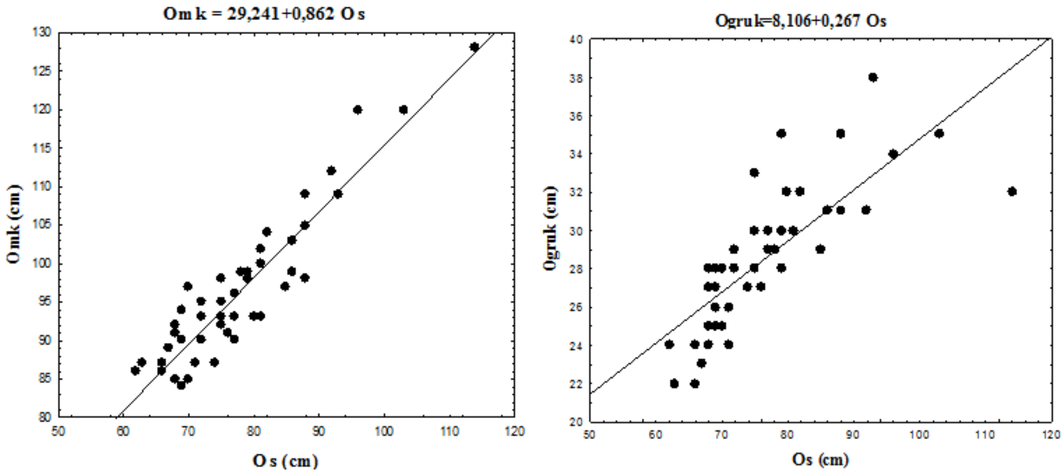


Figure 2. Dependence between waist girth (Os) and a) upper hip girth (Omk), d) upper arm girth (Ogruk)

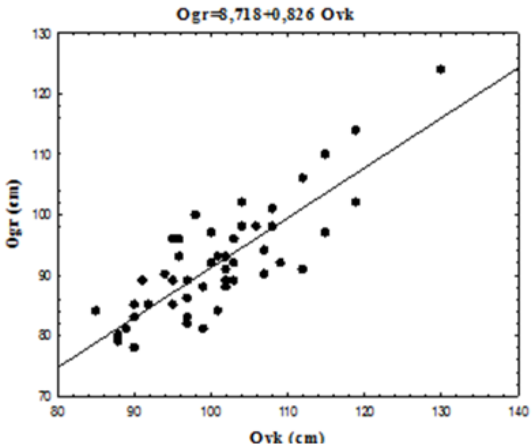


Figure 3. Dependence between a) hip girth (Os) and bust girth (Ogr)

- Choosing the main measurement

Next step is determining or choosing one measurement that can successfully be used for predicting other measurements and it represents the basis for developing of a standard sizing chart.
Three main measurements are chosen, used also in MK standard, and those are: bust girth, waist girth and hip girth, and according to these, the effectiveness of predicting other measurements is evaluated, such as upper hip girth and upper arm girth. By using correlation analysis, correlation coefficients are determined between measurements (Table 4).

Table 4. Correlation coefficients between main measurements

Measurement	Bust girth	Waist girth	Hip girth
Bust girth	1,0	0,916	0,829
Waist girth	0,916	1,0	0,864
Hip girth	0,829	0,864	1,0
Upper hip girth	0,889	0,922	0,922
Upper arm girth	0,791	0,781	0,741
Summary □rxy	**3,425**	**3,483**	**3,356**

The choice of the main measurement is made from the analysis of the main components, according to which the summary value of the correlation coefficient between main sizes is determined. In this case, the sum value of the coefficients is greatest for waist girth. Consequently, waist girth becomes the main component, or the best standard used to determine the dimensions of other sizes.
Waist girth is a very important measure for constructing both upper and lower body clothes. Standards created according to bust girth as the main component are mostly used for upper body clothes, and standards based on hip girth are used for lower body clothes. Waist girth is suitable for both upper and

lower body clothes. On the other hand, small inconsistencies in upper arm girth and thigh girth are not as problematic for good fitting, as previously mentioned measures are. For this reason, in this case the waist girth is used as the best standard for other measurements.

- Choosing the sizing intervals

After determining the main components, the next step is defining of the intervals between sizes, and accordingly, the number of sizes for targeted customer groups. For creating a modified standard for this group, the proportional interval between hip girth sizes between 88,0 and 128,0cm is used.

- Creating a modified sizing system

In table 6 calculated width measurements values based on regression equations are shown, for the chosen interval between sizes for related hip girth value.

Size	Waist girth Wg (cm)	Hip girth Hg (cm)	Bust girth Bg (cm)	Upper hip girth Uhg (cm)	Upper arm girth Uag (cm)
0-36	62	89,05	79,53	82,7	24,7
0-38	66	92,13	82,78	86,1	25,7
0-40	70	95,20	86,02	89,6	26,8
0-42	74	98,28	89,28	93,0	27,9
0-44	80	102,90	94,15	98,2	29,5
0-46	86	107,51	99,03	103,4	31,1
0-48	92	112,12	103,98	108,5	32,7
0-50	98	116,74	108,88	113,7	34,3
0-52	106	122,89	115,27	120,6	36,4

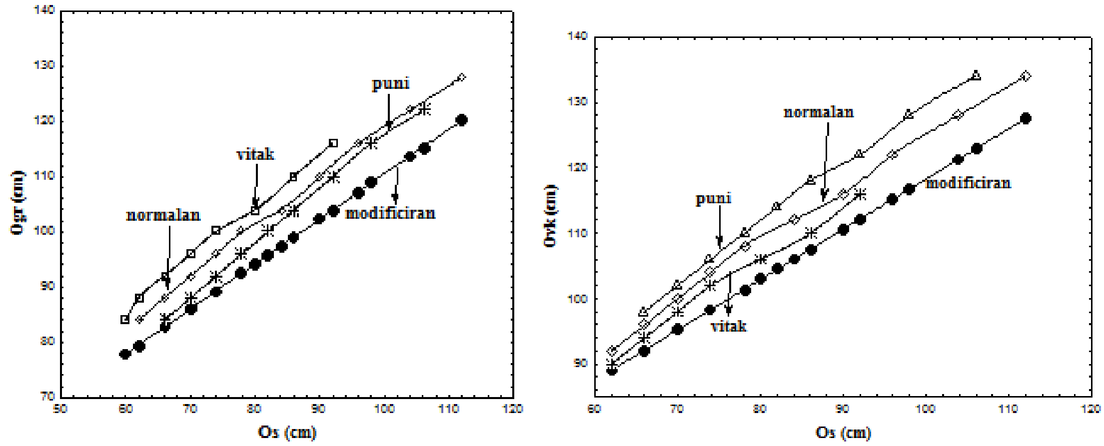


Figure 4. Comparing dimensions of a) hip girth (Ovk) and b) bust girth (Ogr) relating to given values of waist girth according to MK standard for modified dimensions for slim, normal and fuller figure

Obtained values for width measurements relating to waist girth are compared to bust and hip girth dimensions given in MKS for slim, normal and fuller figure for medium height (figure 4).
It can be concluded that the hip girth value is much smaller than given dimensions in MKS for slim figure, and bust girth is smaller than the dimensions given for fuller figure.

5. CONCLUSION

Suggested standard is created based on waist girth as the main component. Regression analysis is then used to predict other measures included in standard. Suggested standard has nine sizes accommodating the interval for waist girth from 62 to 106 cm. Analysis of the effectiveness of the proposed standard for fitting of clothes for the target consumer group relating to current standard has shown good results. For each specific area (bust girth, waist girth and hip girth) included in current standard, the proposed standard gives better fitting results for a larger percent of the population than a current standard.

Methodology used in this paper can be applied in the analysis of different target groups of confection garment consumers, in order to find the best way of clothes fitting for different population groups. This essay presents just one of the possible research models and is the basis for future research.

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PROJECTING MEN'S SWEATERS IN RIGHT-LEFT KNIT WITH INTARSIA PATTERN

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Abstract: *Patterns, obtained by combining loops of different colors, are characteristic for their optical properties, whereby the forming elements are colors and areas. These technical possibilities of the machines have brought a revolutionary change in fashion trends because they have made possible the production of the desired pattern directly on the knitwear. Delicate intarsia patterns are usually produced in right-left knit.*
In this work is presented the procedure for the production of men's sweaters with intarsia patterns in industrial conditions on modern „SHIMA SEIKI" flat knitting machines. Obtained was a program for electronic operation of the machines, necessary for the production of tailored parts of garments, with strong beginnings. The knitwear patterns and the corresponding machine functions are completely computer controlled.
Familiarity with the knitwear production methods and the loop forming process on these machines has made possible the projecting of the basic characteristic of the knitwear in right-left knit. Thereby, united in one phase became the design and creation of men's sweaters, their projecting, as well as the projecting of the men's sweaters production process in right-left knit under real conditions of knitwear garments production.

Key words: *projecting, sweaters, knit, pattern, yarn.*

1. INTRODUCTION

Progress of the textile industry in recent years has led to the emergence of many different methods of producing textile products. One of those methods is knitting, which means the shaping process of yarn by which is obtained a knitwear. Knitted fabrics are flat textile products obtained from the large number of interconnected loops, which are the basic structural elements of knitwear [1, 2].

Modern life can not be imagined without the knitted textile products made of knitting machines. Knitted fabrics are made from different types of yarn, of different yarn fineness and composition of the raw material, and in addition to cotton, wool and acrylic yarn largely are used mixtures, because of its positive characteristics [3, 4]. For the processing in knitting technology elastic fibers are suitable, with uniform fineness and strength because that gives a soft and voluminous yarn.

Development of electromechanical industry has led to the emergence of a completely new generation of flat knitting machines. They fulfill the increasing demands of reliability, cost-effectiveness and flexibility. At a very high technical level with customized designs they are highly customizable, which opens up a whole new dimension of use of these machines. Based on designer creations, at this electronic controlled machines, knitted fabric sample is fully programmable on computer as well as appropriate machine functions. The memory capacity is significantly increased, so the pattern may have several thousands of loops and it is dependent of the number of colors [1].

In this paper is, based on the sketches of men's sweaters, presented a complete procedure for obtaining these models in industrial conditions on a very modern SHIMA SEIKI flat knitting machines [5]. Measurements and tests are made necessary to explain the ways of making knitwear and forming loops on these machines and projecting the main characteristics of right-left knitwear.

2. EXPERIMENTAL

2.1. Making fashion collection

Collection of sweaters with horizontal stripes and "V" neckline is made into a right-left knit on flat machines, which are primarily used for making upper garments. Knitwear on these machines are formed by leading and putting knitting yarn, which is wound on coils, on needles. Thereby yarn passes over the guide and move out of the work zone of knitting on yarn depositor, that lay down yarn on needles. Needles are placed in needle bars and their movement is achieved by using locks that are in the crankshaft of the machine. Formed knitwear is exported from the work zone and rolled on goods shaft.

During the manufacture of right-left knits is involved first system of front needle bar and the second system of last needle bar. Which needle will be involved in the operation depends on the activator. In the right-left knitwear activators are not involved in that needle bar on which should be created knitwear ie. foot of selective platinum stays sticking out of its channel. If the foot of pushing platinum remained sticking out of its channel then there is its effect on the selective platinum, and thus is missing effect of selected platinum on needle suppressor. This moment is happening on that side of the crankshaft with systems where knitting is provided, on the other needle bar will be involved activators and none of the needles will knit [5].

Combination I:	Combination II ,	Combination III:
- dark gray,	*- olive green,*	*- dark purple,*
- black,	*-ocher,*	*- light purple*
- white,	*-brown,*	*- pink,*
- light gray,	*- beige,*	*- blue*

Figure 1. *The collection of men's sweater with horizontal stripes and "V" neckline in different colors*

Knitting these sweaters is starting with render, which is located at the waist, sleeves and neckline and it is knitting together with the front and back sides of the sweater on the machine.

For these models the sweater collar trimming is required because its production on knitting machines is not possible due to the limited number of guides.

Figure 1, shows a fashion collection of men's sweaters designed for modern man and it is an expression of male sophistication. The perfect balance between classic and modern, which is achieved by a combination of different colors [7, 8].

Fashion collection of men's sweaters, whose creations are shown in the previous section, are knitted on very modern flat-knitting machines, Japanese company "SHIMA SEIKI".The program for knitting men's sweaters on these machines is shown in Figure 2

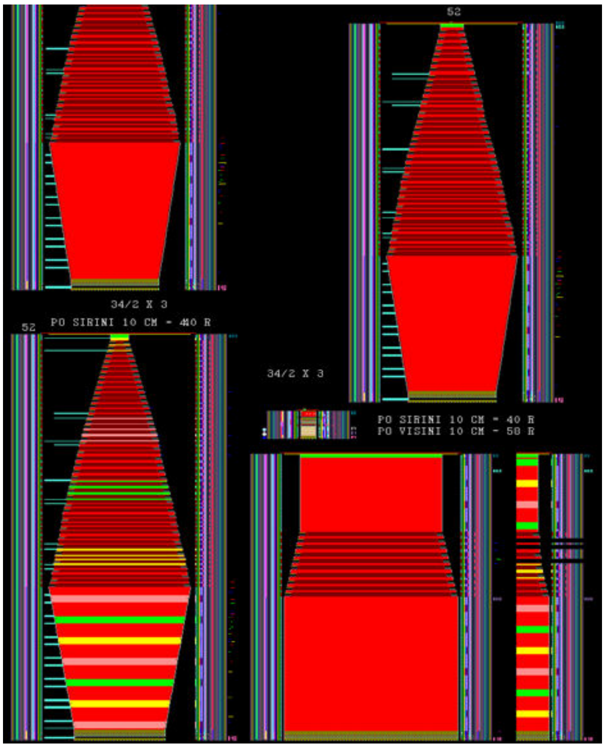

Figure 2. *The program for knitting men's sweaters, the flat-knitting machines "Shima Seiki"*

Color lines that are located on the left and right side of cutting pictures are called command-lines, because different commands set by the programmer are performed based on them. Each of them has its own function and they are divided on left and right command lines [5].

The left group:
1. Special processes.
2. Number of moving needles (1-18 places depending on the machine).
3. Moving needle bar to the left.
4. Moving needle bar to the right.
5. Adjusting the speed of knitting.
6. Passing speed and switching loop speed.
7. Command for stopping the machine in case of yarn breakage or other errors that can occur when knitting.
8. Digital control.
9. Dragging of knit during knitting.
10. Dragging of knit during shifting.
11. Additional commands for machines fineness 3 and 5
12. Command for the machine type RT, which has additional needle bars on the left and right side.
13. Moving the front needle bar.
14. Moving the back needle bar.

The right group:
1. The first repeater.

2. The outer repeater (including the first).
3. Using the guide (guide number is 1-8, while can be worked with the seven colors).
4. Knitting and switching in a single system.
5. Stopping knitting transferring loop and moving the head.
6. Addresses for setting the tension of knitwear.
7. Setting the needles.
8. Take in and take out the guide.
9. Stopping the the command by line-process.
10. Activation of tweezers (for capturing the yarn) and scissors (for cutting the yarn).
11. Loop suppressor.
12. Additional tweaking.
13. Selection of the appropriate head.
14. Adjusting the head movement during transfer. Left or right (movement of the head is always opposite to the direction of transfer).

Experimental material

Table 1 shows brief description of the models and Tables 2 to 4 shows required amount of the yarn for certain combinations of colors

Table 1. *Brief description of the models*

Description	Four color men's sweater with stripes and "V" neckline
Machine fineness	F7
Raw material	100% Co
Yarn fineness	T_t=29,41x2 tex
Supporting material	Thread 150m/piece

Table 2. *Work order by clothing size for production 360 pieces of men's sweaters*

Raw material	Yarn fineness (T_t)	Color	Size/piece				Total (pieces)
			50/64	52/112	54/96	56/48	
100% Co	29,41 x 2	Combination I	20	35	30	15	100
100% Co	29,41 x 2	Combination II	20	35	30	15	100
100% Co	29,41 x 2	Combination III	24	42	36	18	120
Total (pieces)			64	112	96	48	320

Table 3. *Consumption of the yarn for producing a male sweater in size 52*

Yarn fineness (Raw material)	Color			Size			
	Combination I	Combination II	Combination III	50	52	54	56
29.41x2 tex (100% Co)	Dark gray	Olive green	Dark purple		295		
29.41x2 tex (100% Co)	Black	Ocher	Light purple		55		
29.41x2 tex (100% Co)	White	Brown	Pink		40		
29.41x2 tex (100% Co)	Light gray	Beige	Blue		40		
Total (g)					430		

Table 4. *Consumption the yarn for 100 pieces in sizes 50, 52, 54 and 56*

Yarn fineness (Raw material)	Color			Size/piece				Total (kg/piece.)
	Combination I	Combination II	Combination III	50/20	52/35	54/30	56/15	
29.41x2tex (100%Co)	Dark gray	Olive green	Dark purple	6/20	10,3/35	9/30	4,5/15	30/100
29.41x2tex (100%Co)	Black	Ocher	Light purple	1/20	2/35	2/30	1/15	6/100
29.41x2tex (100%Co)	White	Brown	Pink	1/20	2/35	2/30	1/15	6/100
29.41x2tex (100%Co)	Light gray	Beige	Blue	1/20	2/35	2/30	1/15	6/100
Total (kg/piece)				9/20	16,3/35	15/30	7,5/15	48/100

Structural and geometrical properties of of final products

- Theoretical thickness (diameter) of the yarn:
  The machine introduces three the yarn at once in one guide, so that the total yarn fineness is:

$$R = 29.41x2 \text{ x } 2 = 117.6 \text{ tex}$$

$$d' = c' \cdot \sqrt{Tt} = 0.029 \cdot \sqrt{176{,}5} = 0.385 \ mm$$

  c´ - theoretical coefficient (for raw cotton c´ = 0.029) [1, 2]

- Real thickness (diameter) of the yarn:

$$d = c \cdot \sqrt{Tt} = 0{,}0412 \cdot \sqrt{176{,}5} = 0{,}547 \ mm$$

  c – real coefficient (for raw cotton c = 0.0412) [1, 2]

- Loop step:
  From the sample is, horizontally, determined number of loops at 5 cm:

  D_h = 20 loops/5 cm

$$A = \frac{50}{20} = 2{,}5 \ mm$$

- Loop height:
  From the sample is, vertically, determined number of loops at 5 cm:

  D_v = 30 loops/5 cm

$$B = \frac{50}{30} = 1{,}66 \ mm$$

- Loop length:

$$l = 2 \cdot \frac{B^2 + \left(\frac{A}{2}\right)^2}{\left(\frac{A}{2}\right)} = \frac{1{,}67^2 + \left(\frac{2{,}5}{2}\right)^2}{\frac{2{,}5}{2}} = 6{,}96 \, mm$$

Knitwear density:

- Total density:

$$D = D_v \cdot D_h = 20 \cdot 30 = 600 \text{ loops}/25 \text{ cm}^2$$

- Density coefficient:

$$C = \frac{D_h}{D_v} = \frac{20}{30} = 0,667$$

Compactness - porosity knitwear:

- Linear loop module:

$$m_L = \frac{l}{d_t} = \frac{6,96}{0.385} = 18,08$$

- Surface loop module:

$$m_p = \frac{A \cdot B}{l \cdot d} = \frac{2,5 \cdot 1,67}{6,96 \cdot 0,542} = 1,097$$

- Volume loop module:

Knitwear thickness: d_{pl} = 1,3 mm

$$m_v = \frac{4 \cdot A \cdot B \cdot d_{pl}}{\pi \cdot d^2 \cdot l} = \frac{4 \cdot 2,5 \cdot 1,67 \cdot 1,3}{3.14 \cdot 0,547^2 \cdot 6,96} = 3,320$$

- Width loop coefficient:

$$\alpha = \frac{A}{d} = \frac{2,5}{0,547} = 4,57$$

- Height loop coefficient:

$$\beta = \frac{B}{d} = \frac{1,67}{0,547} = 3,053$$

- Cover factor:

$$K = \frac{\sqrt{Tt}}{l} = \frac{\sqrt{176,5}}{6,96} = 1,91$$

- Length padding:

$$D_{ZV} = 2 \cdot d_t \cdot D_v = 2 \cdot 0,385 \cdot 30 = 23,1$$
$$D_{ZH} = 4 \cdot d_t \cdot D_h = 4 \cdot 0,385 \cdot 20 = 15,4$$

- Surface padding of knitwear:

$$P_Z = \frac{100 \cdot (d_t \cdot l - 4 \cdot d_t^2)}{A \cdot B} = \frac{100 \cdot (0,385 \cdot 6,96 - 4 \cdot 0,385^2)}{2,5 \cdot 1,67} = 49,98\ [\%]$$

- Mass padding:

The mean Mass of knitwear in g · m^{-3}: $m_p = \frac{294,8\ g \cdot m^{-2}}{1,3\ mm \cdot 10^{-3}} = 226769,23\ g \cdot m^{-3}$

$$Z_m = \frac{m_p}{\rho} \cdot 100 = \frac{226769,23}{1,52 \cdot 10^6} \cdot 100 = 14,91\ \%$$

- Total porosity:

$$R_U = 100 - Z_m = 100 - 14,91 = 85,09\ \%$$

- Volumetric coefficient of knitwear:

$$K_V = \frac{100}{Z_m} = \frac{100}{14,91} = 6,71$$

- Surface mass of knitwear:

$$m_p = Tt \cdot D_v \cdot D_h \cdot l \cdot 10^{-2} = 176,5 \cdot 6 \cdot 4 \cdot 6,96 \cdot 10^{-2} = 294,8 \text{ g} \cdot \text{m}^{-2}$$

3. CONCLUSION

The process of designing knitwear from idea to finished garment is a very complex process. Therefore, the projecting knitwear must contain all parameters necessary for the realization of its production in industrial conditions. Projecting requires prior knowledge of all the factors related to the structure, construction, and the process of formation of knitwear in knitting room. This includes all the properties of fibers, yarns, as well as their behavior in the treatment process.

Thanks to a new generation of flat knitting machines a number of problems faced by manufacturers of knitwear are solved.That include:

- the need for wider collection and frequent changes of the sample,
- changes in consumer demands,
- change of clothing customs,
- emergence of market saturation,
- the pressure of imported goods and
- changes in the rhythm of the ordering of the trade.

Flat-knitting machines have a consistent system of structural elements with a variety of options that allow you to quickly and smoothly adapting fashion trends. The main feature of this machines is that electronically controlled devices are creating cut parts of garments. These garments i is possible to knit in jacquard weave with the possibility of raport closure as well as a gripper and an embossed weave, while also making a solid start. Dragging knitwear has been refined so that is achieved a very good uniformity of knitwear. Crankshaft speed is programmed according to the type of knitwear.

Knitwear pattern is fully programmed by computer as well as appropriate machine functions. The memory capacity is significantly increased so that the motive may have hundreds of thousands of loops and does not depend on the number of colors.

Acknowledgements

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APPLICATION MATERIALS IN PRODUCTION GEOTEKSTILE-MULTIAXIAL FABRIC

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Abstract:*Application-multiaxial geotekstile fabric is very broad and provides the ability of multiple applications in the field of prevention in the construction of the roads and railways, tunnels, dams, canals, irrigation and drainage, sports, landslides, dumping recyclables, then making filters for waste gases and water, cloth protective suits intervention teams in emergencies, Accessories protective clothing and apparel, civil and military aviation, automotive industry and motorciklističkoj, river and sea shipping, rehabilitation of the landfill and landfill biogas and many other applications.*
This paper presents a short review of applications, methods of production and testing methods geotekstilnih characteristics of finished fabrics, as well as some possible applications of raw materials for the production of geotekstile and other fabrics for different applications.

Key words: *geotextile, multiaxial fabrics, materials, features, clothing, testing, sustainable development.*

1. INTRODUCTION

In the development of new products, services or processes, the goal is a concrete result, functionally defined measurable characteristics and test methods. Technical regulations must be defined depending on the product, the following regulations: technical requirements to be met by the product supplied, conformity assessment procedures, safety requirements, regular and special examinations during the lifetime of the product, the documentation accompanying the product when put on the market sign and labeling of products, requirements for packaging and labeling, etc. Technical regulations and technical requirements contained therein shall be made to protect the safety of life and health of humans, animals, plants, the environment, consumer protection and property and other users.

The overall objective of the implementation of development geotekstile-multiaxial fabric as a new product, the development, production and application in a variety of applications (road and rail transport, agriculture, construction, forestry and water management, and in the field of medicine, textile, automotive and aerospace industries and other areas. implementation of domestic production of the new multiaxial fabrics to achieve significant effects: a product with improved physical, chemical and biological characteristics compared to existing geotextiles, application of global technology, achieving a minimum negative impact on the working and living environment (resistance to UV radiation, radiological and chemical and biological safety, etc.). Additionally would be achieved: increasing competitiveness and time of use of existing similar fabrics increase employment in the country, with a gradual reduction of import substitution of similar materials for various applications, boost domestic production, increase exports and profits, achievement of business cooperation with companies of similar programs, an increase in gross national income and so on.

2. OVERVIEW AND FEATURES MULTIAXIAL FABRIC

Multiaxial fabrics, which have been developed in the company VM Protect (Martin MAT-aramid, UHMWPE Martin MAT, MAT-carbon Martin, Martin MAT-glass, basalt Martin MAT), have excellent mechanical and physical performance and long life. Specificity multiaxial fabric is that it is composed of two or more layers, slow at different angles. This type of production, there has been less deformed easily design and manipulation of the cloth.

The specificity of the technological line is that it provides that after each layer multiaxial "sip" another layer of a material, whether it be a film, viles, felt or other material, depending on the purpose of the fabric. Thus, in effect, can be obtained fabric with 7 or 8 different layers.

Such a way of making a geotextile completely new approach to solving the problems of drainage, filtarcije, separation, reinforcement, etc.
Fig. 1, shows the general appearance, some of the more possible combinations of laying fibers in multiaxial fabric.

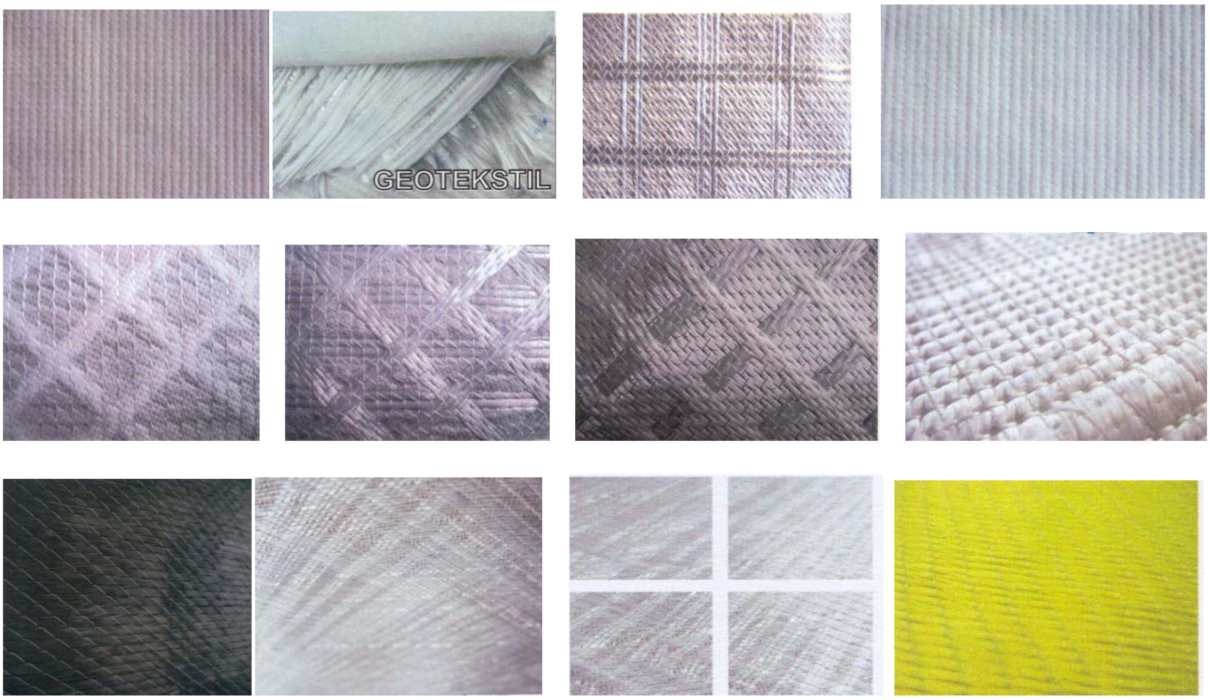


Figure. 1. General and graphic multiaxial fabric, made from a combination of non-woven fabrics and multiaxial layer.

Multiaxial geotextile is a multi-dimensional-layered drainage system, composed of multiaxial layer and at least one layer of non-woven fliza. Multiaxial "sandwiches" MARTIN MAT, is made of two layers of non-woven geotextile viles-A-150, with different core layer, with the combination of fiber glass, polyester, polypropylene fibers processed resins and others.

3. TEHNOLOGICALPRODUCTION MULTIAXIAL FABRIC

On standard weaving looms fabrics are made of cotton and polyester in the mix and in combination with conductive fiber, while the production line is based on multiaxial and multiaxial composite material for environmental protection and the protection of people, combined with different types of yarn, depending on the purpose of the material. Technological line to be after each layer multiaxial "sip" another layer of a material, whether it be a film, viles, felt or other material, depending on the purpose of the fabric. Thus, in effect, can be obtained fabric with 7 or 8 different layers. geotextiles used for the production of 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 viles, 100% PES with viles, 100% glass viles; combination of fibers treated with resins viles.

The fabric is made by passing multiaxial angles in the range of (-22.5° to +22.5°) of yarns, so that the aforementioned fabric samples can be endlessly combined, starting with various combinations of yarn type and fineness, with or without Fliza or termoflizelina, so that, in effect, receive product range. (Fig. 2).

Production requirements multiaxial special fabrics are the basis for adjustments to the existing technological line Company VM Protect COP MAX 3CNC S5 M13, brand liba, a third generation with an installed program in computer production monitoring. Line has 5 mobile robots that can simultaneously take five different layers and 5 different angles depending on the use of fabric.

Figure. 2. Possible angles of geotextile fabric and appearance looms

Machine allows you to adjust the number of layers, angles (0°, ± 45°, 90°, ± 22.5°, ± 30°, ± 60°), the type of yarn (polyethylene, polypropylene, polyamide, polyester), the fineness of yarn (tex), the number of layers of fabric, yarn fineness of yarn in each layer, then the number of cycles per hour, so the piece.

During the work, subject to revision as the number of layers and the surface mass of each layer separately. Such fabric, due to its particular structure, have better mechanical properties than the existing geotextile for different applications. Laboratory testing of samples produced fabric, it was found that the so obtained materials lighter and thinner than the material currently used for lining landfills and for other applications.

The main raw materials used to produce mulatixial geotextiles are polypropylene (PP), polyester (PES), polyethylene of high molecular density (UHMWPE), polyamide (PA), glass fiber, combined with needled nonwoven viles (chemical composition: PP or PES which does not lose favorable characteristics influence the biological and chemical processes, which makes them very useful in coating landfills) or without fliza.

4. CONTROL QUALITY OF INCOMING RAW MATERIALS TO PRODUCE MULTIAXIAL FABRIC

The primary characteristics of geotextiles depends on the purpose and function and is largely based on: filtration, separation, reinforcement and protection. On that basis, determine the following characteristics: tensile strength, elongation at maximum load, the static penetration test (CBR test), elongation at break, a check of the characteristic opening size, water permeability, durability, water flow capacity (for use in irrigating and dumps the liquid waste), the efficiency of care.

Analysis of mechanical properties of fabrics made according to the following standards:

- tensile strength (longitudinal), (min 40 kN/m), [EN ISO 10319],
- tensile strength (transverse), (min 40 kN/m), [EN ISO 10319],
- elongation at maximum force (longitudinal), (min 30%), [EN ISO 10319],
- elongation at maximum force (transverse), (min 30%), [EN ISO 10319],
- static penetration resistance (CDR) test-min 7000 N, [EN ISO 12236],
- thickness (according to EN ISO 9863 (min 3 mm)).

Testing of the hydraulic characteristics of the fabric according to the standards:

- vertical permeability fabrics (h=50 mm), (l/m^2s), [EN ISO 11058],
- with openings 0.90 (μ), [EN ISO 12956],
- thick fabric, (mm), [EN 964-1],
- specific weight, (g/m^2), [EN 965],

- water permeability (normal to the plane) - dh=50 mm, (EN ISO 11058),
- the speed of the water flow in the plane (ISO 12 958).

Declaration contains basic information about the product name of the manufacturer and product, surface fabric weight, width and length of the roll, the date of manufacture.
The quality of the finished product-multiaxial geotextile has a decisive effect the quality of raw materials. Any material that arrives in the warehouse runs already pre-determined acceptance testing:
a) evaluation of the sample material (supplier data sheet, certificate of quality, visual control, internal analysis, certified laboratories),
b) after internal control, the yarns in the accredited laboratory shall: fineness of yarn (tex), breaking force (daN), elongation (%), composition (%).

The primary characteristics of geotextiles depend on the purpose and functions, which are mainly based on: filtration, separation, reinforcement (reinforcement) and protection. On that basis, determined by the following characteristics: tensile strength, elongation at maximum load, the static penetration test (CBR test), elongation at break, check the characteristic opening size, water permeability, durability, water flow capacity (for the application in water management and landfills with liquid management), the effectiveness of protection.

In the discussion, one can see some types of materials to their micro surface appearance, some characteristic properties (mechanical, thermal, electrical), and the appearance of raw materials in the form of granules or fibers. Some of this material may be used in the manufacture of geotextiles and multiaxial fabric, but some of the materials used in the production of textiles and clothing in the clothing peaple use. Usually mixed with natural fibers (cotton, viscose, etc.) or just from their own fibers for protective clothing intervention teams in emergencies (fires, floods, earthquake, environmental accidents, etc.). The following materials are widely used in the preparation of other wood and other clothing apparel, as well as in the manufacture of components in civil and military aviation, automotive industry and motorsicle, river and sea shipping, and many other applications.

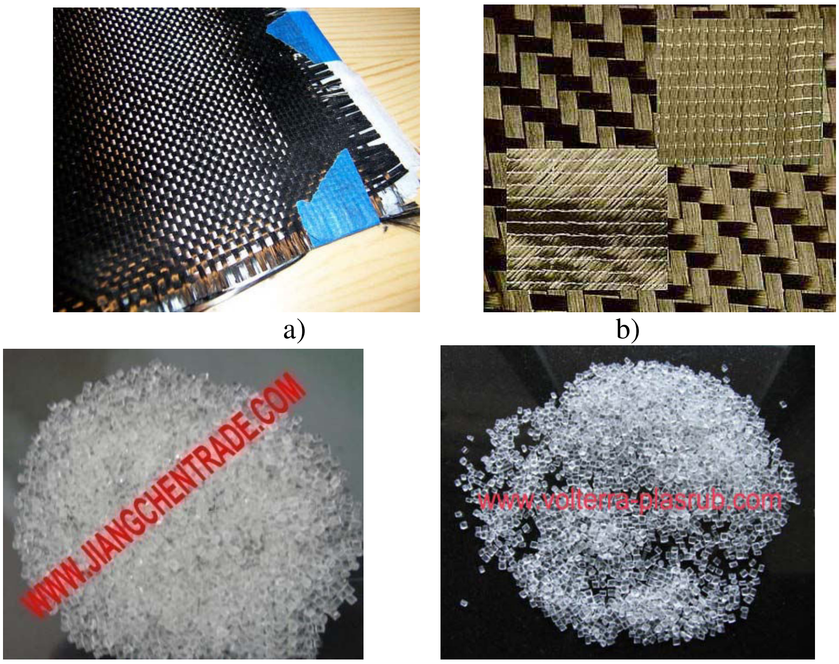
5. APPLICATION OF CERTAIN MATERIAL IN PRODUCTION GEOTEKSTILE-MULTIAXIAL FABRIC

5.1. 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 Figure 3, 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.



a) b)

c) d)

Figure.3. Appearance carbon products and raw granules a) Carbon product, b) Microscopic appearance of carbon fiber, c, d) raw granules

In Figure 3, 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

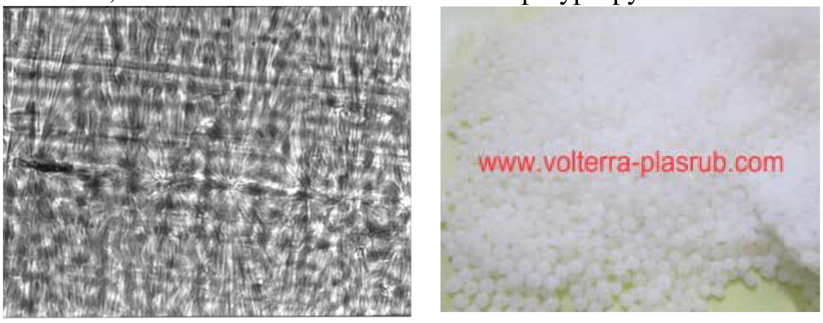
No	Properties-Polycarbonate-PC	Test Method	Unit	Data
1.	Density	ISO1183	kg/m3	1.20 × 103
2.	Melt Volume Flow Rate (300°C, 1.2kg)	ISO1133	g/10 min	27
3.	Water adsorpton	ISO 62	%	0.23
4.	Tensile stress at Yield	ISO 527	Mpa	65
5.	Tensile stress at break	ISO 527	Mpa	65
6.	Nominal tensile strain at break	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)	ISO75-1	°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

5.2. Polypropylen-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. 4, shows the microscopic appearance of the fabrics made from polypropylene and raw look at granulated. Table 2, shows the basic characteristics of polypropylene.



a) b)

Figure. 4. Apparel fabrics and raw materials of polypropylene
(a) the microscopic appearance of the surface of the polypropylene fabric,
(b) propylene raw material in the form of granules.

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

5.3. 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

5.4. Polyester (PEs)

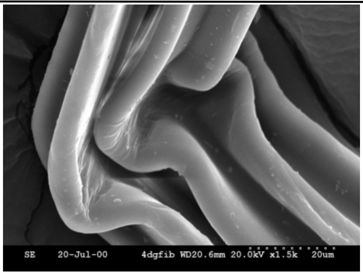
Polyester is a category of polymers which contain the ester functional group in their main chain. Although there are many polyesters, the term "polyester" as a specific material most commonly refers to polyethylene terephthalate (PET). Polyesters include naturally occurring chemicals, such as in the 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.

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. Fig. 5, 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) d)

Figure. 5. Show intermediate fibers and fiber content of polyester
a) Microscopic view of polyestarskog fibers, b) raw materials in the form of granules, c) 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

5.5. 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. 6, 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.

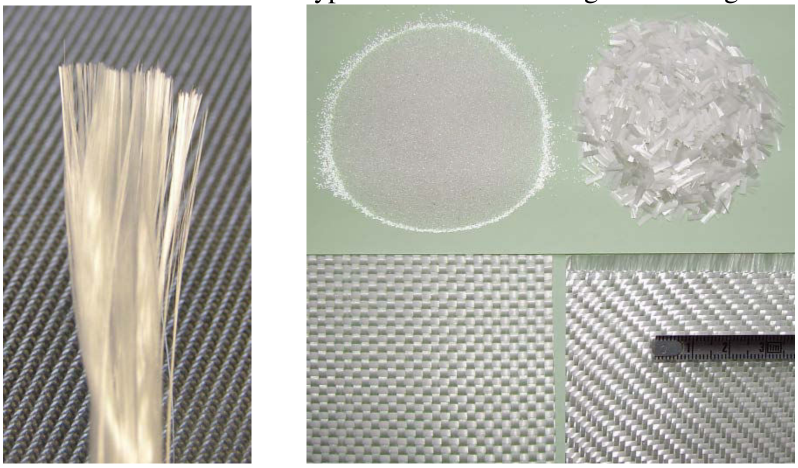


Fig. 6. Of fiber and micro fiber surface produced by voice.

Table 5. Some features of Fiber Glass

No.	Fiber type	Tensile strength (MPa)	Compressive strength (MPa)	Density (g/cm^3)	Thermal expansion $\mu m/(m \cdot °C)$	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

5.6. 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/cm^3

6. CONCLUSION

Geotextile-multiaxial fabrics are widely used in various fields, such as in the construction of all types of roads, agriculture and water resources, geology, ecology, making clothes for emergencies, apparel and textiles, hardware, automotive and other areas.

In making geotextile fabric must be respected technical requirements that are mandatory for manufacturers, ranging from the type and quality of raw materials, production and other parameters that provide the required level of quality and above all, reliability and safety, especially when it comes to apparel and knitwear garments.

Many considered the materials used in the manufacture of geotextile fabric used in making clothing and home textile industry, where the composition and production itself are subject to additional quality control and product safety and compliance with European and international regulations.

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ANALYSIS OF TRENDS OF FILTER MATERIAL

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Abstract: *The following general classification filters. Consider new technologies in the field of filter material , the structure filters, raw material composition. The dependence of the distribution and performance of the filter on the physical and chemical properties of filter products, technological conditions of the filtering process and the type of filter material. The problem of designing, building , construction and choice of filter material , which in most cases are crucial for filtration , especially early in the process when caught on the surface of the first material of the solid phase to the sediment , as this is determined by rate of filtration (filter output) filtrate purity and other parameters.*

Key words: *filter materials, structure, purpose properties.*

1. INTRODUKTION

Acute environmental situation related with air pollution and industrial waste water, resulting in the need to develop new technologies, the use of cheap filter elements that allow multiple regeneration.

Create a filter materials that combine high performance with Hold capacity, is today the most important task, the successful solution of which is promoted as the right choice of designs filter system, filtration process conditions and choices most filter materials.

Filter materials can be used as filters and when pre- cleaning water, gases, organic solvents, mineral and organic solvents, low -acid, mono- alkali solvents, oils, radioactive aerosols, etc.. Currently, for the manufacture of filter elements, a broad range of synthetic polymers. Along with polyethylene, polypropylene, polyamide and polyester fibers, thermoplastics are an advantage, which is very suitable for processing by extrusion, which makes it possible to obtain single thread or yarn. To protect and clean the environment from harmful emissions from oil pollution, processing and disposal of waste and used sorption filter materials.

At the core of porous filters of all kinds is the process of gas filtration through the walls, in which solid particles are trapped, and the gas passes completely through them. Filter partitions varied in structure, but mostly they consist of fibrous or granular cells and are divided into the following types:

- Flexible porous walls - woven materials from natural, synthetic or mineral fibers, nonwoven fibrous materials (felt, punched and glued materials, paper, cardboard, fibrous mother), cellular sheets (foam rubber, polyurethane, membrane filters);
- Semi- cellular walls - layers of fibers, flakes, woven wire mesh, placed on supports;
- Rigid porous walls - granular materials (porous ceramics or plastics, sintered or pressed powders of metals, porous glass, carbon-graphite materials etc.) Fibrous materials (formed by layers of glass and metal fibers), metal mesh and perforated sheets.

Depending on the purpose and size of the input and output concentrations, filters conventionally divided into three classes: fine filters, air filters, industrial filters.

2. RESULTS AND DISCUSION

Recently woven filters are improved through the use of new materials. In such filters, are used filter materials of two types: ordinary fabrics made on looms and felting obtained by stalling or mechanical interlacing fibers punched method. In typical filter cloth size pinholes between the filaments is 100-200 microns. Previously, these filters are produced mainly from natural raw fiber and yarn structure, which led to their fragility, now - of synthetic fibers and yarns, single and multithread yarn. It is possible to obtain a framework that is able to carry electrostatic charges, which helps in filtering air mixtures and gases.

Today has developed various methods of surface modification of woven filter method applying a different material. In particular, may be laminating several layers of filtering. Example – "Filterlink" filters, a feature which is very smooth front surface that is highly resistant to contamination (Ivanov M., 2003).

Filtration capacity of tissues depends on the nature and number of pores in the fabric, which are determined by raw material composition and its structure. We found that the filtering capacity of tissue due to the peculiarities of its structure (plain weave , the minimum density, maximum surface porosity and maximum pore cross , like the base, and on the weft) (Ivanov M., 2003).

Fibrous filter element filter consists of one or more layers of fibers are uniformly distributed. Fibrous filters with pores evenly distributed between the thin fibers run with high efficiency, the degree of purification of 99.5 - 99.9 % for gas filtration velocity of 0.15 - 1.0 m / s and P = 500 Pa ¸ 1000. Filter with glass-fiber materials possible cleaning corrosive gases at temperatures up to 275 ° C. For fine cleaning of gases at high temperatures , apply filters with ceramic wool satin stainless steel with high strength and resistance to changing loads, but their hydraulic resistance is - 1000 Pa . Fibrous fine filters used in nuclear power engineering, radio electronics , precision instrumentation, industrial microbiology , in the chemical- pharmaceutical and other industries. Filters allow you to clean large volumes of gas from the particulates of all sizes, including submicron (Pelyk L., 1999).

Particular interest are knitted filter sleeves made wear knitting way. Their strength, deformation characteristics and surface density varies easily. With this method may manufacture seamless filter element which reduces the economic costs of more raw besides precludes rapid destruction of arms in the joint zone. Seamless filtering sleeves have been tested and working in cement plants, food processing, machine building industry and construction materials. Analysis of seamless wear knitted filter bags showed high efficiency dust collection η = 99,99%, bre athability B = 165 dm^3/m^2*s, tensile strength long sleeve diameter of 200 mm is 88 kN. The efficiency of 19-25 months. Hose satisfactorily treated with reverse blowing. The surface structure can shake even the limestone dust that has settled and hardened on the sleeve. The degree of regeneration after blow down is 94-97 %. RMS surface density in wear knitting sleeves is 345 r/m^2 (Ivanov M., 2003).

Earlier in the non-woven filter material applied felt, however, because of the small frangible strength and low permeability of its use was limited. Improved methods of casting polymers from the melt allowed to start producing extrusive air- filled polymer fibers , called «spunbonded». New materials technology have made it possible to obtain an extremely small diameter fibers, satisfactorily proved in the implementation of fine filtration. From these plastics can be made layered filtering material such as "sandwich".

There are also filtering materials in the form of grids, obtained with single wire and plastic fibers (see also Figure 1). Given the particular filter should be considered in the category screens, a feature which is guaranteed mesh size (Ivanov M., 2003). Screens can be obtained in several ways, the most common of which - sintering several grids. To carry on the thinnest wire mesh filter using multilayer nets, called abroad Bopp's Poromet.

A novelty among the filter material is membrane. After developing methods of ultrafiltration membranes are used to remove solids from liquids. Rapid recognition of membrane technology and the creation of a new trend - microfiltration, was due to the need for a small.

Figure 1: Example of filtering.

With this process achieved a high degree of purification, filter but it is associated with a significant pressure drop , therefore membranes should be material in the form of greater strength. To solve this problem, they provide special grid supporting layer. Development of materials for membranes produced in two ways: first - design development filtering membrane that can operate at high differential pressure (membrane with reinforcing mesh, multi-layer membrane), the second - to obtain materials with defined pore size, a minimum of dispersion and uniform distribution of pore on the surface. A reasonable value and importance of the membrane are the main element of water treatment equipment. At the same time they are the main product in the market filtration materials.

Also the trend of popular filter material provides filters made of metals and ceramics, which makes it possible to apply membrane technology to filter corrosive solutions with high temperatures (Ivanov M., 2003). Today many Ceramic membranes are produced by foreign firms.

Outstanding scale popularity gained replaceable filter elements which are often referred to cartridges. After working life they are released or regenerated. Cartridges are a complete design consisting of filter material, bearing components, which provide mechanical strength and connection elements of the filter housing.

Modern cartridges are characterized by diverse range of content and different characteristics. Cartridges are divided into two types: the main element of the first type is a segment of a cylindrical tube, closed on both sides for input and output filtering thread. In the inner cavity of the tube is placed filter material. The second includes cartridges that consist of a set of identical, series-connected filter elements arranged in a single package. In recent years, the basic design elements have not changed. The most important changes were folded devices for cleaning of gas and air (Pelyk L., 1999). Fillers are different cartridge filter media: activated carbon, ion exchange resins, natural and artificial mineral compounds, etc.. Technical solutions implemented to improve cartridge filters were designed to counteract the formation of dead zones, areas breakout filtering flow and compaction bulk material.

One of the most popular categories of filter material is air and gas filtration. Over the past decade, this branch has developed considerably. At present, there used materials from alloy of polypropylene sulfide rubbers. Strict legal requirements on environmental protection and improvement requirements to air cleaning, caused attention to the problems of removal of fine particles from air mixtures (Ivanov M., 2003). Because of the ability to accumulate dust in air masses and electrify and serve the cause of the explosions, special importance in gas cleaning came with electrostatic filter medium resistance.

Much attention is given to the ceramic and metallic materials due to the importance of capacity environment clean hot gases, since it is known that both of these types of materials capable of withstanding high temperatures. The most common metal filters made of corrugated steel tape heat resistant and porous ceramics. These filters combine a variety of treatment with continuous heat resistance. To make the air masses disposed not only solid dust particles, but also toxic impurities developed composite materials that combine filtering medium with adsorption materials or materials that remove impurities. For example, activated carbon combined with fibers or filaments.

3. CONCLUSIONS

For today, there has been a great activity in introduction of new technologies in the field of filtration materials.

Quality of distribution and filter performance depends not only on the physical and chemical properties of filter products, technological conditions of the filtering process, but also on the type of filter material. Therefore, the design, construction, manufacturing and choice of filter material in most cases is critical for filtering, especially early in the process when caught on the surface of the first material of the solid phase to the sediment, as this is determined by rate of filtration (filter efficiency), the purity of the filtrate and other indicators.

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EMBROIDERY IN THE INTERIOR DESIGN

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***Apstract**: The conference proposes within the disciplines and specialized domains in textile materials, the approach of embroidery, technique and materials - a contruction idea -, as a form of practicability, ambient, location esthetics, respectively in the context of the defining design through its interdisciplinary function. In this respect, within the economy of the project, the textiles become important in comparison with architecture, the product design of textile creation and production itself either industrial or traditional (hand-made). Basically, we aim at relating interior architecture to textile material: architecture defined by building materials (stone, wood, iron, concrete, glass, etc.) vital technical facilities and directing the interior space through strong artificial illumination, natural heat sources - an overall conceptual harmony and habitat - intermediated through the furniture pieces (arredamento) and the refurnishing of the walls with techniques typical of and applied to textile materials (poorly updated nowadays as compared to those in history) within the prespective of modernism, more precisely postmodernism.*
Taking into account the display of the work we have in view the following problems and elements:
1 - History, categories, functions in architecture and textile creation – embroidery. The expressing of problems and objectives in architecture and textile materials.
2 - Ambient, decorations, renewals, influences and correlations, trends in textile production and embroidery – perspectives in the economy of design within the contemporary context, year 2012;
3 – Raw materials, methods, applying techniques, interior garnement.

Key words: *embroidery, design (ambient), trends, functions, techniques applied in textiles*

1. INTRODUCTION

In the context of disciplines and specializations approaching the textiles, the conference suggests the approach of embroidering by emphasizing the techniques and materiality in the usage of rental aesthetics, in the environmental design. While using pre-existing aspects and data, the reason consists in the interdisciplinary *idea of construction*. Given this preamble, the work's economy, we mention that the textile series or traditional industrial production – that *hand-made* found on the market – due to aesthetic projections, assimilate the creative values (see the creative department), before and subsequently, of the textile design related to the architectural interior (see the specialized teams). The explanation is that, although they are not artistically autonomous and do not represent the research subject of the metaphysical beauty, such as paintings and sculptures, the fabrics, including the embroideries, are finally focused on the aesthetics of the body and habitats; the role of philosophy covers a generically cultural space. On the other hand, the technical and industrial textile products express a research which is more different than our analysis, thus than the one reflecting the human body's outfit and housing.

Regarding the present subject, the idea of construction is defined through the connection between the house objectives (the solid structure) and the textile fashion (fluctuant correspondences on a historical scale). More precisely, we operate with the architecture defined through specific materials (stone, wood, iron, concrete, glass etc) and vital technical installations, with the administration of inner spaces by means of stage-lighting, a source of natural heat – a *conceptual ensemble of harmony and habitats* – mediated by furniture items (*arredamento*) and textile materials to re-dress the walls, the pavement, with the techniques applied according to the space utility. We also add the fact that the connection has to be updated given the relationship with the previous epochs as we live from the viewpoint of modernity, more precisely of postmodernity. (Figure 1)

Figure 1

Considering a good conceptualization of the present paper, I have focused on our strategy related to the creation and definition of embroiderings, simultaneously with the *presentation of the historical data* in the first chapter referring to the origins, categories, functions and objectives of textiles, in order to define it through a set of problems which are typical from the perspective of progression and different fluctuations. From this viewpoint, we have cultural contexts, preferences and other determined causes in mind.

With the second chapter referring to the ambiance and its associated references, decorations, innovations, or various influences and correlations, we launch the debate upon some trends in the textile production and embroidering. Thus we note several perspectives in the economy of contemporary design developed in 2012 and 2013. What we'll further have to do in the last segment is to approach some aspects related to raw materials and application techniques in finite products.

2. BRIEF HISTORICAL BACKGROUND

One of the aims concerning the historical approach of embroidering consists in the emphasis of the most differentiated usage starting with aesthetic motivations, elements denoting the social and heraldic class up to their democratization related to the utilities developed socially and in connection with the technical evolution.

Embroidery, an ornamental work made by means of needle techniques, is an Arabian term, „Ragma”. The written documents and the works in painting and sculpture certify that the genre has been practised from ancient times as the oldest evidence comes from the 16th century Egypt b.Chr. It is about *motives* decorated with figures made of brown thick thread, preserved due to the desert-like climate. Moreover, while observing the Egyptian statues, we also notice the usage of *embroidered clothing*, *decorated* with pearls; there are also similar findings in the Babylonean, Persian, Phoenician and Syrian context. Reliable sources drive us towards the 6th century Byzantium, when the emperors and the *church magnates used to prefer sumptuous clothing and decorations* embroidered in golden and silver thread with gemstone insertions. Towards the end of middle ages the oriental embroidering propagates within the realms of the United Kingdom, the German context and Italian republics, a period when tapestry also develops. The real triumph of embroidering definitizes during the

Renaissance simultaneously with the *secular liturgical outfit* and the popularization of some technical books with drawings conceived to facilitate the accomplishment and reproduction of series ornamentation. After the French Revolution the *stylistics are more simplified* yet at the end of the 17th century we notice some *technical inovations* due to the „Arts and Crafts" movement founded by William Morris. In 1872 the "Royal School of Needlwork" Foundation from England becomes more and more modernized. In the meantime, the American colonists brought, from over the Atlantic, some techniques which they adapted and applied on silk, wool and flax by using vegetal colours and methods of manual braiding mixed with sewing procedures to obtain the *triple point* and the *loope*. From the 17th century Asia Europe borrowed the Chinese embroidering and the precious elements of the feminine kimonos. The beginning of the third millenium becomes a real „art of the past-time" – supported by a complex history of the series production due to the development of mechanic machines after 1828 –, returning to the *sensibility* and *traditional practice* of the genre.

Functional categories in the *Gobelins Factories*. Charles Le Brun, the court painter of Louis XIV, had founded the first enterprise for the royal residence by associating carpenters for the furniture, goldsmiths and weavers. In this case the textile practice is conceived to have an environmental role. In 1662 Colbert (settled by Fouquet) decided the unification of weaving and tapestry manufactory in Paris and Maincy, and the "large-smooth" term starts being exclusively used in 1837. Associated with the "National Furniture" since 1936, today the enterprise produces series weavings and contemporary tapestry. Due to a factory, ***Beauvais Tapiserie*** (with its workshops in Paris and Beauvais), founded in 1664, the process of private fabrication developed in the XVIIIth century in partnership with artists such as Boucher. At the beginning, the factory realized *decorative ensembles for relaxation and curtains*. Before being associated and managed by the "National Furniture", deprived by some private support, it survives through the order pronounced by the "Royal Repository furniture". After the bombardments in 1940 and the harbor from Gobelins, some workshops, returned to Beauvais in 1989, produce the low-function from the XVIIIth century. They make carpets at the **Savonerie** factories (in the workshops from Paris and Lodeve); furthermore, considering the policy promoted by the kings of France, Henric IV and Louis XIII, the luxury of the monarchs harmonized with the splendor of landscapes, where one could find the royal residence, the textile creation reach ornamental values. Finally, between 1906 and 1913 the tradition from Gobelins was associated to modernity, the Gobelins Galeries were settled by Formigé for the exhibitions which functioned until 1939. After long restorations, in 2007, under the auspices of the public domain, they re-opened the Service for the Patrimony, for *creation and artistic crafts*.

The textile product in architecture – the *environmentally decorative function.* Before approaching the trends in the context of textiles and embroidering, the historical data indicate a great deal of connections among *intimacy*, *aesthetics* and *functionalism* needed by the body and habitat. *In architecture*, *embroideries integrate environmentally*. In *Le grand livre de la decoration* (New Guide to Decorating), Mary Gilliatt emphasizes the role of decoration in a rhetorical way by highlighting the preference as a profoundly human sketch analyzing the creation of life's frame. There are a lot of differentiated discussions concerning the cultural practice in which man is involved through the association between dreams and reality. *Heat* is created by means of decorations, through the art applied in stone, stage-lighting, colours, textile materials. The *garment* appears as an *aesthetic re-dressing*. The ornament and style, the embroidery in this case, set up that precious "savoir faire" given the harmony, preciousness and capacity to improvise needed in the human reflection. The success of these attributes consists in the combination between the building's comfort and aesthetic style; besides, in our lives they drive us towards the success of the connection established between *fashion and client* – and strategically towards practice, aesthetics and economy. Given the aesthetic solutions related to the habitat objective, known throughout history, there are pictorial interpretations through coloristic effects and harmony, through the filter of stage-lights as some means of spatialization or "mystical directing" etc. On the other hand, in our alternative, "Revetements muraux" highlights the walls with textiles, applied murally, or the tapestry, the pavement with its fabric from rural traditions, the mat, the carpet, and especially the stage-light from the bedrooms, curtains, window blinds, and embroidered curtains for the windows. It develops the context given a series of special effects such as the light production, the space scenography, demanded by the function of space.

3. Ambience, decorations, innovations, influences and correlations, trends in the textile production and embroidering.

Perspectives concerning the design economy in the contemporary context (2012-2013).

The client-fashion couple, focusing on the context in which the contemporary design advances, through a strategic application as I had shown in the "practice-aesthetics-economy" relationship, assumes a series of specialized techniques, the cultivation of good taste and mainly the arts specialized in environmental aesthetics; the word "economy" involves the product and the evolution of the market. From this viewpoint, we have got examples in advertising and commercial slogans:"Would you like to have your home re-decorated?","Are you in touch with the current tendencies of inner arrangements?", "Group dynamics create professional efficiency!" or, "Transform the design of your house ingeniously by using the specialist's recommendations!"

What needs to be mentioned is the capacity to correlate aspects in all the work segments from the creation of the product to the market itself. In this sense we have the trends, the raw material, the production, the variations of the market etc. As it concentrates on the idea of benefits, the commercial highlights the preferences of the epoch and the definition of preferences by means of ingeniosity and comfort, the revival of a product associated with the stylistic update and improvisation. In the team of designers the attributions are balanced according to its specialists: a member who deals with planification, one with lighting, another one with the space organization and the distribution of furniture items for the last to take care of the finishing process and details – a strategy characterized by rapidity and expected effects. In the same market context we have a new specialist in inner arrangements, here the role of creativity consists in projection modalities through the elimination of the team; the arrangement is done by the consumer. It is about DIY (*do it yourself*) which consists in the promotion of projects intermediated by DIY clubs transmitting the methods of ambience organization, and also in the reconditioning of furniture items and antiquities, or in the recovery of recycled or recyclable materials. In other words, it is about the re-invention of comfort and habitat harmony, a return to sensibility, after those decades when the radical vanguardist effect had dominated preferences and the consumer market. These data are necessary for the definition and introduction of the connection between furniture and textile materials in the habitual scen

According to statistical sources, specialists certify that in 2012 there is a variety of orientations related to the habitat trends. For example, we initially notice the emphasis on male preferences defined through the soberness of furniture lines, less intense colours, as the wrapping in textile items favours the idea of functionalism. (Figure 2) Furthermore, we notice a visible orientation towards some little furniture items, striking textile decorations with complex patterns meant to create a warm atmosphere full of emotion and colour. On the other side, there are the tendencies which generally appear daring, combining images with wild prints associated with some tempered textile chromatism.

Figure 2

Then there is the elegance highlighting sumptuous brocades in the Venetian style, in metallic nuances and silver or golden tones, with coral or amethyst influences **(Figure 3)**

Figure 3.

or in other cases real scenographies conceived from abundant decorations aiming to create some elegant romantic and welcoming spaces. (Figures 4-5)

Fieure 4. ***Figure 5.***

The year of 2013 brings textile trends characterized by embroideries and knitted items, contexts weaven in stripes, floral models, African motives, decorations from sophisticated curtains defined by some subtle refinement, all alternated with paintings, engravings or even interventions with parietally applied letrisms. (Figure 6). The embroidering and knitted items used in decorations and updated again, the ones that had been used during our grandparents' time, emphasise the interest for nostalgia and intimacy due to the personalization of interiors, expressing a hallmark of the new sensibility sensed in the postmodern expression assimilated today in the habitual space.

Figure 6

In this sense, the tendencies, applied both in clothing and arrangement of interior contexts, approach the handmade work, colourful carpets with hundreds of knots, decorative woven baskets, and other decorative elements which cannot be realized in series by great corporations. (Figure 7)

Figure 7.

The specialists, supporters of the social space, assimilatesome characteristics such as energy and dynamism without compromising the visual elegance and harmony, recommending the usage of stripes, regulated geometric strips and their various juxtapositions in textile compositions. In the same space the designer indicates the minimalist decoration by using the black and white colours or some striking red, in which the wallpaper and graphic art, the furniture tapestry and the minimalist tapestry, the carpet and other textile products are mixed. (Figure 8)

Figure 8.

One interpretation coming to support the connection denoting socializing orders, regarding the popular culture, which through extension, is associated with the *grapher* type practice, and the contents of a written text, an interpretation and assimilation of postmodern expression, would refer to the one of the walls inscripted with the favourite letters and quotations. The manual sketches and writings on the walls which had become popular due to the graphic artists were encouraged as a result of the designers' demands when creating the decorative wallpapers and stickers to decorate the space with the buyers' favourite texts. The African type themes from the modern European and American villas**,** present in 2013, with furniture items made of wrought iron sculptures, manual decorations and statues, leather and warm colours and animal prints in the homes of fashion addicts create exotic decorations for the most refined and luxurious preferences. In the dynamics of trends noticed in the interior design, there is a more complex application of textile materials especially of embroidering, and the preference for floral patterns on white backgrounds. The distinctive mark, updated today together with the romantic expression, intimacy and feminity used in the vacation homes, is given by the development of these patterns in the furniture tapestries, paintings and wallpapers overtaken from the curtains' embroidering**.**

Beyond the trends in the last two years, there are several recommendations for the embroidered curtains, they represent a stylistic constant attribute in elegant houses. An explanation: the sumptuous room claims for curtains harmonized with the ensemble and details of the space to create a highly complex and refined inner image. The diversified scale of this goal is due to some precious materials such as the veil, silk, brocard, etc. From this viewpoint the interior design (see Studio Insign) the *styilling* recommend, in the organization of classical, baroque, romantic styles, embroidered curtains selecting those embroiderings which are not loaded with motives, the harmony with the furniture and other decorative and artistic objects and genres. Concerning the compositional organization of curtains there are some observations according to which the intervention embroidered at the surface should be done at the lower margin, in the middle or on the whole surface; technically, they can be composed from more items or simply, from only one; for the suspension or grip, one should make some adequate systems. The professional application assumes recommendations related to preferences (to avoid the confusion with the Kitsch), special care, protection and technical care.

4. MATERIALS AND TECHNIQUES IN EMBROIDERING

As an art of decorations and personalization, intermediated by a great deal of clothing items and textile objects, with utilizations determined by the technical capacity, embroidering had developed starting with manual practices, sewing, the simpla embroidery machine and the loom, supported by drawings. Although the progress of embroideries aims at specialization and technical attributes – bringing with itself the evolution in personalization and the idea of beauty through visual impact, light and the brightness provided by materials, especially by using the embroidery thread provided with some qualities like durability and resistance in time to physical deteriorations caused by repeated washing and other external factors – it returns to the sensibility and practice of the genre in question, as we had certified in historical references, by underlining the fact that technically the embroidery is configured through some very complex stylistics.

We are interested in at this point, when the embroidery is made with computerized embroidery machines – personal ones, see the already mentioned DIY –, are the specific products and the modalities used to obtain the highest quality and maximum efficiency. In this sense, a very important role is taken by the technical embroidery thread with different aesthetic qualities such as the viscose, *polyester, metallic thread, cotton, acrylic thread and the thread for the shuttle*. We mention that the material's structure, the thread is made from, is determined as utility and aesthetics in the production and goal of the final material, for which we mention several examples. Thus regarding the embroidery directly touching the body, the luxury and thin embroidering recommends the viscose. The exterior articles use the polyester thread, while the church articles use the metallic thread. The *acrylic* thread is used in knitting and warm materials. A special and economic insertion is represented by a material, the *filmoplast*, which consists in a self-adhesive stratum protected by a squared sheet, used to embroider the articles – strips, neck ties, badges, cuffs. Regarding the embroideries on thin supports (*organza, veil, silk*) there is an insertion (foil) named *termofilm*. The reflective, fluorescent fibres, through their nuances and light or colourful vibrations, are used for wedding dresses and dining room curtains. When the goal focuses on a large embroidery (the background of the embroidery as such), for saving time and material, we suggest one material which imitates the embroidery, *step*, overlapped with embroidery elements provided with graphic elements to obtain the relief effect. In order to get the desired aesthetics one uses another material named *puffy* (a sheet of thin sponge whose effect is obtain from *"satin stitch")*. Tehnically, the relief or broken embroidery is made through manual cuttings, incisions or perforations by means of glue gun, methods applied in the case of synthetic materials.

The complex stylistics I referred to at the beginning of the present chapter starts which the selection of fibres according to the necessities of the final product, and in the case of design it is completed with the techniques of inner arrangements. As the object of our support in this segment consists in the presentation of some techniques defined stylistically, for a more coherent connection with environmental design, we mention some data regarding the idea of dressing/wrapping (*revetement, habillage*), which are essential in the context of interiors: *stage-light, special effects, wall padding, floor and pavement padding, materials for windows with curtains, doubling fabric, blind stocks, blinds folded or accordion.* Concerning the last one we might notice the most diverse fabric, thin or thick, hard or soft, textiles, velvet or silk, the most sophisticated prints and embroidering**. (Figure 9)**

Figure 9.

The material support used in embroidering is variable, from the simple canvas (*grege*), different types of cotton and precious wool, to muslin or organz veil. The wool and golden or silver thread, the fluffy fiber and sumptuous texture or fibres in the current modern industry can inspire creation equally, while technology and the specialized design enclose the arch of factors in the execution of interior embroidery. Regarding the applied texture defining the genre we notice a variety of means which are finally defined stylistically while we do not miss techniques such as *points plats, crossover points, laced points, composed points, point games*, *Le Hardanger, Le Bandera* or *mixt techniques.*

From the many techniques provided with some stylistic correspondence in the interior design we take a first example, *Le Bandera.* By means of this technique they reproduce polychrome decorative motives, elaborated in a very complex way, in stylistics *rocaille* and *rococo.* (**Figures 10, 11)** The central composition contains natural or anthropomorphous romantic motives.

Figure 10.

Figure 11.

The background of the canvas, which gives the name to this technique, is made of some white or ochre cotton, woven from motives in relief, textures in parallel lines, or traditionally named, in "honeycombs". Nowadays they work on flax supports. The volutes drawn in this type of embroidery remind us of the stucco work of ceilings and portals in the houses built in the Baroque style. The ornamental scheme used, especially in the French region, Turin, is easily associated with the model of wrought iron practiced in the bed design. The volutes are always embroidered in the *chain with no return* formula, the lines of these chains vary between three and six years in the so-called Advanced Bandera. The characteristic of the chain's central lines consists in the usage of clear colours to emphasize the relief effect while the volutes are coloured in bright light blue suggesting the creation of a game from Bordeau red shades, or brown tobacco, imitating the wood, combined with golden yellow. The floral motives are related to the garden – peonies, irises, tulips, roses made in the point pricked technique. This technique can be recognized through the simultaneous presence of the point punctured with parallel threads. The chains on the margin are sober and those in the middle are based on intermediary and clear colours, all being executed from the wool specific to the Bandera point, from a single thread yet one combined with lines in the form of a double pivot, preferred to the simple point, and searching for the sinuous effect. The transition created by spaces which need to be filled in with points in double pivots and chained paints, more solid than volutes, can stop in a star point. The technical and stylistic seniority of this pattern had drawn the collectors' attention, yet it certified real revirisments in the 20th century such as the tendency named "The Second Futurism" initiated at Turin in 1925. Nowadays we notice a progressive update of the Bandera embroidery in the apartments of piemonese noble circles or peripheral artisanal boutiques in Masio up to the last decade of the recently completed century.

A technique in embroidering which seems really relevant is known as *Points plats* providing us with diversity both as text inventivity and utility **(Figure 12)** Thus the general characteristics such as the *composition from straight lines, different lengths*, *regular intervals with silky visual effects, strictly delimited margins*, like in the case of *"Point arriere" or "launched point"*, can be found in textures like *pivotal point, little points, Gobelin oblique, launched straight point, princess point, point de Paris* etc.

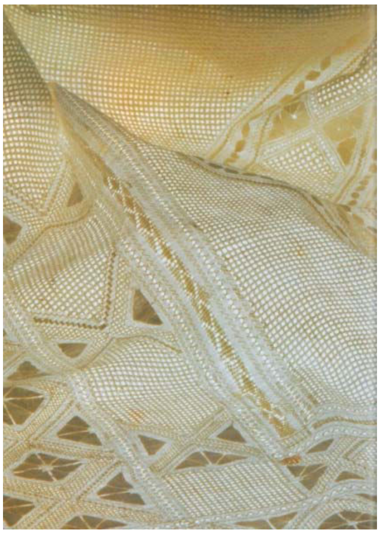

Figure 12.

The *Point arriere* or *Holbain point* was used in the female clothing, famous in the 14th century, the *Gobelin oblique* or *Gros point* embroidered on a support of monofila or double canvas is used in tapestry compositions like authentic Gobelins. Regarding the technique named the *small point*, derived from the Gobelin oblique, is executed on a support of double canvas in two threads, horizontal or vertical, mainly aimed to re-wrap the armchairs, sofas or sacks.

In threshold of the 3rd millennium the practice of embroidering using mixed techniques is important again in this type of design, given the revival of the so-called “old and highly refined things”. (Figure 13) Besides the fact that in creative clothing the techniques revive bright costumes, the refined fringes update real methods to decorate the curtains, the sets of napkins and large table cloths reminding us of the simple canvas at the beginning of the 20th century; yet the creation which drove towards masterpieces needed the mixed art of pearls, sequins and various elements lightening the small point or the cross point.

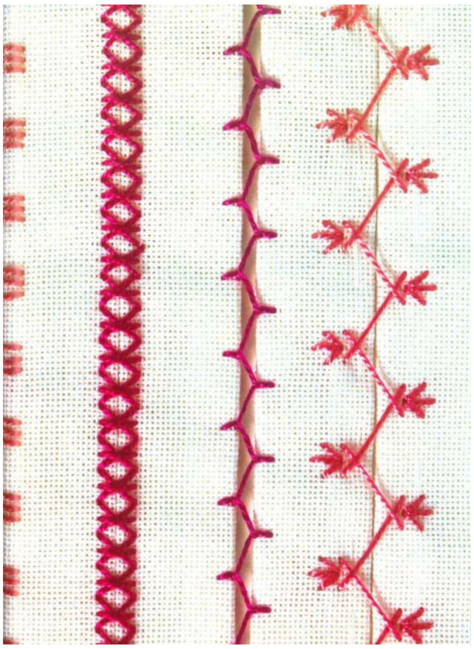

Figure 13.

The variety of this technique comes to enrich the creation of embroideries given the liberty in the utilization of means and methods through improvisation and ingeniosity. Therefore, methods like unification point, cross fantasy point, Cretan Gobelin oblique, bared cross point, buttonhole point, rosette point are only some of the technical strategies applied. In our analysis, in the environmental design, the technique creates a really fantastic variety starting with small and ample objects, needed in the kitchen or dining room, for vacation homes and luxury spaces or locations with limited economic goals.

Observation: considering the fact that our topic is far from being completed, we may state that our theme claims to be continued from the research viewpoint, developed in technical terms and extended in relation to stylistics, the aesthetics meant to explore through improvisation and experiment. In embroidering the stylistic subject is far too vast, and the technical techniques become more and more complex, while the utilities of the environmental design diversify more and more.

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CREATIVITY AND TECHNOLOGY – GENERATION AND ATTITUDE CHANGE IN THE APPAREL INDUSTRY

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Abstract: *Humanity spends a lot more on fashion goods, than is necessary for such purposes as clothing. However, never have people dealt as much as now with their outfit, and have not consumed such quantities of apparel. There are always newcomers on the fashion scene, on the other hand collection design means much more today than "creating some nice products", or developing their technology. Quantitative and qualitative expectations and manufacturing conditions became tight. This is a moment of paradigm-shift in fashion industry, which became one of today's most unsustainable global businesses. There is a structural change required; it is necessary to limit collections, to define their target group, to determine the brand DNA, and to work more cost-effective. The apparel industry is confused by changes in consumer behavior. Multi product concept was a total blunder. Fashion is driven today by youngster fashionists and managed by celebrity fashion-bloggers. Season boundaries are blurred; therefore the trend forecasting and trend analysis became flourishing business. Working methods of fashion and apparel industry of the future will be completely different, as well as technical conditions of the whole system. Demand for diversity, immediacy, interactivity and virtuality, will be even higher than now. Creative opportunities offered by modern technology will determine the future.*

Key words: *Sales trends, Fashion trends and the trendsetters, modern technology, Future of collection design, global perspectives of apparel industry*

1. INTRODUCTION

The glamour of fashion industry drives many young people in their career choice. Even if it is not so, youngsters believe that *their* talent qualifies them for having great drams, and for superb success similar to their idols have. Fashion has never given work to so many people, and has never operated with that much great "staff." Despite the fact that the apparel market is saturated *there are thousands of newcomers seeking for a job in this industry each year, what do not result automatically lower salaries for higher demands, but is closely connected with applying of some new working methods, and heaving here some newfangled phenomenon.* As a result, the apparel industry has never been as risky as it is today. The depression lasts for five-six years.

Innovative technologies and Internet offer an endless palette of creative opportunities, and sales work upon new rules. Criteria have changed. Setting of the brand strategy use to ahead the designing process of the current collection, and the manufacturing conditions can have a huge impact onto it as well. Collection practices, working methods and criteria of the 21th century fashion industry are quite different than they were 20 years ago, will be completely different in the upcoming future. Demand for diversity, immediacy, interactivity and virtuality will be even higher than now. Creative opportunities offered by modern technology will determine the future. The next generation of designers is right here, the future has already begun.

2. ACTUAL SALES AND CUSTOMER TRENDS

First of all: let's go shopping! Because let's face it honestly, we love to shop. *"One store a day, and you don't need a doctor!"* was the motto of global a global jeanswear brand[1] ten years ago. Since then the extent escalation in the situation is well known. There is as much if not more written today about

[1] Miss Sixty

the rhapsodic market changes in the magazines, than their professional content is. According to article of *The Wall Street Journal* [1] people wear only about 20% of their wardrobe regularly, all the others are regrets. Shopping is often more about desire than necessity, and the retail industry knows that well; many times people buy on a whim, or at the reason of ill-advised retail therapy.

Options of the creative customer became whimsical; a second hand piece is easily preceded by a 500 dollar CK dress. [2] The reference points have ceased to exist. Terms, as "lasting value", "creativity", "up to date fashionable", "sporty elegance" or "classic" became phrases. So called *digital divas* [3] are browsing feeds of *their favorites* on Facebook, buying gear without setting a physical contact with it. The **fast fashion**, well known as *Pronto Moda*, is forcing companies to update their product range with the hottest items of the catwalks if possible immediately, "*transcripting*" them into cheap, – i.e. wearable and manufacturable – mass-products, and offering them to their customers in the shortest possible time. Over the regular spring-summer and autumn-winter seasonal collection the product range must be periodically updated by smaller capsules. To live with this process means non-stop design, ongoing product development and pre-production coaching, unending developing of the brand strategy, perpetual market research and continually look for new trading options.

An international e-commerce agency operating within the framework of the University of Arizona [4], made a research in the United States and part of Europe among a total of 7500 customers. 22% of respondents were identified as a new category of customers called *digital diva*. Who are they? 53% are living in a household relationship, women between the ages of 25 and 44, part of them has children. The way how they shop and what they buy makes them special; 29% of them spent earnings on fashion items attracting other 40% of customers by sharing on the social network sites! Another milestone in retail is those concept shops and showrooms, which do not hold any products on stock and do not reserve personnel. Their complete product range is virtually and the entire product line can browsed on screens, and the order – along with free shipping ¬ can be downloaded via the remote device. [5] Art installation replaces conventional stocks of a regular store.

2.1. Visions of Modern Technology in the Future Life, and Some New Retail Techniques

Upon the vision of futurist, *Ray Kurzweil*, the fusion of man and technology becomes more natural then than it is now believed; in 20 years modern technology will be integral part of our life. [6] People can take care of anything from their homes, and will no longer bind to the urban lifestyle. Brand stores and shopping centers will be forgotten, as well as the shopping will be a thing from the past. After 20 years everything will be recycled, and due the nono-technology anything can be prepared at home, and can be all printed at home by using 3D printer. There some global brands, for who the virtuality is not distant vision of the desired future, but current reality. The use of virtual technology made brands non-stop available to their customers: by using smart phones, Internet, GPS and use a QR codes extends the communication and distribution opportunities and it enriches visual communication by creative solutions.

2.2. The Role of Social Media in Building of Brand Image and Enhancing Competitiveness

More and more are using social media for business; not only because it is a popular to set daily contact with the customers, but also a way of brand communication, an opportunity of self expression for the creative. That's why most of the brand put emphasis on the daily on-line activity, such as on effective product development and quality sales. However, it became very important who keeps this work, and how often a new entry is posted; to maintain the interest of the readers, a new item must be tweeted on a daily basis. Currently, the best known social media sites are *Facebook*, *Twitter* and *YouTube*, but this may change in an instant, and there are more and more profiles on the professional networking platform, *LinkedIn* too. However companies strengthening community presence confirms the fact that more and more people are using these sites for business purposes, but should be mentioned, that only slightly more than half of consumers are watching ads on the social web. Using a variety of apps can extend the effectiveness of corporate advertising.

But there is far more hidden potential in the social media tools; e.g. there are shops where multimedia mirrors are placed, which customers use to take pictures of themselves in certain product; after uploading images to a remote community page their friends can put likes in their new feeds, and may drop a comment. But the data of these pages isn't necessarily representative, nor genuinely reflect the respect of the brand. Monitoring agencies can offer help in this.

3. THE FUTURE DIRECTIONS OF SUSTANAIBLE FASHION INDUSTRY

The so called "crisis" of apparel industry is a transition period prior to complete renewal. This is a moment of **paradigm-shift** in fashion industry, which became one of today's most unsustainable global businesses. Paradigm-shift is a term quite often used these days, as well as the **sustainability** is, providing an opportunity for many misconstrue as well. In the annex of UN about Towards Sustainable Development stays: *"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."* [7] . This development is not a stabilized harmony, but rather a continuous change, in which the use of resources, purpose of investment, the direction of technological development, and the institutional changes are consistent both with the present and future needs. From the very beginning many questions arise connected with these statements above. Here's a bunch:

- What kind of breakthrough is necessary to be made, to reevaluate the current practice of *fast fashion designing*? How to manage fashion collections differently, if is true, that it is closely related with the crisis of the complete apparel industry?
- What are the near and long-term prospects in offering innovative and useful ways of organizing of the work on seasonal collections? Are these quantities of gear really necessary?
- Is our sector able to catch up with the ideology of sustainability in real, and if so, how?

4. FASHION TREND AS A BUSSINESS: CONCEPTS AND FEATURES

As American designer *Michael Kors* says, there was a time, when fashion has arrived from catwalks or entertainment industry. By now, creative influences come both from the heights and the depths, and the Market constitutes the final medley. The first known fashion trend forecasting agency was IM International, founded year 1968 by David Wolfe, on the Kings Road in London. [8] Since the information comes at a price fashion trend forecast became a highly marketable product, and number of fashion trend observer agencies has grown rocketed[2]. But fashion today seems to be driven today by young newcomer talents and managed by some celeb-bloggers, who make disputable credit of the professional platforms, negating their authority. Basicly, fashion trend forecasting, is also based on complex trend monitoring and analyzing. [9] Its main points are the following:

- The trend hunters locate trend germ, identifying the emerging concepts and definitions;
- Gathering all the information they try describe the likely direction of development;
- "Wrapping" the information into thematic units they adapt it by actualizing color, material and the shape. Thematic units use different color palette, fabric and accessory range, also the

[2] The most common are: http://www.wgsn.com, http://www.stylesight.com, http://www.trendstop.com,

proposed design is different, as well as the cutline and shapes. (Usually, three or four of these seasonal themes.) Elements will result a specific outlook suggested to a specific target group.
- A trend forecast also foresees the target audience that is expected, recommends the time of placing them on the market, as well gives suggestions for its visual merchandising as well.

This creative activity is attractive for many young designers, as well because of endless possibilities of professional fulfillment it offers, as well since the number of job seekers has grown rocketed. (The number of jobs has declined, thus each year there is a plenty of young designers on the fashion scene left without concrete work/job.) Now, creating of **fashion forecast mood boards** seems to be a way for professional debut. They can be easily published on the different spaces on the Internet ¬ as for example *Pinterest* ¬, an as well easily confused by official trend information.

5. MOODS, TRANSCRIPTS AND THE „COPY AND PASTE" EFFECT

What these so called trend forecasting and trend analysis agencies offer is a nice but not well mashup of stiles with blurred season boundaries. But: *All the new things are born upon existing ones***.** *Mashup* ¬ or popularly: *remix* ¬ is a transcript of existing things, which mixes stylistic features of known works editing them in free style. Basically it is a digital genre, which occurs in several non digital modalities. This is interesting to us because of the unique problems generated by appearing in fashion. Since exact forecasting and visualization of the first impresses became especially significant, enthusiastic moodboard-makers gather everything: images of the publications, source material from the web, color palettes, sketches and inspirations, as well as images of some already made clothes. Photos of manufactured products will serve as the inspiration for doing "something similar". And at the end is not easy to separate when the new product is a transcript, a so called a remix or mashup, and when it is a *plagiary*.
T*he essence of fashion is in its massive proliferation*; therefore the audience has always refused radical change of the shapes. Most of things for what we desire are what we have seen in our immediate environment. A brand collection is based on numerous private and somewhere saw idea; where and when has been some of them seen in this trans-cultural world, no one cares - since now! The root of the multi product idea *was total look*, offering complete product range to the fashion consumer. But few years of its existing was enough to be sure that it was a total blunder for most of the brands; there are endless quantities of unsellable stocks; too much of those unsellable compared with the sellable. [10]

5.1. Instant Fashion

Lot of manufacturers – generally located in Asia – who work for well known, influential global brands offer pretty nice products developed for these big labels. Anyone who worked together with the Far East can verify the opportunities that lay on the ground of endless showrooms full of apparel developed for brand; huge quantities clothes that can be easily *personalized*, e.g. replaced from one to another label. Finally, it is the reason of heaving many lookalike brands fighting on the market with excellent quality but similar product range = nearly same brand collection = almost same identity. Conclusion: *It's easy to fail with an excellent product range that is lacking the brand soul, and charming mistakes born upon the artistic whim.* Apparel industry fights with is hugely swollen inestimable stocks, which are practically impossible to value even technically or aesthetically. *Fashion leaves a pollution footprint.* In short, the apparel market is infested by trash. [11]

This problem is not only an economic one, but is also important because of its significant environmental and sustainability aspects.

6. FUTURE OF COLLECTION DESIGN, GLOBAL PERSPECTIVES OF APPAREL INDUSTRY

The current problems of fashion and apparel industry are born as a result of its recent working methods. They can be assumed in the following keywords:

- Fast fashion and demand for immediacy;
- Young designers left without job and practice;
- Moodboarding and pseudo-forecasting;
- Personalized manufacturers products gathered from the Internet;
- Degradation of local brands and local light industry due the globalization.

Due the overhead costs and logistics in order, vital aspect of managing is cost-effectiveness. It is important to limit the time for execution of work, to limit the quantity of the collection, to limit its target; to limit the product range.
For this reason, it is important:

- To have a clear definition of competence and role hierarchy;
- To specify the workflows;
- To optimize the workload per capita, and mutual transfer of knowledge;
- To clarify the deadlines, assignments and their enforcement;
- To have logical structure, uniformly accessible and manageable internal administration;
- Clearly defined marketing goals and quality demands;
- Efficient working tools, trained staff and qualified, creative professionals.

Within fashion, the apparel industry will became more virtual and seasonal collections will be presented by using 3D virtual technology, making brands more accessible. Designer and artistic tools will be even more virtual, and technological knowledge will take great part of the professional skills. Interactivity will be a must have of launching the collection. I believe, we are close to time, when quality expectations will meet real demands of the market in that way, keeping with the demands of sustainable development.

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ANALYSIS OF DIMENSIONAL STABILITY OF RIGHT-LEFT KNITTED FABRICS

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Abstract: *This paper analyzes the dimensional stability of the right - left knitwear. Dimensional stability knitwear is an important indicator of quality knitwear. Testing samples were made of unifilar combed cotton yarn of fineness 21 tex in composition 100% cotton, twists 600m-1 and strength 2,725 N. Samples were prepared in one frame needle machine of fineness E26 with approximately equal horizontal densities and different vertical densities of knitting. Three types of samples were made, as follows: Group I: m = 153.4 gm-2, Dh = 12.1 cm-1, Dv = 21.3 cm-1, Group II: M = 131.13 gm-2, Dh = 12, 5 cm-1, Dv = 15.9 cm-1, group III: m = 117.2 gm-2, Dh = 11.6 cm-1, Dv = 13.2 cm-1. The differences between raw, bleached and stained samples were measured by coefficients densities. Measured values of coefficient of density of raw knitwear for the first group of samples is C = 0.57, for the second group is C = 0.79 and for the third group is C = 0.876. After that this knitted fabrics are bleached. Whitening procedure consisted of the following phases: boiling, bleaching, wringing, washing and neutralizing, softening, drying and fixing. Measured values of coefficient of density of bleached knitwear for the first group of samples, where is C=0.68, for second group of samples is C=0.98, and for third group of samples C= 1,116. Raw knitwear are also stained. The staining procedure consisted of the following stages: before bleaching, coloring, squeezing, washing and neutralizing, softening, drying and fixing. Obtained values of the coefficients of density for colored knitwear for the first group of samples is C = 0.565, for the second group is C = 0.705, and for the third group is C = 0.816. The obtained values show that with the reduction of the vertical density of knitwear, coefficient of their densities is significantly increase.*

Key words*: cotton knitted fabrics, dimensional stability of knitted fabrics, density coefficient of knitted fabrics*

1 INTRODUCTION

Knitted fabrics are produced for different purposes, and because of them require appropriate features custom application in future. Each type has a specific knitwear specificity that determines its characteristic features such as length, width, thickness, surface mass, thickness, breaking strength, elasticity, thermal properties, color, touch, look, etc.. [1].

The stability of the structure of knitwear at the effect of different processing technology and power depends on its mechanical properties, which are caused by the characteristics of the structural elements of a lower rank (threads, fibers) involved in their construction, and the parameters of the structure and design themselves knitwear (applied interlacement, density arrays and rows of loops, the depth of cooling, etc.). [1, 2, 3]. Also the organization of the technological process and a way of making knitwear in the production facility can have a significant impact on the stability of the structure of knitwear.

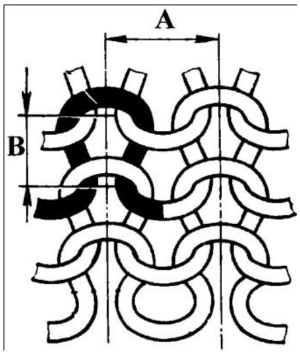
When analyzing the dimensional stability of cotton knitwear starting point is the change in density of loops in rows and rows. This change can be traced through the coefficient of density. In fact, one of the most important parameters, from a technological point of view the production of knitwear is the density of which is the number of loops on the surface of the unit. This parameter has a profound effect on all the other features izrađivanog twists. The knitwear is made of basic structural units - the loop in knitting that are arranged in vertical rows and horizontal rows. Therefore different:

The vertical density representing the number of loops in a row on a given unit length, and which is marked with Dv;
Horzontalna density, which is the number of loops in a row on a given unit length, and which is marked with Dh and

The total density of knitted fabric that represents the total number of loops per unit area of knitwear. This density is in fact a product of horizontal and vertical density of knitwear and is determined by equation (1):

$$D = D_V \cdot D_h \qquad (1)$$

One loop by height of knitt covers an area level loop, which can be marked with a B, as in Figure 1



Picture 1: The height of a loop and a loop step

Therefore, the vertical density of the knit is directly proportional to the measuring unit in which the density is determined, and inversely proportional to the height of the loop. It can be expressed by the following equation (2):

$$D_V = \frac{M_j}{B} \qquad (2)$$

Mj - measuring unit
B - the height of the loop.

The thickness of the knitted loop occupies a space of its width, which is also called the step loop and marked in Picture 1 with A. Taking into account the previous discussion is that:

$$D_h = \frac{M_j}{A} \qquad (3)$$

A - knit width

2. KNIT DENSITY RATIO

Density knitwear is often assessed through the number of loops on the correspondi ng unit of area. This information often does not give a true picture on the basis of which they could make general conclusions about the observed twists. The reason for this lies in the fact that the ratio of rows and rows of knitting is not always the same in a given unit length. This ratio for smooth knitting right-left has a value of 8:11 and is different for different kinds of knitwear. However, two knitwears can have the same vertical and horizontal density and to differentiate. The stitch density is largely dependent on the composition and properties of the raw yarn which knitwear is made of. So knitwear made from yarn that is obtained from staple fibers appear thicker than knitwear made of filament yarn. The ends of the fibers of the yarn loops to meet the gap, and therefore knitwear looks thicker. Also, if a different yarn is used, that count would get a different lather knitwear. Knitted fabrics made from finer (thinner) will have the greater area between the loops, low ductility, etc, while knitwear that is made from thicker yarns have much latherer loops, rough touch, low ductility, etc... Therefore, care must be taken when choosing the yarn that the choice is in line with the finesse of knitting machines. Only then it can get good knitted elastic properties.

The most important parameter in producing high-quality knitwear is the choice of appropriate density of made knitwear. Density depends knitwear:

• refinement of the knitting machine, because the thickness of the needle determines the basic size of the trap, which can range from the basic size only within certain limits;
• the thickness of the yarn, which at the same fineness of the knitting machines and the same depth of cooling affects the shrinkage of the knitwear, and thus the number of rows and rows of loops in knitting the appropriate unit of length;
• the depth of cooling, which directly affects the vertical density knitwear.

If the height of the loop B and loop width and the term quotient we are given the coefficient of the relationship between density. The ratio of density can be represented by the following formula:

$$C = \frac{B}{A} \tag{4}$$

The coefficient of the knitwear density given by expression (4) is in fact the relationship between horizontal and vertical density, the same relationship between the height and the width of the loop if we consider the same unit of length of the knitwear. If we consider a smooth right-left knitted the observed unit length of 10 millimeters, it will have to be:

$$C = \frac{D_h}{D_V} = \frac{\frac{10}{A}}{\frac{10}{B}} = \frac{B}{A} = \frac{\pi}{4} \approx 0.8 \tag{5}$$

For a simple right-left knitwear this ratio has an approximate value of 0.8, but usually in real terms it varies from 0.69 to 0.87. Depending on the density of the knitted fabric and its collection and therefore the coefficient of density can be taken for analysis of the knitwear collection after its removal from machines and various processing procedures of making knitwear [4 – 10].

2 MATERIALS AND METHODS

The aim of the study was to evaluate the applicability of the ratio of knitwear density for analyzing changes in their shrinkage after processing the staining and bleaching procedures. For testing samples are made of cotton knitwear unifilar worsted yarn count of 21 tex, rated in composition of a 100% cotton, stranding 600m-1 and volume 2,725 N. From this yarn woven samples smoothened jersey right - left knitwear to one bed needle circular knitting machines of large diameter fineness of E26. In addition to the analysis of structure parameters are analyzed and knitwear features of used yarn. The results are shown in Table 3.1.

To examine the stability dimension, knits are made in three different groups of samples. Different groups of samples were obtained by changing the value of input yarn tension in the system for knitting, the yarn tension devices. It is known that an increase in tensions entering the system for knitting and stitch density increases in the series. At the same time it reduces the consumption of yarn in the loop and thus increases the surface mass of knitwear. Thus made three groups of samples with different densities, ie knitting. depths of cooling. The samples were relaxed for 72 hours and then performed their analysis and the results are shown in Table 3.2.

After analyzing the raw relaxed knitwear industrial bleaching was done for the same samples. Bleaching procedure consisted the following phases: boiling, bleaching, wringing, washing and neutralizing, softening, drying and fixing. For bleaching procedure, raw knitted fabrics in bowel were merged and put in bath with a winch. The ratio of material and water was 1:10. Knitted samples were boiling for 60 min, before bleaching procedure. Boiling solution contained> water, lavotan TVI - detergent and calcium soda. After discharges of this solution, samples are bleached in new solution which contains> Kontavan - optical stabilizer, calcium soda and hydrogen peroxide. The samples are boiled on 980C in duration of 30 min, and then in solution was added Tubbolanc HA-PD- optical bleach. After this, bleaching procedure was continued in duration of 65min. Then, fleet is cooled to 600C in next 30min, and relished. After this procedure, samples are washed on 600C and soften with "Mansa Finished 2606" in duration of 30min on 400C temperature. After drying the samples were re-analyzed. The goal was to determine how the processes of knitting and bleaching affect on shrinkage of knitted fabric with different densities i.e. on coeficient changes in knitted fabric densities.

After the analysis of raw knitted samples was performed on the relaxed knitwear, they were industrialy painted. The staining procedure consisted of the following stages: prewhitening, painting, draining, washing and neutralizing, softening, drying and fixing. Staining was performed on the knitwear pieces as were in a worm shape and put in a tub with a churn. The ratio of material and water was 1:10. A solution of prewhitening contained water, "Lavotan" calcium soda and hydrogen peroxide. Staining solution contained: "Meropan DPE" color 15gl-1, industrial salt 30GL-1, caustic soda, vinegar, fabric softener and a averages for removing excess paint "Kotoblanc RS". The staining procedure was performed at 60 ° C of 60 minutes, with color added to 20oC. Knitwear was then pressed by passing between a pair of rollers. Then it dried by passing heated air through the kiln and eventually the fix was done.

After this phase of processing knits was done, samples were re-analyzed and the results are shown in Table 3.2. The analysis goal was to determine how knitting, bleaching and dyeing processes affecting the collection of knitwear with different densities, ie. the change in density of knitwear.

Knitting and testing of the samples was carried out at a temperature of 20 ± 20C and relative humidity 65 ± 4%. For the analysis of structure parameters, knitwear standard methods were used. Horizontal and vertical density of loops in knitting was measured at 2 cm, and the average value was calculated on the basis of 10 individual measurements. Weight per square meter of knit was calculated based on 5 single measurements of some samples. The strength and stretch of the yarns were tested on a dynamometer, where the length of the tube was 500mm, and the rate of extension 0.08 m / min. It is pre-loading the yarn was 0.5 cN / tex. The average values of all measurements were based on 20 measurements. The average values of twist are determined to torsionmeter with a load of 0.5 cN / tex based on 20 measurements.

3 RESULTS AND DISCUSSION

Test results of the main characteristics of the yarn are shown in Table 3.1. Test results of the knitwear structure parameters are shown in Table 3.2. In the process of the results of measurements conventional statistical methods were used. The tables are only the results of average values and coefficients of variation.

Table 3.1: Results of the main characteristics of the yarn

Number of mesuring	Stranding (m^{-1})	Strengh (N)	Elongation (%)	Yarn count (tex)
1	606	2,7	4,6	20,50
2	595	2,9	4,8	20,7
3	594	2,8	4,4	20,85
4	600	2,6	4,6	20,85
5	603	2,66	3,8	20,78
6	611	2,9	4,8	20,76
7	595	2,74	5,2	20,96
8	546	2,82	5,0	20,84
9	664	2,7	5,2	20,85
10	523	2,92	3,9	20,90
11	598	2,9	4,6	20,93
12	609	2,7	4,8	20,73
13	620	2,66	4,0	20,04

14	623	2,48	4,4	20,19
15	595	2,50	4,6	20,25
16	597	2,6	4,2	20,28
17	600	2,68	3,8	20,42
18	603	2,54	4,6	20,50
19	611	2,8	4,0	20,52
20	606	2,9	4,4	20,7
$\overline{X}$	600,05	2,729	4,48	20,63
Cv (%)	4,47	4,99	9,33	1,3

Table 3.2: Results of structure parameters knitwear

Samples of I group						
Structure of the knitwear	Raw		Bleached		Colored	
	$\overline{X}$	Cv (%)	$\overline{X}$	Cv (%)	$\overline{X}$	Cv (%)
Šp(cm)	158,76	0,44	127,78	0,45	161,52	3,04
$m_p(gm^{-2})$	153,4	1,28	152,05	1,43	141,09	1,63
D_h /2cm	24,2	1,65	30,4	4,92	23,40	2,09
D_v /2cm	42,6	1,15	44,4	1,1	41,40	1,93
C	0,57	1,32	0,68	3,99	0,565	1,58
A(mm)	0,824	1,46	0,66	4,9	0,85	2,30
B(mm)	0,47	2,1	0,446	1,1	0,48	0,40
Samples of II group						
Structure of the knitwear	Raw		Bleached		Colored	
	$\overline{X}$	Cv (%)	$\overline{X}$	Cv (%)	$\overline{X}$	Cv (%)
Šp(cm)	160,2	0,656	133,4	0,8	165,48	0,36
$m_p(gm^{-2})$	131,13	1,8	122,16	2,13	109,60	1,14
D_h /2cm	25	2,53	28,4	4,22	22,20	3,37
D_v /2cm	31,8	2,35	29	2,18	31,60	3,23
C	0,79	3,96	0,98	5,58	0,705	6,17
A(mm)	0,8	2,37	0,702	4,54	0,90	3,32
B(mm)	0,628	1,79	0,013	1,83	0,63	3,43
Samples of III group						
Structure of the knitwear	Raw		Bleached		Colored	
	$\overline{X}$	Cv (%)	$\overline{X}$	Cv (%)	$\overline{X}$	Cv (%)
Šp(cm)	179,12	0,66	140,24	0,39	175,16	1,12
$m_p(gm^{-2})$	117,2	4,33	106,36	2,14	96,70	3,32
D_h /2cm	23,2	3,23	25,4	5,34	20,40	5,00
D_v /2cm	26,4	1,86	22,8	3,28	25,00	3,58
C	0,876	4,82	1,116	7,8	0,816	7,94
A(mm)	0,86	3,47	0,79	5,6	0,98	4,88
B(mm)	0,76	1,94	0,03	3,41	0,80	3,35

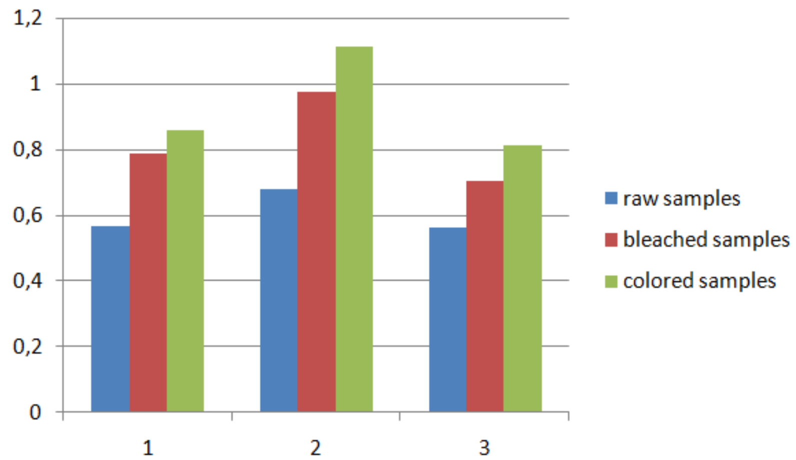
Tags in Table 3.2 are: SP (cm) - width knitted sample in cm mp (gm-2) - mass of a square meter of knitwear in gm-2, and DH / 2cm - horizontal density expressed in number of knitted loops to 2cm; Dv / 2cm - vertical density expressed in number of knitted loops to 2cm, C - coefficient of density knitwear, A (mm) - mesh width in mm and B (mm) - the height of the loops in mm.

Test results show that the characteristics of the yarn samples were made from knitted cotton unifilar combed yarn twists 600.05 m-1, measuring 2.729 N, 4.48% elongation and fineness of 20.63 tex.

Test results of the knitwear structure parameters show that changing the value of input yarn tension in the system for knitting and significantly changing values of vertical density knitwear. The largest tensile force was in the first group of samples. This results in the highest value of the vertical density knitwear Dv/2cm = 42.6. In reducing the tension in the other group of samples, reduce the value of the vertical density was Dv/2cm = 31.8. Upon further reduction of tension in the third group of samples, there is even reduction of the value of the vertical density was Dv/2cm = 26.4. It also shows the results of measurements in bleached knitted samples. For the first group of samples values of vertical density knitted samples were Dv/2cm=44,4, for second group of samples Dv/2cm=29, and for the third group Dv/2=22.8. It also shows the results of measurements in colored knitted samples. For the first group of samples knitted vertical density was Dv/2cm = 41.40, for the second group of samples Dv/2cm = 31.60, and for the third Dv/2cm = 25.00.

The results also show a change in mass per square meter of knitwear. Of the raw sample weight knitwear for the first group of samples is 153.4 gm-2, the second group of 131.13 gm-2 for the third group of 117.2 gm-2. Also this change is present in colored patterns. Thus, the mass of the first group of samples 141.09 gm-2, the second group of 109.60 gm-2 and the third group of 96.70 gm-2.

A more comprehensive indicator of the change is the ratio of density of knitwear. It shows the relationship between horizontal and vertical density, the same relationship between the height and the width of the loop if we consider the same unit length knitwear. Figure 2 shows the comparative values of the coefficient of density of samples of raw, bleached and colored knitwear.



Picture 2: Comparison of density values of the coefficient of raw, bleached and colored knitwear patterns

Picture 2 shows that the coefficient has a density of knitwear for all three groups of samples with a lower value of colored samples, and a higher value of bleached samples compared with samples of raw knitwear. This is due to finish fixing the dimensions of knitwear. Specifically knitwear that was hose shaped to finish is subjected to compressive shrinkage of the compactor. Prior to entering the work area for the collection of knitwear is steamed and stretched using special spreader to the desired dimensions. The tested samples were taken from existing production program for making knitwear companies so that during testing could affect the value of the machine settings compressive shrinkage of the compactor. This suggests that the final stage of finishing with colored and bleached knitwear affects on structure changes of the three groups of samples.

4. CONCLUSION

Dimensional stability knitwear is an important indicator of their quality. It creates difficulties in finishing of garments and later during use or wear and maintenance of jersey garment knitwear. Dimensional stability knitwear depends on their structural and constructional solutions, as well as the technological requirements of making the knitting process. In addition, the most important is role of the material, structural, physical and mechanical properties of yarn, horizontal and vertical stitch density, depth of cooling, as well as applied interlacement knitwear. Knowing the connections of structural and mechanical properties of knitwear reflects the posibilities of their proper design depending on the future use. This paper therefore analyzes the dimensional stability of the right - left knitwear by coefficients of their density. The study shows that the ratio portrays as an important indicator of the comparative value of the characteristics of raw, bleached and colored knitwear samples. The tested samples were taken from existing production program for making knitwear companies so that during testing could not impact on value of the machine settings compressive shrinkage of the compactor.

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REINDUSTRIALIZATION SERBIAN ECONOMY WITH EMPHASIS ON CLUSTER FORMATION IN TEXTILE INDUSTRY

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Abstract: *Due to the very difficult economic situation and impending financial consequences, Serbia must, under specific regulated financial relationships to initiate the process of re-industrialization as the only way for progressive economic development. However, even in the planning phase, Serbia is in great difficulties, since the re-industrialization involves the introduction of a completely new technology, requiring large investments for a long time and also training of all necessary staff profiles.*
In this context, Serbia must take the following steps: a financial consolidation abroad and within the country, the definition of a brand new business and administrative management of the state, reduce corruption, stabilize the currency, security and sustainability of energy required amount of food, reversed and improve the negative demographic changes introduced profila with other education stakeholders as possible and set priorities, etc.. All these processes are important in the processes of industrialization of the economy and are very interesting related to the negotiation process in Serbia's entry into the European Union.

This paper provides a brief overview of the possibilities and prospects of re-industrialization of the economy of Serbia, with reference to previous investments in the corridor zone 10, the most interesting areas, and the benefits of clustering in the textile industry in Serbia.

***Keywords**: Re-industrialization, The economy, Textile, Fashion Apparel Clothing, Cluster, Investment, Serbia.*

1. INTRODUCTION

The concept of privatization taking place in the last two decades in the states (Yugoslavia, Serbia and Montenegro, and Serbia), and the sudden and drastic liberalization of consumer goods are directly struck by the real sector, especially our own metal and textile industry. This approach has led Serbia into a deep economic, political and general social crisis, which they complement and adversely affect the theoretical re-industrialization. Bad policy reforms and weaknesses in the political, economic, financial, monetary and other forms of institutional resources and the like., With disastrous management of foreign debt, led Serbia into a position of highly indebted countries.

In Serbia, have been recorded and many other problems, which are important in the re-industrialization, as for example: all weaker necessary qualitative human resources with a large outflow of all kinds, especially when it comes to human resources for sophisticated industrial products, the lack of investment funds and programs, technological obsolescence, high indebtedness to foreign and domestic banks, the lack of foreign markets and others. These are all facts that do not inspire hope that the accumulation of the Serbian economy a quick fix, especially because in the last decade mainly by the same or partly the same personnel who, through their ignorance, poor working and doing what is necessary over time, contribute to many negative trends in our economy. [1][4]

Today we have the opportunity to hear often extremely optimistic, but quite unrealistic statements by politicians that Serbia is increasingly created conditions for the recession. In order to really what happened is needed economic growth of 5-7% for several years in a row, which is evident in the difficulties that Serbia is practically impossible.

2. TRANSITION EFFECTS OF INDUSTRIAL SINCE 2001. SERBIAN

Post-socialist economic transformation of Serbian society and transitional shift from command-planned to a market economy, conditioned the general fundamental structural changes in all sectors of the economy. Market operations, designed neo-liberal ideology, would require a whole different ownership structure, organization design, governance, and communication within and outside the company than the one that was dominant in the era of self-management socialism.

Serbian economy began to crumble the disintegration of Yugoslavia, wars waged on its territory, the UN sanctions, inaccurate transition and privatization, then the criminal NATO bombing, and after the democratic changes again, wrong privatization, with many industrial facilities in this period were destroyed or brought to the hopeless economic situation.

Country establishes the Agency for privatization that through the tender and special offers, offers industrial enterprises for sale. This process was carried out according to the Law on Ownership Transformation Act and privatization, along with numerous annexes were eventually brought, depending on the economic environment, which, however, was not positive, as expected. First they sold, then a profitable enterprise, as for example: cement plants, breweries, a pharmaceutical company, chemical products, textiles, tires, tobacco, etc. [1]

When it comes to the textile industry and as part of Yugoslavia, and later, in Serbia there were no small towns that did not have a facility for production of textile and clothing apparel. The very fact that the big cities like Belgrade, Novi Sad, Vranje, Leskovac, Paracin, Subotica, Zrenjanin, Kragujevac, Kraljevo and many others, textile production had Sjenica, Novi Pazar, Arilje, Gornji Milanovac Inđija, Ivanjica and many other smaller towns.

In addition due to a lack of ownership transformation, companies in so doing encounter with a large presence of the gray economy, both in terms of legal and illegal trade. The strong presence of imported goods from China, Turkey, Greece and other countries, it is evident that widespread marketing of domestic products in markets throughout Serbia. In such circumstances, manufacturers of domestic goods is not a leg to survive in the legal economy, and yet unjustly forced to enter the informal economy.

In many factories have found a new owner, a certain number of workers and now goes to work, and the state simply does not know what to do with them and their continued existence through so-exists. restructuring, with the state subsidizing so production, the non-payment of taxes and fees, electricity, water and the like, the company and the country is one big load. Proponents of privatization as an important transition process, including the proponents of the privatization, expected to over-optimism that such a process would bring progressive economic development and social stability. Life is denied them, because those expectations were not realized, because about 30% of the privatization was to no avail, and the effects of transition in Serbia re-industrialization, were extremely negative, primarily because:

- boost the economy generally proceeded from the budget, to fund the development, funding agencies, insurance companies, ministries and their offices, treasury and others,
- the instruments were in the form of grants, loans (domestic and foreign), guarantees and training, the formation of clusters, business incubators in other respects,
- effect of this financing, the funds spent, is very poor, with no apparent productivity but visible social programs and fruitless attempt preservation of existing jobs, as well as easing the tense situation among the workers through of minimum fees,
- significant contribution to the realization of such a poor transition has a very significant presence of kleptocracy and the presence of corruption in the highest political institutions, which led to the point where the power used by individuals for personal gain and profit of the parties, and all at the expense of population population,
- and others.

Way to perform poorly with obvious facts, open the appropriateness of orders of the European Union to review the legality of the documents and the 24 companies in Serbia, the European Parliament is marked as disputed in privatization and asked for their check.

3. PERSPECTIVES REINDUSTRIALIZATION SERBIAN

The fact that the investment in the economy of Serbia, the 2012th and this part of the 2013th, was less than 2011th, according to the pessimistic expectations of foreign investments in the coming years. The economic crisis in many countries, especially in the neighboring countries and some EU countries, significantly slowing economic activity, which is mainly based on domestic resources and comparative advantages.

In order to overcome the difficulties and Serbia entered into a serious re-industrialization, has to make fiscal consolidation (the fulfillment of obligations and abroad and within the country) and to increase the level of economic activity. In countries in transition, there is usually a drop in production and it decreases the first few years, and then created the trend of production growth. In Serbia, the trend was the opposite, variable permanent decline of production, more than 20 years. Therefore, Serbia must start re-industrialization as the only path to economic development that is much needed and as soon as possible. This path is not easy, fast and simple, because Serbia is known as a country where a lot of financialization present, characterized by the financial sector and the services that make for a long time most of the GDP, which is unacceptable for 25% of the unemployed labor force.

Re-industrialization, means including a completely new technology, requiring large and long-term investments, which must provide: the sustainability of all forms of energy and integrated transport, adequate food, increase fertility, improve and expand education and other stakeholder profiles. However, in addition, to implement the plan of re-industrialization to create a new administrative mechanism of governance and their interconnection. Otherwise the investment into such functioning of the state would lead to an even greater waste of money and faster to bring the state into greater debt crisis.

Today, Serbia is the most difficult question, what should be the driving force of the re-industrialization, and where to focus scarce resources and human resources. Some kind of self-rescue can begin arranging major effort imposed by the ambient environment, in particular: energy, agricultural and food industry, automotive industry, textile and construction industries, agricultural machinery, transport logistics, information technology and so on.

4. FEATURES AND GENERAL STATE RESOURCES IN SERBIAN RE-INDUSTRIALIZATION

Of the last two decades saw a steady decline in employment in the industry. According to the data of the Statistical Office of Serbia in 1991., the industry and the craft were engaged 1.02094 million workers, 2002., the number was 711,725. Two decades later, 2004th, the manufacturing sector was employing 551 429 workers, 2010th, 407 154. According to the 2012th, the manufacturing industry employed 378 789 workers., which is 17.7% of total employment. It can be seen that Serbia in the last two decades has lost about 700,000 industrial workers.

All these negative circumstances significantly impede the planning and implementation of economic policy, which should be directed towards the following directions: production for export, inflation control, regulation of fiscal policy, public expenditure and reducing the overall rationalization of state institutions, and regulation of para-fiscal taxes, reducing external and internal debt, reducing corruption and kleptocracy eliminate, to the formation of accountable and effective state institutions, as in many EU countries, in other words radically changed business environment. [11]

It seriously needs to define priorities at the level of industries, whose products can be sold on the world market, otherwise, they would not be allowed to be in the event of a miscarriage of the plans invested state funds into a social program, but must be returned to the state or commercial bank.
The purpose of incentives must be long-term financing, but the opportunity to get in as soon as possible to enable the company to operate independently.

The largest number of industries in Serbia has no sustainable growth, all of which are largely financed with borrowed resources that pay high interest rates-approximately 20% annually, with the indexation rate. The risks of over-indebtedness are enormously high, many companies have gone bankrupt or have filed for bankruptcy, and industry can not invest in their business or anticipated depreciation of equipment, making it completely technologically inefficient and unprofitable. [6]

5. SIGNIFICANCE CLUSTER FORMATION IN THE TEXTILE INDUSTRY SERBIAN

Under cluster means joining the group of companies and institutions in the public and private sectors, which aims to increase the competitiveness and business efficiency and to ensure the Serbian branch of industry as a whole. Textile industry cluster in Serbia was registered in September 2010th, and the establishment of ideas started 1.5 years ago, on the initiative of some companies in textile industry from Cacak, Belgrade Arilja, supported by competent sectoral research institutions. The idea was mainly to focus on the territory of Serbia, and to include the textile fashion industry, with as many private companies, as holder of the brand.

Until today, the cluster has expanded and is currently made up of about 20 private companies.
In addition, members of the cluster are also academic, technical and professional institutions. As supporting institutions that support the entire initiative as example: Some Regional Development Agency, the Agency for Local Economic Development, Regional Centre for Development of Small and Medium Enterprises (DSME). In support of small and medium-sized enterprises are very important: the legal framework, institutional framework, financial resources, better access to new skills and knowledge, shared services, and support for partnerships, branding, developing marketing strategies, working together on innovation, effective implementation of QMS, co-financing from private and public entities and others.

The total number of directly employed within the cluster is about 3000, and indirectly through a cooperative network of over 4000 employees. Through the activities there are opportunities to generate new jobs in the member companies through a number of activities that can be implemented.
Cluster vision is that through a number of activities, states serve as the lead organization in support of strengthening the overall economic competitiveness of enterprises related to the textile and apparel industry whole market in Serbia, and the other abroad.

Cluster in the textile industry has a huge role in achieving economic growth and the competitiveness of countries in transition, in their accelerated path towards the EU market.

Establishing clusters in the textile industry in Serbia is of particular strategic importance for the development of Serbian economy and so far there are association-clusters in clothing and textile industry, whose sole purpose is gathering experts from the industry, to better represent their interests.
Due to the advantages that primarily reflected in the cooperation, interdependence and exchange information, knowledge and experience, companies that are members of the cluster can achieve better results than those that are not. [8][9]

The main strategic goals of the cluster can be seen through the following activities:

1. Cooperative in the public and private sectors, with the aim of raising activities of cluster members, and hence the sector as a whole.
2. Increase efficiency and the success of the cluster members and their workforce, through a series of programmatic interventions that will aim at cooperation in professional activities and exchanges in all aspects.
3. Stimulation of medium-and long-term financial sustainability.
4. Expansion more services to the states through joint activities with the intention of achieving savings for its members, as well as through the development of innovative projects.
5. Encouraging organizations to lobby and help the textile industry in Serbia, with the aim of improving the business climate in the textile industry.

6. Expanding membership and activities in the long term in order to capture firms of similar rank in textile fashion industry, with domestic and foreign capital.

The realization of this goal, the cluster associated with the textile industry in the form of cooperation and many other institutions in the country and abroad, as for example: the Ministry of Finance and Economy-the kind of support innovative clusters, the National Development Agency of Serbia-the implementation of projects Merr of the Agency for Foreign Investments and Export Promotion Agency-a series of program activities together with local cluster, the Agency for Export Insurance AOFI-lower interest rates for firms cluster members, the Regional Development Agency - an agreement on strategic partnership and co-operation from the beginning of its establishment, many municipalities-cooperation in the SEE EU IPA funds as co-financiers of innovation cluster project, the EBRD project to support clusters and rusty marketing promotional materials, SECEP EU project-from inception to now the constant support and work with consultants, training programs, courses, workshops the cluster members and the like, GTZ ORF project of the German government-cooperation textile associations SEE countries and the development of future activities and business cooperation, Regional Development (DSME) Belgrade, Serbian Chamber of Commerce support the entire industry.

The most famous cluster in the apparel and fashion industry in Serbia is FACTS (Fashion Apparel Cluster Serbia), which includes a number of states, some of which are: Tiffany production, Extreme Intimo, Luna, Garman, Leonardo, Sanatex, Veriteks, Azzaro, Baby Kids, Passage, Legend, Geger, AMC, Faculty Mihajlo Pupin Zrenjanin, Faculty of Applied Arts, Belgrade, Higher Technical School of design, technology and management of a Belgrade et all.

6. PERCEPTION OF SMALL AND MEDIUM ENTERPRISES (DSME) IN THE TEXTILE INDUSTRY SERBIAN

Economic development of Serbia in the textile, fashion and clothing industry could be in the near future based on development and expansion of SMEs through their association in the form of clusters. In this respect, Serbia could quite apply based on validated models that are used in western countries. In order to achieve this it is necessary to increase the availability of professional development and training as well as academic and professional secondary education.

Small and medium enterprises (DMSE), it is necessary to provide easier access to financing various development and incentive programs, increase the liquidity of the company through the transparent allocation of resources, improve and increase legal certainty, which would enable faster collection of loans, thereby reducing the amount of necessary collateral required by the lenders. Such companies must be dynamic, flexible and efficient, to the new products and services to stimulate the competitiveness of the national economy in this area. The process of giving incentives should be neutral with less bureaucracy and greater transparency. In all these activities, it is necessary to encourage the cooperation of innovative companies and research centers and institutes for their research, and for other users. [5]

Small and medium-sized enterprises in the textile, fashion and apparel industry through legislation to enable the administration reduced with minimal costs. This would increase the competitiveness of enterprises, the fulfillment of the prerequisites to increase exports, with the state providing export credit guarantees and assistance in finding foreign partners through bilateral chambers of commerce.

7. INVESTMENTS IN TEXTILE INDUSTRY IN SERBIAN CORRIDOR ZONE 10

In Belgrade, lnđija, Subotica, Novi Sad, Svilajinac, Jagodina, Nis, Leskovac and other towns in the area of Corridor 10, the standard of living is slightly higher than in many other places in Serbia. Out of a total of some $ 18 billion of foreign investment in these areas is almost placed sixth. Foreign capital, decides to do so primarily in order to reduce transportation costs, contracted with the local population, increased demand for goods, promote economic growth, cheap labor, many of the benefits that the state provides investors, convenient location in South Eastern Europe, etc. It significantly contributed to the Serbian state incentives in the form of: co-financing of each position, giving of the benefit of land holding, releasing a certain time of payment of taxes and contributions, and many others.

However, investment in the area of Corridor 10 in the textile, fashion and garment clothes are not important, which to some extent expressed little interest of domestic and foreign investors in general to investments in textile ibdustriju Serbia. Through some future cluster activities, is likely to create better conditions to make investments were significant, not only in the corridor zone, but also outside it. Some of these investments are implemented and in which there is some production are:

- Germany's *"Falke"* in Leskovac opened the unit for the production of socks.
- The Rumi Croatian company, *„Adriana text* ", member of the Italian, *"Calzedonia"*, plans to build a plant to 5,000 m^2 manufacturing swimwear. The value of investments will amount to € 7.2 million euros and will employ about 71 workers by the end in 2014th., another 193 workers. According to forecasts of expected total annual revenues of approximately 2.232 million euros.
- Significant investments and businesses, "*Insert"* from Belgrade, shoe manufacturers and lower parts of the fashion footwear. lnsert working for renowned customers-Chanel, Christian Dior, Valentino, Prada, Serda Rossi et all. It is planned to build new office space of 4,000 m^2, with an investment of 1.5 million euros. It now has about 100 employees by the end of this year we expect another 90 new jobs.
- In announcing the agreement on the allocation of budgetary resources to boost the Italian company to open a shoe factory, *"Geox"* in Vranje, which will invest 15.8 million euros with 1,250 workers employed. The plan is projected to produce 1,250,000 pairs of shoes a year, and for each position the company to get 9,000 incentive from the Government of Serbia. [5]

8. CONCLUSION

Without growth in economic activity can not be solved major problems in Serbia, such as increased employment, improved living conditions, stop the exodus of young and educated professionals abroad, can reduce the burden of repayment of foreign debts , increase exports and living standards, increase the gross national income, etc. From all this it follows that Serbia needs to access re-industrialization, but not with the expansion of the existing industrial policy and existing institutions. This is confirmed repeatedly demonstrated the negative current mechanisms, because Serbia has good plans industrial policy, coordination and control of institutions, mechanisms to prevent corruption and kleptocracy, there is no market discipline, a big-spending, lack of cooperation between the government and the economy, there is an open process of consultation too-present political government, the so-called. particracy, not an expert, that the money would be invested and spent rationally and others.

In the re-industrialization of the textile, fashion and clothing industry needs to pay more attention to the creation of better conditions for the operation of small and medium enterprises, modeled on related companies in developed western countries, can greatly contribute to a better and faster economic growth.

According to some estimates, Serbian textile industry is in the worst situation in the last few decades, a number of reasons: lack of working capital, the presence of the gray economy, lack of interest and lack of needed young professionals, the lack of primary production (clothing manufacturers are import dependent, in addition to materials and imported materials), lack of soft loans, etc.

To solve such problems, the role of cluster formation in the textile industry in Serbia is of particular strategic importance for the development of this branch of the Serbian economy, which is one of the goals gathering of experts in this field, in order to better represent their interests and solve existing problems.

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STRATEGIC MANAGEMENT OF DESIGN ACTIVITIES

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Abstract: *Strategic level of management of design activities is defined through creating connections between design, business strategy, and identity and culture of the company. The main goal is controlling the consistency of work of the design sector (department) within the company, as well as incorporating design activities in the processes of the entire business strategy formulation. In those cases the design manager takes a role of strategic consultant, which helps in determining the long-term design vision of the company.*
At the strategic level, the design manager has several key roles: visualizing business strategy; researching key competence; collecting marketing information and innovation in management processes.
Design manager, accordingly, has to participate in determining the design strategy, selecting of the strategy alternatives and implementing the chosen option. At the same time , he seeks to implement design knowledge in the variable market vision and to monitor the progress of design spirit through the business goals.

Key words: *strategic design management; business strategy; strategy consultant; determining strategy; selection of the strategy alternatives; strategy implementation.*

1. INTRODUCTION

At the strategic level of management, it is necessary to create a relation between design, business strategy, identity and culture of the company. Purpose of this is controlling the consistency of design activities within the company, as well as incorporating design in the process of determining the business strategy. At the same time, long-term design vision is very important. In those circumstances, the manager of the design sector in a company or the employed design expert become strategic consultants of the top management.

Strategic level of design activity management demands from the design manager to accept new tasks such as: visualizing business strategy; researching key competence; collecting marketing information and innovation in management processes.

Design managers have to participate in all fazes of the strategic management of design activities. Primarily, they have to be involved in determining or formulating the strategy, which means analyzing competitiveness (both external and internal), as well as goal setting. Also, design managers are involved in choosing the feasible strategy, as well as its implementation.

As active judges of the whole process of strategic management, design managers are striving to implement design knowledge in the variable market vision. In practice the design strategy is more a result of the chosen path than consecutive key management decisions.

2. STRATEGIC PROCESS OF MANAGING DESIGN ACTIVITIES

Strategic process of managing design activities involves: formulating the strategy based on strategic analysis (external and internal analysis of competitiveness, setting organizational goals, strategic evaluation); choosing the feasible strategy and strategy control.

2.1. Formulating the strategy: competitiveness analysis

The purpose of analysis of the competitiveness is to determine the attractiveness of a department or activity that the company belongs to. Attractiveness is primarily measured by margin of profit of the invested capital, as well as by other success indicators that must be recognized and managed by every company that wishes to survive on the market.
Competitiveness analysis is done through two consecutive evaluations and synthesis of SWOT analysis.

2.1.1. External analysis – prospects and threats

External analysis or environmental analysis are done on two levels: prospects of the company and its design function (1) and threats to the company and its design function(2). According to this, by analyzing the attractiveness of a given department or failing activity, the design manager explores:

- Important environmental influences in the previous time period and their effect on the future period. Given approach considers key political, economical, social and technological factors.
- Competitive advantage of the given national market by using business strategy, specific conditions, local demand, and stimulation between departments (sectors).
- Strengths that define the nature of the competitive business environment through admission barriers, intensity of the rivalry between existing competitive businesses, threats by the new competitors, negotiation skills of the suppliers and buyers, threats by substitute products, etc.

Analysis is finalized by constructing the scenario based on the key factors and change factors. Scenario planning is based on verifiable presentation of predictions for the next five years.
Second activity of the design manager is analyzing the competitiveness of his company, meaning:

- Determining strategy clusters made by regrouping of the companies within departments with similar characteristics.
- Determining the strategic domain of company's activities, considering that the potential design input is in the company's perception of its own activity.
- Determining the segments of the market that have similar buyers and product users. Criteria for segmentation based on demand are : the type of buyers, usage functions, ways of distributing and geographic zone. On the other hand, criteria for segmentation based on offer are: the type of technology, the structure of expenses, control of competence according to key success factors, etc.

Design manager is supposed to find the best criterion for determining market segments and effective resource allocation.

Finally, each domain of company's strategic activities must be well matched with the attractiveness of the given department and competitive resources of the company.

2.1.2.Internal analysis : strengths and weaknesses

Internal analysis of company's strengths and weaknesses based on its resources or strategic capabilities is also done on two levels. The first level is the level of company's strengths and design functions, and second level is the level of weaknesses. According to De Mozota (1, pg. 241), the internal analysis includes:

- The revision (reanalyzing) of the resources, which includes their identification and classification, that can be internally or externally engaged by the company in order to support its strategy. Those resources are human, physical, non-material ,and especially unique, owned by the company.
- The analysis of key competence through analyzing the value chain, which enables identification of the function that can ensure the competitive advantage of the company and resources from which to develop those advantages.
- Benchmarking, as a comparative method which helps in comparing the company's capabilities with best practices implemented in other companies.
- Balanced business portfolio, as an instrument which aids in confirming the importance of portfolio activities of the given company.

Generally speaking, the company can be divided in multiple ways. Primarily, the company needs to be divided into several homogenous sections or strategic segments. Strategic segment is a homogenous part of activities identified by the combination of the key success factors specific of that domain and

independent from other domain of activities of the company. Each of the strategic domains mobilizes specific knowledge that the company has experience in and searches for competitive advantage.
Strategic segments have to be analyzed through two variables: competitive position of the company in each of its segments (1) and value of each segment (2). This enables the creation of specific design strategy for each segment.

The last step in the process of internal revision is the selection of key success factors, that have to be mastered by the company in order to bypass the competition. At the same time, the fundamental question is raised about the place of design in given key factors. The most common success factors are: position of the company on the market, position based on expenses, commercial image and distribution, profitability, financial power, etc. All those factors help with defining of the design strategy.

Finally, going from internal and external SWOT analysis, the concurrent analysis is finalized. SWOT analysis is the main instrument of strategic analysis that is very compatible with the strategy of management of design activities.

2.2. Formulating the strategy : setting the goals

Strategy formulation depends not only on corresponding results of the external and internal analysis, but also on understanding of circumstances that determine the goals of the company. Therefor, the design manager has to carefully consider the strengths that affect the company's goals. According to De Mozota (1, pg. 243), these strengths are in question:

- Corporative management that defines the company's interests and ways in which its goals and priorities should be achieved. This management became more complex due to separation of management and ownership and tendency to make the company depend more on its stakeholders.
- Power/influence matrix that separates the investors according to their power and interests involving the company's strategy. Although there is a solution for common goals, there are often differences in expectations of interested stakeholders, so it is very useful to analyze them.
- Business ethics determine the global positioning of the company which is tied to its responsibilities towards the local community .
- Culture context on different levels: national and professional culture.

So, there are many opposing sides affecting the company's goals. Goals are closely intertwined with the mission, vision and identity of the company. Company mission is to support the reason of its existence. Mission has to be visionary in the sense that it has to deduce the strategic aims of the company and confirm its main value. Design manager should participate in defining of this vision by creating the concept which integrates communications and strategic values of the company.

At the strategic level the design manager is included in constructive approach of building the reality, through language. Consequently, design is the unavoidable process, for creating as well as diffusing of perceptions, visual and abstract. Those perceptions are materialized and become visible through the visual identity of the company and its focus on specific identity components. Identity components are company's culture and its three elements:

- Symbolic elements: corporative values, myths, rituals, taboos
- Company image observed through three elements: company's image, professional image, strengths graph
- Leadership style that can vary from possessive to seductive or wise

Creating the identity is a dynamic process that unifies all the aspirations of the employees in the common goal, which increases their enthusiasm. Design strategy is formed according to focus on some of these components of its identity:

- Focus on leader: managers and employees identify themselves with the image of company's president, internally and externally.
- Focus on business activity: managers and employees see themselves as professionals and experts in specific activity.
- Focus on behavior: bureaucratic , with precise rules, which leaves little initiative to the employees, or flexible with dependence on abilities of adaptation to new assignments and jobs of managers and employees.

2.3. Strategic evaluation of design activity management

Coming from previously mentioned new roles of design managers on strategic level of the design activity management, the evaluation of the design sector (function) has to be made. The goal is to identify strengths and weaknesses of design activity management, as well as consistency between design and business strategy of the company. It is very important to evaluate the effectiveness and coherency of the design decisions. Conclusively, it is about strategic evaluation of management of design activities. There are four key elements of this evaluation: evaluation of coherency, product strategy, informational systems, communicational strategy.
Coherency evaluation is supposed to show: whether there is a visual unity between design strategy and business strategy, is there a visual coherency between product strategy, communication and information, is there a global design strategy.

In product strategy several elements should be known: the role of design in product strategy, who is monitoring the design role in strategy of new product launching, how is the investment divided between different types of design. In informational systems, several questions must be answered: what is the purpose of design in informational systems, is there a systematic procedure of tracking the design of competitors in outlets, what kind of sales material is given to retailers, what is the role of design in internal communications.

In communicational strategy it is important to know: what is the link between expenses of graphic and architectural design and expenses of corporative communications, what is the percent of design expenses for different communication techniques, who is responsible for graphics and relations between graphic markings and corporative communications.
The goal of strategic evaluation is to integrate design activities into the process of formulation of business strategy of the company. This evaluation is based on the comparative analysis of design results in the field of product strategy, informational system and communicational strategy.
In these situations the companies form a board for strategic change, which consists of managers of different departments (marketing research, personnel, finances, design, communications, object management). The board's activities consist of meetings with marketing, production, research and development sectors and outlet staff, and all of company's outlets, factories and offices. Those meetings enable collecting of the information necessary for the final evaluation, with the help of key questionnaires.

3. CHOOSING THE DESIGN STRATEGY

Design strategy can be observed as a way of helping the design expand within the company. Choosing the design strategy means choosing the aesthetic positioning which will reflect the company's design approach. In other words, the choice will define the aesthetics that the design is supposed to have within the company.

Design strategy varies depending on the type of business. Companies differ in valuing the importance of design in strategy. The level of importance of design is often directly related to the attitude of the director-owner of the company. One of the tasks of design is to make business strategy visible. In doing so, the design strategy must be based on all aspects of global image relating to communications, products and company location.

Managing the company's visual identity (communications, products, objects) demands a systematic approach. That means that all the decision makers in the company must appreciate the effective and consistent role of design. In doing so, design standards must be established, giving the information on their applications , but also diverging from the norms should be accepted in order to create variations. Defining of the design standards determines place and role of design amongst key success factors within the company or its parts (profit centers) , as well as responsibility of design sector towards other sectors in the company. So, it is important to clarify the role given to designers in comparison to other creative forces in the company, especially specialists in communications, research and development, as well as teams for new product development.

The level of responsibility of design as the key factor in achieving the competitive advantage is defined through the level of its effect on innovations, information and communications. This will determine the resources given to design , positioning of the design within the company and choosing the design mix.

Design managers have to carefully consider available alternatives while choosing the design strategy. While doing so they can use three design strategies based on generic strategies of Michael Porter.
Some companies apply alternative known as "designer – founder strategy ". This strategy is based on the idea of the founder of the company, and it is close to business strategy. It is especially accepted in fashion industry, where design or creation of the product plays a strategic part. Designers – founders are present in other industries too.

Designer-founder strategy reflects the relationship between the entire business strategy and the strategy of different operational activities – between vision and implementation. Companies have at least three strategic design options available: strategy based on expenses, strategy of design differentiation, strategy based on market. Design strategy based on expenses is suitable for companies that prioritize advanced technology as means of achieving the competitive advantage. This means that technological development creates design position similar to function of research and development. Tasks given to designers are innovations and lowering of production costs, in order to sustain the leadership in technology.

Strategy of design differentiation is based on the power of marketing and company's image. Important aspects of this strategy are positioning of company's brand and market participation. Design strategy should improve market position, as well as leader position and image. Marketing activities help with different aesthetic positioning which highlights symbolic dimensions of the product and their communicational value. Design position is closely intertwined with marketing position.

Design strategy based on market is used by companies which specialize in only one segment of the market. Design role is to improve their position in specific segment as well as to better understand the customers, especially the consumers of their products. Accordingly, design should enable aesthetic differentiation and positioning that highlights the functional component of the product design. In this case the product design and customer behavior research have top priority.

Design managers actively participate in choosing the directions for implementing the determined strategy, as well as in development of design department actions that will be in accordance with the chosen direction. Main strategic directions are: upstream and downstream integration, innovation, diversification, internationalization, recession and alliances. These different directions can be followed by progressive gaining of new knowledge, internally, through innovations, integrations and internationalizations, and externally, through fusions, acquisitions, alliances and recessions.

4. IMPLEMENTING THE STRATEGY OF MANAGEMENT OF THE DESIGN ACTIVITIES

Strategic management of design activities consists of acquisition of special methods of implementation, or design expanding as the key factor of company's success. Above all this is about defining the design mix.

Design mix consists of allocation of design resources and budget between different parts of the company. This means that design mix expresses the division of the budget for design between different design shapes and activities, according to determined design strategy.

In this way, for example, if the company thinks that its most important visual components are business documents, then the graphic design will be favored. On the other hand, if company invests its design energy into products and packaging, then product design will come first, also if outlets and work environment are the priority, then the interior design is favored.

Accordingly, design integration within the company implicates defining of the priorities of each business year. In this case it is very important to consider the consistency between the marketing mix and design mix, as well as between design mix and investments in communicational activities of the company.
By participating in strategic analysis, design manager defines the goals of the design department (sector), and then chooses design investments and the necessary budget for the program of design activities. Efficacy of allocation of budget funds depends on trust in the design and coordination between design budget and budget of other company sectors.

5. CONTROLLING THE STRATEGY OF DESIGN ACTIVITIES MANAGEMENT

Implementing the strategy of design activities management is closely connected to work control and the efficiency of the design. According to this, different instruments are used to evaluate realization of strategic goals, such as return on investments in design activities (ROI) and its influence on company's business. Strategic management of design activities implicates financial control and review. This demands a close cooperation of design manager and financial sector.

Integration of the design function into the whole business of the company demands setting of the criteria for measuring the strategic value of design. This refers to measuring of the design influence on company's vision, market creation and its chain value. Also, impact of design on stock market value of the company can be measured.

Design control doesn't have to be limited to final effects, but has to consider the expansion of design influence through the company. Also it is important to measure design influence in each sector of the company, as well as each level of decision making.

6. STRATEGIC MANAGEMENT OF DESIGN ACTIVITIES IN THE CONTEXT OF STAFFING AND LEGAL PROTECTION

With the help of design it is possible to initiate the changes in behavior of the employees of the company. Design manager can help staff manager with communication improving by: creating and sustaining internal and external information networks and establishing the exchange spot; building long term internal and external connections with design faculties; recruiting in order to expand design and evaluate the creative profile of collaborators, help with their careers, identifying reciprocal expectations of collaborators, designers and buyers, because design can improve new staff expectations concerning autonomy and individualism.

Creating a pro – design climate within a company is not possible without accenting the influence of design on decision making while recruiting staff and managing employees careers. Design managers have to continually improve every aspect of design protection. Intellectual property rights are non-material rights that have value and can be transferred and licensed with adequate compensation. It is important to recognize these rights and to take necessary precautions. Protection of intellectual property rights prevents the theft of new designer models or solutions. Intellectual property rights consist of : copyright, patents and labels. If the design solution has innovative qualities, it is possible to patent it. When design solution qualities are innovative, they are under copyright law. Protection with the registered trade mark is possible when the products are sold under specific label.

7. DESIGN DECISIONS AS PART OF DECISION MAKING SYSTEM IN COMPANIES

In companies that look at design as a key factor of success, it is important to find an instrument of including the design into the decision making system.
Design sector or department must have its representatives in the director board. Representative can be a design manager, or design manager together with quality manager, or design manager with communication manager. Nevertheless , the importance of design must be appreciated by all board members.

Big companies that have design sector, define the roles of different teams. Some teams will be given the assignment to realize the long term design missions, both internally and externally.
The role of design management is creating the atmosphere that supports design in each sector of the company. The aim is to integrate design with the organizational culture of the company. Also, design management can't be separated from implementation and promotion of the informational systems. The choice of computer system affects the design management in the field of innovations, communication management as well as different levels referring to launching of the new product. Informational design sets the standards, so all business documents must be consistent and well designed.

Giving design the most important role, top management expects from design manager to provide strategic diagnosis with the purpose of transforming and anticipating new business visions of the company. It is expected of design to monitor the changes in business environment and outer world, in order to predict their influence on company's goals realization. In case of weaker business, design manager will advise top management on where to find innovative areas that can be used to get useful information. Companies doing business in turbulent business environment should place their trust in their designers to evaluate the chances of new products and visions of competitors.

Design sector should be organized in a way that clearly defines its vision for the future products and markets. Accordingly, design manager will strive to create prepositions for unlimited creativity. In this way, by providing a separate room which will constantly showcase the prototypes (models, samples), the discussion on those new design solutions can be provoked. Also, it is possible to induce a competition within the sector for the best design solution of the month.

8. CONCLUSION

Strategic management is a concept which integrates strategic and tactical aspects, as well as decisions for directing the company's potential towards business areas in which it can achieve adequate concurrent advantage. Strategic management of design activities proposes creating the effective relation between design activities, identity and culture of the company and its business strategy. The goal is controlling the consistency of work of the design sector (department) within the company and to integrate design activities into the process of formulation of business strategy of the company. In given circumstances, design manager becomes strategic consultant.

Strategic management is a process that consists of these components: formulation of design strategy (internal and external concurrence analysis, goal setting, strategic evaluation), choosing of feasible strategy, implementing of the strategy and design strategy control.
Design managers must carefully consider available alternatives while choosing the feasible design strategy. Some companies apply alternative known as "designer – founder strategy ". This strategy is based on the idea of the founder of the company, and it is especially accepted in fashion industry.
Strategy of differentiation through design relies on the power of marketing and image. Design strategy is supposed to strengthen the market position and image of the company and its products.
Strategy based on expenses is based on contemporary technology , where the position of design is close to function of exploring and developing products.

Implementation of design strategy is often done through design mix. Design mix consists of allocation of design resources and budget between different parts of the company. In this case it is very important to consider the consistency between the marketing mix and design mix.
Integration of the design function into the whole business of the company demands setting of the criteria for measuring the strategic value of design. This refers to measuring of the design influence on company's vision, market creation and its chain value. Also, impact of design on stock market value of the company can be measured.

Strategic management of design activities includes legal aspects, especially the protection of new design solutions. Strategic management of design activities, especially in those companies which value design as the key success factor, needs instruments for including design in decision making system. In that case, the design department would have to appoint its own representative in director board.

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DIMENSIONAL STABILITY OF RIGHT-LEFT KNITWEAR

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Abstract: *This paper analyzes the dimensional stability of right - left knitwear. For testing, samples are made of cotton knitwear unifilar combed yarn count of 21 tex in composition of 100% cotton, stranding 600m*$^{-1}$ *and volume 2,725 N. Samples were prepared in one needle bed machine, fineness E26 with approximately the same horizontal densities and different vertical knitting density. Three types of samples were made: Group I: m= 153,4gm*$^{-2}$*,* D_h*=12,1cm*$^{-1}$*,* D_v*=21,3cm*$^{-1}$*; II group: m= 131,13gm*$^{-2}$*,* D_h*=12,5cm*$^{-1}$*,* D_v*=15,9cm*$^{-1}$*; III group: m= 117,2gm*$^{-2}$*,* D_h*=11,6 cm*$^{-1}$*,* D_v*=13,2cm*$^{-1}$*. For the purpose of testing the samples were washed in a home washing machine with centrifugation at 60°C. After washing at 60 °C the sample shrunk by the width of the 2.41% and 2.51% in length, the second sample shrunk by the width of the 5.51% and 2.22% in length and III sample shrunk by the width of the 11.29% and the length of 0,33%. The test was also performed at 90°C where all three samples were washed by centrifugation with and obtained different results.*

Key words*: cotton knitwear, knitwear dimensional stability, shrinkage of knitted fabrics after washing.*

1. INTRODUCTION

The process of final assembly of knitted sportswear is complex and it is done by reshaping knitwear as a flat two-dimensional material in an appropriate three-dimensional shape of clothing. It is essential that the three-dimensional shape of clothing in addition to static and dynamic anthropometric requirements of the human body, to adapt and dynamic conditions prevailing in the use of clothing. Quality of the clothing includes aside from aesthetic and functional requirements and dimensional stability, the ease of maintenance, pleasant feeling when worn, etc. Great impact on all of this, as well as the construction of clothing has the materials of knitwear from which clothing is made. This paper the particularly observed subject is the dimensional stability of sports apparel made of various types of knitwear of composition to 100% cotton and mix cotton / elastin.

In the technological process of knitting garments occur many problems because the structure of knitted fabric is relatively unstable. Problems usually occur in storage of knitwear, in the construction, laying, fixing and tailoring, sewing process, where it is necessary to achieve a satisfactory stitch quality in terms of strength, flexibility and aesthetics. Dimensional instability in knitwear creates difficulties in the finishing of garments and later during use or wear and maintenance of a knitted garment. The particular problems with dimensional stability clothes occur when washing the clothes in the final finishing.

Knitted fabrics are produced for different purposes, and because of them require appropriate features in custom application in future. Each type of knitwear has specificities that determines its characteristic features such as length, width, thickness, surface mass, breaking strength, elasticity, thermal properties, color, touch, look, etc.. [1].

When analyzing the dimensional stability of cotton knitwear the starting point is the change in density of loops in horizontal and vertical rows. This change can be traced through the coefficient of density. In fact, one of the most important parameters, from a technological point of view, in the production of knitwear is the density of which determines the number of loops on the surface of the unit. This parameter has a profound effect on all the other features the made knitwear. The knitwear is made of basic structural units - the loop in knitting that is arranged in vertical rows and horizontal rows. Therefore we can differentiate:

• Vertical density, which is the number of loops in a row on a given length unit, and which is marked with Dv;

• Horizontal density, which is the number of loops in a row on a given length unit, and which is marked with Dh and

• The total density of knitwear which is the total number of loops per unit area of knitwear. This density is in fact a product of horizontal and vertical density of knitwear and is determined by equation (1):

$$D = D_V \cdot D_h \tag{1}$$

2. PROBLEMS THAT OCCUR WHILE WASHING OF KNITWEAR

In the studies that have been done to improve the quality of clothing products, it was found that the biggest problems in the company "SEVENTY FIVE" occur when washing finished garment products [2]. The biggest shrinkage of knitwear occurs, thus greatly reduces the quality of the product because there is a significant change of the size of clothes. Today, however, a number of companies - manufacturers of knitwear garments rely on the results of knitwear testing that is done in specialized institutes and the supporting documentation that comes when buying knitwear. This creates a problem in the construction of production preparation because the prediction of the shrinkage of knitwear in the wet finishing, based on these results are not reliable.

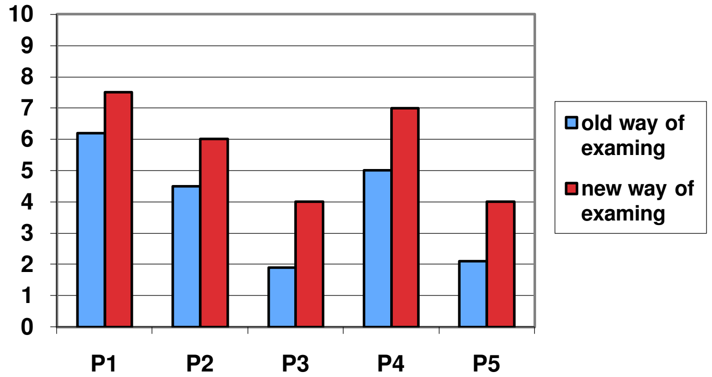
Specifically, this method tests knitwear based on methods that take into account that the wet processing procedures leads to the relaxation of knitwear. Knitwear immersion in water at a temperature of 40C, which is 0.1% of a wetting agent in a time of 48 hours is achieved by wet static state of relaxation. After this knitwear is squeezed by centrifugation, dried at a temperature of 60C and left some time to sit out in the standard atmosphere. In addition to wet static relaxation there are: full and complete relaxation. If the knitwear is washed with detergents for 15 minutes at 40C the process may be full relaxation. Then knitwear is squeezed by centrifugation, dried for 1 hour at a temperature of 70C and left to dry out for some time in the standard atmosphere.

Complete relaxation is achieved after they have been washed in a time of 20 minutes with at 40C. Then the knitwear is squeezed by centrifugation, dried 5 hours at a temperature of 70C and left to dry out for some time in the standard atmosphere. It is still not the complete relaxation of cotton knitwear that possible with a chemical process by soaking cotton knitwear in a 12% solution of sodium hydroxide at a temperature of 60C for 1 hour. After this the knitted fabric is rinsed, drained and spun dry and laid to rest in a standard atmosphere some time.

Also, in this type of testing the fact is that knits lower density have a greater distance between the loops, which allows them to shrink more. In shrinking such knitwear, an increase of their thickness occurs thereby increasing their volume, which leads to greater porosity. This causes increased heat insulation properties that favorably affect the qualitative characteristics of garments. These kinds of knitwear, with lower density, are more difficult to stabilize than dimensionally knitted knitwear with higher density. The knitwear shrinkage is significantly affected by the composition of the yarn, its fineness and the number of loops. This is particularly evident when the yarn has different in diameters, but with the same delicacy and the same composition.

In this case, there are a number of different yarn twists and frictions between the fibers in it are not the same. In the case of a small number of twists, a yarn has more free spaces and the elasticity. It could be said that the knitwear made of finer yarn shrinks more than knitwear that is made from coarser and stronger yarns if both kinds of knitwear are made under the same conditions, ie. on the same machine. Its shrinkage depends on the density of the knitted fabric and therefore the coefficient of density can be taken for analysis of the knitwear shrinkage after its removal from the machines and various processing procedures of knitwear [3 – 11].

Therefore, in the previous research, the dynamic testing of knitted material in the production is proposed [2]. Specifically, it is proposed that a larger piece of knitwear measuring 1x1 square meter is marked. This is done by marking with a water-repellent ink within a square piece of knitted fabric measuring 1,5 x1,5 meter. A representative sample of all 5 samples is made (P1-footer white; P2-single green; P3-singl/lycra blue; P4-singl/lycra striped and P5-futer/lycra and pink) of the material that was in the company warehouse, for which laboratory tests were previously performed. Such pieces of knitwear were sent to the industrial laundry in exactly the same conditions as the washing of clothing occurs. After the washing, the percentage of knitwear is determined by measuring the shrinkage. The compared differences gives the results of shrinkage values in percent, by the laboratory (old) method of testing and the results obtained by the new method of evaluation of the shrinkage of knitwear in length, and the values are given in the following diagram in Picture 1:



Picture 1: Differences of compared results, according to the old method of testing (laboratory) and results obtained by the new method of the shrinkage test of knitwear by length

Differences of compared results shrinkage values in percent, according to the old method of testing and the results obtained by the new method of testing the shrinkage of knitwear in width, are given in the following diagram in Picture 2:

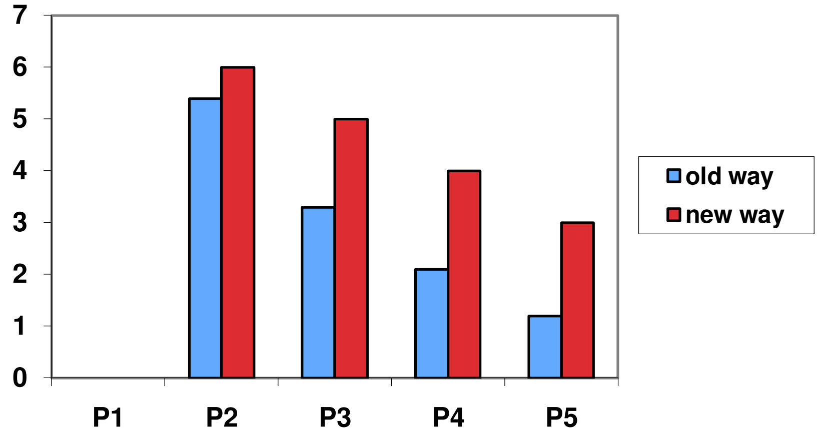


Figure 2: Differences of compared results, according to the old method of testing (laboratory) and results obtained by the new method of the shrinkage test of knitwear in width

From pictures 1 and 2, there are differences between the results of tests by the old and the new method of testing. Taking into account the new and old test results in the construction preparation showed that the new test results far more acceptable. This is because it practically proved that the application of these results in the correction of measuring cutting parts to give the exact set of clothing sizes. This means that the influence of knitwear shrinkage in this way is eliminated from the of dimensional changes of the final product.

3. MATERIALS AND METHODS

Based on previous findings, in this study the analysis of shrinkage is done after washing three types of samples that differed only by the density. The test samples were made from knitted cotton unifilar combed yarn fineness of 21 tex in composition of a 100% cotton, equating $600m^{-1}$ and volume 2,725 N. From this yarn woven patterns smooth jearsy right - left knitwear to one needle bed circular knitting machines of large diameter fineness E26. In addition to the analysis of the structure of the yarn, parameters and characteristics are analyzed of the used knitwear. The results are shown in Table 3.1.

To examine the stability of dimension, knits are made in three different groups of samples. Different groups of samples were obtained by changing the value of input yarn tension in the system for knitting, on the yarn tension devices. It is known that an increase in tensions entering the system for knitting and stitch density increases in the series. At the same time it reduces the consumption of yarn in the loop and thus increases the surface mass of knitwear. In that way, three groups of samples with different densities, ie knitting depths of jerasing were made. The samples were relaxed for 72 hours. Then their analysis was conducted and the results are shown in Table 3.2. After analyzing the raw relaxed knitwear washing was done.

The samples were cut in the tube form, dimensions 30x30cm. 5 washings were performed on the same three samples (total of 15 samples). For the purpose of testing the samples were washed in a home washing machine with centrifugation at 60°C and 90°C with the addition of detergent "Meryl". Measuring the size while washing with centrifugation at 60°C was carried out after the first wash and the results are shown in Table 3.3. During the washing with centrifugation at 90C measurements were performed after the first, third and fifth cycle. We then conducted their analysis and the average results are shown. The test was done on the marked knitwear size 30x30cm, a knitwear shrinkage was determined by the length and width using equation 2:

$$S = \frac{(a-b)}{a} \cdot 100 \ [\ \%\ ] \quad (2)$$

S - shrinkage of knitwear in % affected by the washing
a - dimensions in inches before washing
b - dimensions in inches after washing.

Knitting and testing of the samples was carried out at a temperature of 20 ± 20C and relative humidity 65 ± 4%. For the analysis of structure parameters of knitwear, standard methods were used. Horizontal and vertical density of loops in knitting was measured at 2 cm, and the average value was calculated on the basis of 10 individual measuring's. Weight per square meter of knitwear was calculated based on 5 single measurements of particular samples. Strength and stretch yarns were tested on a dynamometer, where the length of the tube was 500mm, and the rate of extension 0,08m/min. It is pre-loading the yarn was 0.5 cN / tex. The average values of all measurements were based on 20 measurements. The average values of loops are determined on a torziometer with a tension of 0,5 cN / tex based on 20 measurements.

4. RESULTS AND DISCUTION

Test results of the main characteristics of the yarn are shown in Table 3.1. Test results of the knitwear structure parameters are shown in Table 3.2. For the processing of the results of measurements conventional statistical methods were used. Only the results of mean values and coefficients of variation are shown in the tables.

Table 3.1: Results of the main characteristics of the yarn

Number of measuring	Comparisment (m^{-1})	Strenght (N)	Elongation (%)	Fineness of the yarn (tex)
1	606	2,7	4,6	20,50
2	595	2,9	4,8	20,7
3	594	2,8	4,4	20,85
4	600	2,6	4,6	20,85
5	603	2,66	3,8	20,78
6	611	2,9	4,8	20,76
7	595	2,74	5,2	20,96
8	546	2,82	5,0	20,84
9	664	2,7	5,2	20,85
10	523	2,92	3,9	20,90
11	598	2,9	4,6	20,93
12	609	2,7	4,8	20,73
13	620	2,66	4,0	20,04
14	623	2,48	4,4	20,19
15	595	2,50	4,6	20,25
16	597	2,6	4,2	20,28
17	600	2,68	3,8	20,42
18	603	2,54	4,6	20,50
19	611	2,8	4,0	20,52
20	606	2,9	4,4	20,7
$\overline{X}$	600,05	2,729	4,48	20,63
Cv (%)	4,47	4,99	9,33	1,3

Table 3.2: Results of the testing of parameters of the knitwear sturcture

Parameters of the knitwear sturcture	**I gropu samples**		**II group samples**		**III group samples**	
	$\overline{X}$	Cv (%)	$\overline{X}$	Cv (%)	$\overline{X}$	Cv (%)
Šp(cm)	158,76	0,44	160,2	0,656	179,12	0,66
$m_p(gm^{-2})$	153,4	1,28	131,13	1,8	117,2	4,33
D_h /2cm	24,2	1,65	25	2,53	23,2	3,23
D_v /2cm	42,6	1,15	31,8	2,35	26,4	1,86
C	0,57	1,32	0,79	3,96	0,876	4,82
A(mm)	0,824	1,46	0,8	2,37	0,86	3,47
B(mm)	0,47	2,1	0,628	1,79	0,76	1,94

Tags in Table 3.2 are: Šp(cm) - width of knitted sample in cm; $m_p(gm^{-2})$- mass of a square meter of knitwear in gm^{-2} ; D_h /2cm - horizontal density expressed in number of knitted loops to 2cm; D_v /2cm - vertical density expressed in number of knitted loops to 2cm, C - coefficient of density knitwear, A (mm) - mesh width in mm and B (mm) - the height of the loops in mm.

Test results show that the characteristics of the yarn samples were made from knitted cotton combed yarn twists unifilar 600,05m^{-1}, measuring 2,729 N, 4.48% elongation and fineness of 20,63 tex.

Test results of knitwear structure parameters show that changing the value of input yarn tension in the system for knitting and significantly change values of vertical density of knitwear. The largest tensile force was in the first group of samples. This results in the highest value of the vertical density of knitwear and it was Dv/2cm=42,6. In reducing the tension in the other group of samples it reduced the value of the vertical density was Dv/2cm =31,8. Upon further reduction of tension in the third group of samples, the value reduced even more so and the vertical density was Dv/2cm =26,4. The results also show a change in mass per square meter of knitwear. In raw samples the mass of knitwear for the first group of samples is 153,4gm^{-2}, the second group of 131,13 gm^{-2} for the third group of 117,2 gm^{-2}.

Table 3.3: Results of the testing of parameters of knitwear structure

Samples done at 60°C	**Samples of I group - shrinkage in %**		**Samples of II group - shrinkage in %**		**Samples of III group - shrinkage in %**	
	By width	By lenght	By width	By lenght	By width	By lenght
1.	2,33	1,67	4,67	4,00	11,60	0
2.	0	3,33	6,67	3,33	11,00	0
3.	4,00	4,67	5,67	3,67	12,33	0,30
4.	4,76	6,33	5,00	3,33	12,67	0,66
5.	3,00	3,00	5,33	3,00	12,67	0
6.	1,33	1,33	5,33	1,67	10,00	0
7.	2,00	2,67	4,67	2,00	10,67	0,33
8.	3,38	2,33	5,00	1,00	9,67	0,67
9.	2,33	1,00	4,67	1,67	10,33	0
10.	2,00	1,67	5,33	2,00	10,00	0,33
11.	1,33	2,00	6,00	1,67	12,00	0
12.	2,00	2,33	6,33	1,33	11,60	1,00
13.	3,33	2,00	6,00	1,67	11,30	0,67
14.	2,33	1,00	5,67	1,33	11,60	1,00
15.	2,00	2,33	6,33	1,67	12,00	0
$\overline{X}$	2,41	2,51	5,51	2,22	11,29	0,33

For the first group of samples at 90 ° C in washing with centrifugation after the first wash shrinkage in width amounted to 5,03% and 5,53% in length; After the third wash the shrinkage in width amounted to 2,67% and 9,37% in length; after the fifth washing shrinkage in width amounted to 5,47% and 8,03% in length.

For the second group of samples at 90 ° C in washing with centrifugation after the first wash shrinkage in width was 3,75% and the length of 6,60%, after the third washing shrinkage in width was 5,40% and 8,80% in length; after the fifth washing shrinkage in width was 4,60% and 11,33% in length.

For the third group of samples at 90 ° C in washing with centrifugation after the first wash shrinkage in width amounted to 15,20% after the third washing amounted to 16,42% and after the fifth wash accounted for 16,52%. Lengthwise spread throughout knitwear and after the first wash 2,13% after the third wash 0,18 and 0,36 after the fifth wash.

Based on the obtained results it can be concluded that after washing, there was a significant change in the dimensions of the samples. Extra-large dimension change occurred in sample III. This sample had the lowest density of the vertical loop which caused major changes to its size in the wash.

5. CONCLUSION

Dimensional stability of knitwear is an important indicator of their quality. It creates difficulties in finishing of garments and later during use or wear and maintenance of jersey knitwear garments. Dimensional stability of knitwear depends on their structural and constructional solutions, as well as the technological requirements of making of the knitting process. In addition, the most important role of the material, structural, physical and mechanical properties of used yarn, horizontal and vertical stitch density, depth of jersey, as well as interlacement applied in the knitwear. Knowing the connections of structural and mechanical properties of knitwear gives the possibility of their proper design depending on the future use. This paper therefore analyzes the dimensional stability of the right - left knitwear after washing. The study showed that after washing, significant changes happened to the dimensions of the samples. Extra-large dimension change occurred in sample III. This sample had the lowest density of the vertical loop which caused major changes to its size during the wash.

Acknowledgements

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THE REPUBLIC OF SERBIA TEXTILE INDUSTRY AND THE EU LAW ON ENVIRONMENT PROTECTION

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Abstract: *Textile industry is complex and includes various techniques and technologies for preparation and production of natural or synthetic fibre. It is also, large consumer of various auxiliary chemicals which are necessary for finalization (dyeing, printing, finishing and coating) as well as large consumer of water and energy. Harmful effects on the environment which are the result of emission during manufacturing process of textile and the materials that in final phase make the product are expressed (from pesticides used in treating plants which natural fibers originate from through manufacturing process to packaging). Since manufacturing processes are changing various chemicals for treating products, raw materials, water amount and energy are also changing. As a result, relatively high level of emission goes to all media of the environment and the effects are considerably more harmful. In the Serbia pollution of the environment from textile industry is various but the stress can be put on water pollution. In the paper, the authors present basic data on Serbian textile industry, pollutions made by, as well as on enforcement of EU environment protection law in the field of textile industry within the legal system of the Republic of Serbia.*

Key words: *textile industry in Serbia, environmental concern, EU environment legislation relevance to the textile sector .*

1. INTRODUCION

Textile industry is one of the longest and most complicated industrial chains in manufacturing industry. The importance of this sector in the European economy is shown through the fact that EU textile and clothing industry actually achieved a turnover of 165 billion euros, involving 181423 companies, which employed about 1 780 000 people in 2012. (The EU-27 Textile and Clothing Industry in the year 2012) The largest textile manufacturer in EU is Italy, far ahead of Germany, the UK, France and Spain. These five countries together account for over 80 % of the textile and clothing industry. The textile and clothing industry is a diverse and heterogeneous industry which covers an important number of activities from transformation of fibers to yarns and fabrics to the production of a wide variety of products such as hi-tech synthetic yarns, wool, bed-linen, industrial filters, geo-textiles, clothing etc. The sector is an important part of the European manufacturing industry.

Textile industry is complex and includes various techniques and technologies for preparation and production of natural or sintectic fibres (see also Figure 1). It is also, large consumer of various axiluary chemicals hich are neccessary for product finalisation (dyeing, printing, finishing and coating) as well as large conumer of water and energy.

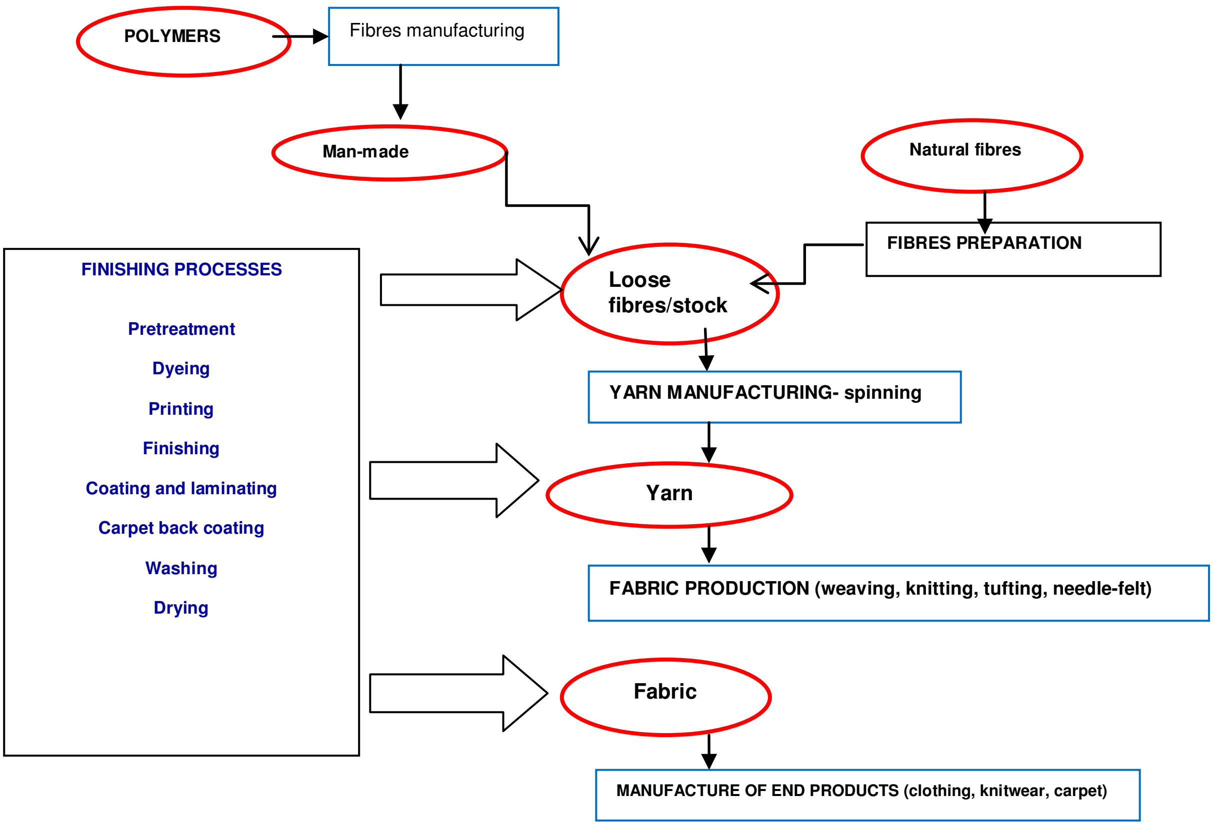

Figure 1. General Diagram of Processes in the Textile Industry (Integrated Pollution Prevention and Control (IPPC) Reference Document on Best Available Techniques for the Textiles Industry, 2003)

2. TEXTILE INDUSTRY IN SERBIA

Also, textile production has importnat place in manifacuring industry in Serbia with export of 921 million dolars in 2011. Acording to the Chamber of Commerce and Industry of Serbia textile industry is 4 th export sector in the Republic of Serbia. Today, there are more than 1,185 textile and garment companies in Serbia. The majority (77%) are private small and medium enterprises. Capacity for good textile and garment production can be found in all parts of Serbia, but there are several centers of the industry. The most relevant ones are the Belgrade region, Vojvodina, Central Serbia, and the area around Novi Pazar in South Serbia. This section will profile some of the more prominent firms in each of these regions. (Textile Industry in Serbia a sectoral study and company overview, 2004, Jefferson Institute) Today, 22 companies in Serbia are: Emient I Zeleznicar from Subotica, Calcedonia Sombor, Fulgar Becej, Fulgar Zrenjanin, Pompea Ililary Zrenjanjin, Golden Lady Loznica, Zekstra Novi Sad, Golden Lady Valjevo, Kluz Kozara, Dunav Grocka, Kosmaj Beograd, BVK Beograd, Javor Ivanjica, Pompea Brus, Brusjanka Brus, Nitex Nis, UCB Prokuplje, Falke Leskovac, Lisca Babusnica, Grupo Fiorentino Vlasotince. (see also Figure 2).

Figure 2. Textil Industry in Serbia

The textile industry Serbia is highly dependant on imported materials. Cotton is not produced in Serbia, but it is extensively processed. The most important companies in Serbia producing viscose, nylon, polyester, polyamide and polypropylene are "Dunav" Čelarevo and "Dunav" Grocka. Some 3,300 tons of synthetic yarns were produced in 2003 (14% from 2002), 689 million m2 of artificial silk (36% from 2002) and 23 million m2 of synthetic filament (19% relative to 2002).

Serbia's textile factories are highly developed in terms of dyeing, washing and various forms of finishing works. Nearly 50 clothing factors have printing capacities. There are also sample capacities for pleating, hemstitching, stone washing, etc.

3. ENVIRONMENTAL CONCERN

Harmful effects on the environment which are the result of emission during manufacturing process of textile and the materials that in final phase make the product are expressed (from pesticides used in treating plants which natural fibers originate from through manufacturing process to packaging). Textile industry is characterized by highly specific, complex and fragmented manufacturing system. Some of them are manufacturing simple fibers, yarns, fabrics for making clothes, industrial products and household furniture. Since manufacturing processes are changing various chemicals for treating products, raw materials, water amount and energy are also changing. As a result, relatively high level of emission goes to all media of the environment and the effects are considerably more harmful. Viewed from numerous aspects human life becomes endangered.

As mentioned before, pollution of the environment from textile industry is various but the stress can be put on water pollution. In other words, textile industry is a large consumer of water so wastewater come from almost all processes: from preparation of raw materials, dying of fibers as well as in finishing process and special treatment of final products, therefore, they are highly heterogeneous according to composition and quantity. There are also other kinds of pollution such as air pollution with dust and industrial dust but they are much rarer.

Preparatory processes of textile include the use of different auxiliary substances which are important in later process of textile treatment but they significantly increase water pollution. However, wastewaters from dyeing are the worst because of composition and quantity which is the result of a wide spectrum of textile colorants available on the market. General characteristic of wastewaters from dying process is, firstly, high content of organic materials and high percentage of colours. (Cibulic, V. V. et al, 2013) Variation of PH value is also characteristic for wastewater coming from textile industry, from exceptionally acid reaction through neutral to weakly alkaline as well as temperature variations from 20 to 70˚C. (Valisieev, G.V.1990, Kalcev, V. 1990, Kallo, D. 2001). Most frequently found substances in wastewater are salt, natural fibers and dirt (biocide wax…), starch, polyvinyl – alcohol, carboxymethyl – cellulose, preparatory substances (mineral oil, esters), emulsifiers, detergents, carboxyl acids (mostly acetic acid), urea, complex compounds, organic solvents and others (Integrated Pollution Prevention and Control (IPPC) Reference Document on Best Available Techniques for the Textiles Industry, July 2003.)

More than 90% organic chemicals and additives in pre-treatments and at dyeing do not stay on fibers while it is reverse in final treatments and processes. When organic raw materials which go into manufacturing process are in question almost 90% end up in wastewater and the rest is discharged in the air.

4. EUROPEAN ENVIRONMENTAL LEGISLATION RELEVANCE TO THE TEXTILE SECTOR

European Environmental legislation of relevance for the textile sector: Integrated Pollution Prevention and Control (IPPC), Emission Trading System (ETS) Directive 2003/87/ec of the European parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC, Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) and other directives with relevance for the sector. Several directives related to the environment directly affect the European textile and clothing industry, such as those relating to waste management or to industrial emissions.

4.1. Integrated Pollution Prevention and Control (IPPC)

First piece of environmental legislation of relevance for the textile sector is the Integrated Pollution Prevention and Control (IPPC) Directive. This Directive aims at minimising pollution from various industrial sources throughout the European Union.

The variaty and amount of used chemicals, water and energy classifies a textile industry as a potentialy environmental threat and put it in the group of industries which are mandatory to the IPPC Directive.

Plants for the pre-treatment (operations such as washing, bleaching, mercerization) or dyeing of fibres or textiles where the treatment capacity exceeds 10 tones per day are subject to the IPPC Directive, i.e. are required to obtain an authorization (environmental permit) to operate. According to the IPPC Directive, permit conditions must be based on Best Available Techniques (BAT). The Reference Document on Best Available Techniques for the Textiles Industry (BREF) was adopted in 2003. This document provides general information on the textile sector and on the industrial processes used within the textile sector (in particular fibre preparation, pre-treatment, dying printing and finishing). It provides data and information concerning emission and consumption levels and describes the emission reduction and other techniques that are considered to be most relevant for determining BAT and BAT-based permit conditions. A revision of the BREF textiles is were 2009.

As mentioned before conditions from permission must include limit values of emissions which must be based on the Best Available Techniques (BAT). Best Available Techniques include the most effective and most modern phase in development of activities and methods for their realization by which, in principle, it is pointed at practical convenience of specific techniques for provision of basic base for limit values of emission that should prevent or merely reduce emission and its influence on the environment as a whole. In Annex IV beside Directive twelve factors which should be taken into consideration, generally or in special cases, at determination of best available techniques, paying attention to level of costs and benefits from using concrete measures in accordance to the principle of precaution and prevention. In order to make easier system functioning which is related to BAT, EU Commission organized exchange of information between experts of member countries, industry and organizations in the field of environment. These activities are coordinated by European IPPC Office within EU common research centre in Sevilla whose activity is adoption and publishing BAT Reference Documents (BREFs). Participation of publicity in the process of decision-making is also regulated by relevant regulations of Directive (D. Todic, 2001)

This BREF addresses installations for the pretreatment (operations such as washing, bleaching, mercerization) or dyeing of fibers or textiles. Particular attention is given to the following processes: fibers preparation, pretreatment, dyeing, printing, finishing. Upstream processes which may have a significant influence on the environmental impact of the subsequent wet processing activities are also briefly described. The backing of carpets is also included. All main textile fibers types, namely natural fibers, man-made fibers derived from natural polymers such as viscose and cellulose acetate as well as man-made fibers derived from synthetic polymers are described, including their blends.

Serbia has achieved a high level of transposition of the IPPC Directive, with the adoption of the Act on Integrated Pollution Prevention and Control in 2004. While Serbia still applying IPPC legislation in this area, struggling with the incomplete national legislation on this specific area, incomplete documentation provided by the operator and use of BAT, EU goes a step further. After a comprehensive analysis, EU have identified a need for a new Directive. IED entered into force on 6th of January 2011. with aim to eliminate the disadvantages of the existing legislation concerning emissions from industry, replacing 7 existing Directives which in certain segments overlap and cover similar activities. IED is much more comprehensive and therefore more extensive and brings innovations which are based on 5 principles: integrated approach, improved and clarified BAT concept, flexibility, inspection and public participation. Concerning Serbian IPPC legal framework, IED will certainly provide some changes since the Act on Integrated pollution prevention and control is complex and comprehensive including a number of additional Acts and by lows which should be revised in following period.

4.2. Emission Trading System (ETS)

Another piece of legislation which might have an impact on the textile sector is the legislation relating to the European Emission Trading System. Directive 2009/29/EC, amends Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community. Annex I of the Directive defines the categories of activities to which this Directive applies. In this framework, textile companies can be impacted by the ETS Directive if they have combustion installations with a total rated thermal input exceeding 20 MW. This is the case of some big textile industry, but not in Serbia.

The Directive stipulates that installations in sectors or subsectors which are exposed to a significant risk of carbon leakage shall be allocated allowances free of charge (on basis of a benchmark). The Directive defines the conditions for a sector to "be deemed to be exposed to a significant risk of carbon leakage" (Art.) and sets that the Commission shall adopt the list of sectors at risk by the end of 2009.

Directive 2003/87/EC determines the scheme for trading with gas emission permits with green-house effect within the Community and which changes and supplements Directive of Council 96/61/EC which was changed and revised by Directive 2004/101/EC with the aim of improving the reduction of gas emission in economically efficient way. Directive is applied on emissions which are the result of the activities stated in Appendix I, as well as on the green-house gases CO2, CH4, N2O, HFC8, PFC8 and SF6 without any influence on requirements prescribed by Directive 96/61/EC. From 2008 member countries have the possibility to apply trading with quota emission on activities, facilities and green-house gases which were not stated in Appendix I if the Commission approves it taking into account all relevant criteria. Member countries were obliged to provide, from 1st January 2005, that no plant takes action stated in Appendix I whose result will be gas emission related to this activity unless the operator has the permission issued by relevant institution or if that plant is temporary excluded from the scheme of Community. In five-year-period from 1st January 2008, as we as for every further five-year- period every member country had to decide about total quota which would be distributed for that period and it was supposed to start procedure for distribution of the quota to the operator of each plant. This decision is made at the latest 12 months prior to beginning of the period for which it is made and is based on national quota plan distribution of member countries taking into account public opinion. Every member country has the obligation to establish a national plan which includes total amount of quota which will be distributed for the period and also a proposal of quota distribution. The plan should be based on objective and transparent criteria taken into consideration public opinion. Commission and member countries should be informed at least 18 months before the beginning of the period. Member countries are also obliged to provide transfer of quota: a) among the subjects within the Community and b) between the subjects within the Community and subjects from the third countries if these quota are in accordance to the procedure without other limits beside those which Directive includes or accepted in accordance to its regulations.

4.3. Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)

The sector will also be affected by the new REACH Regulation on chemicals, being a downstream user of a wide variety of chemical preparations.

REACH is the Regulation (EC) **N**o 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the **R**egistration, valuation, **A**uthorization and Restriction of **Ch**emicals. It came into force on 1 June 2007. REACH is the Regulation of EC on chemicals and their safe use and the aim of its adoption is to improve protection of human health and the environment through better and early identification characteristics of chemical substances as well as to strengthen innovative and competitive potentials of chemical industry in EU. After registration of substances according to REACH producers and importers are obliged to register every new substance unless they are exceptions including risk estimation and measures of reducing risk if necessary. Basically, REACH is applied to all substances, not only to substances used in industrial processes but also to those which are used in everyday life. All producers and importers of chemicals are obliged to identify and manage risks liked to substances they produce and put on market and for substances over 1 ton annually it is necessary to offer proof that appropriate measures have been taken about which European Agency for Chemicals (ECHA) must be informed. Substances with high level of concern because of their characteristics are the subject of control and they are progressively replaced by appropriate alternative substances or technologies if they are economically or technically acceptable. When it is not possible REACH system of authorization should provide that the use of these substances is approved only if their use is justified from the aspect of total benefit for the society. Authorities of EU have power to put limits for production, use and put on the market substances which cause unacceptable risk for human health or the environment while authorities of the member countries are responsible for providing respect of REACH via inspection as well as by prescribing and imposing sentence in cases of disrespect of relevant regulations.

The enforcement of REACH has a great impact on the textile and leather industry. Textile and leather products belong to articles under REACH regulation. Those products might contain Substances of Very High Concern (SVHC) and REACH restricted substances regulated by REACH regulation. Suppliers (manufacturers, importers or retailers) shall first identify all possible toxic chemicals in their products. If the products do not contain SVHC and REACH restricted substances above the threshold limits of REACH, the products are compliant with REACH.

In our country harmonization of national regulations with EU regulations is in progress. Managing chemicals and biocide products in our country is under jurisdiction of Agency for chemicals which was founded by Serbian Government. Inspection in the field of chemicals is performed by inspection for the environment, market inspection and local municipality inspection. Basic Law which regulates this issue is Law on Chemicals from 2009 which is partially harmonized to Regulation 1907/2006 (Regulation REACH), but it is considered to be fully harmonized with the following EU regulations: Regulation 1272/2008, Regulation 440/2008, Regulation 689/2008, Regulation 648/2004, Directive 67/548/EEZ, Directive 99/45/EZ and Directive 2004/42/EC. Besides, Regulation on confirmation of Rotterdam convention on the procedure of giving compliance for import based on the previous information for certain dangerous chemicals and pesticides in international trade and Stockholm convention on long-term organic polluting substances. For further harmonization with EU regulations it is necessary to adopt a great number of by-laws which will be fully harmonized with Regulation 1907/2006 (REACH), Regulation 1272/2008, Directive 004/42/EZ, Directive 98/8/EC, etc. In this sense the List of classified substances will be updated (Annex 6 Regulation 1272/2008- REACH), List of substances which cause concern (Annex 14 Regulation 1907/2006), List of active substances in biocide product (Annex 1 Directive 98/8/EC) update of adopted bylaw regulations and their harmonization with changes of relevant regulations in EU.

4.2. Other directives with relevance for the sector

Whenever Biocides products are added to textile products with specific properties (e.g. repeal fleas, mites and mosquitoes or avoid allergens) the provisions of the Biocides Directive have to be complied with.

5. CONCLUSION

Harmful effects on the environment which are the result of emission during manufacturing process of textile and the materials that in final phase make the product are expressed (from pesticides used in treating plants which natural fibers originate from through manufacturing process to packaging). Textile industry is characterized by highly specific, complex and fragmented manufacturing system. Some of them are manufacturing simple fibers, yarns, fabrics for making clothes, industrial products and household furniture. Since manufacturing processes are changing various chemicals for treating products, raw materials, water amount and energy are also changing. As a result, relatively high level of emission goes to all media of the environment and the effects are considerably more harmful. Viewed from numerous aspects human life becomes endangered.

A pollution of the environment from textile industry is various but the stress can be put on water pollution. In other words, textile industry is a large consumer of water so wastewater come from almost all processes: from preparation of raw materials, dying of fibers as well as in finishing process and special treatment of final products, therefore, they are highly heterogeneous according to composition and quantity.

First piece of European environmental legislation of relevance for the textile sector is the Integrated Pollution Prevention and Control (IPPC) Directive. The variaty and amount of used chemicals, water and energy classifies a textile industry as a potentialy environmental threat and put it in the group of industries which are mandatory to the IPPC Directive. Another piece of legislation which might have an impact on the textile sector is the legislation relating to the European Emission Trading System.

The sector will also be affected by the new REACH Regulation on chemicals, being a downstream user of a wide variety of chemical preparations. In our country harmonization of national regulations with EU regulations is in progress. Basic Law which regulates this issue is Law on Chemicals from 2009 which is partially harmonized to Regulation 1907/2006 (Regulation REACH), but it is considered to be fully harmonized with the following EU regulations: Regulation 1272/2008, Regulation 440/2008, Regulation 689/2008, Regulation 648/2004, Directive 67/548/EEZ, Directive 99/45/EZ and Directive 2004/42/EC. For further harmonization with EU regulations it is necessary to adopt a great number of by-laws which will be fully harmonized with Regulation 1907/2006 (REACH), Regulation 1272/2008, Directive 004/42/EZ, Directive 98/8/EC, etc. In this sense the List of classified substances will be updated (Annex 6 Regulation 1272/2008- REACH), List of substances which cause concern (Annex 14 Regulation 1907/2006), List of active substances in biocide product (Annex 1 Directive 98/8/EC) update of adopted bylaw regulations and their harmonization with changes of relevant regulations in EU.

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FASHION BLOGS STYLE INFLUENCE

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Abstract: *This paper presents the influence of fashion blogs and bloggers on fashion, style and lifestyle. It Describes the reflection of the Internet era to create a lifestyle and taste. This paper Introduces us to the basic meaning of the blog, blogger, fashion and style. It also give facts about type, categorisation This paper presents the most influential fashion blogger of 21 century. Author of this paper looks back at the blog goals and financially motive. It present how to turn writing and taking pictures in source of profits. Scientific point of view presents the theoretical basis of marketing segments word - of – mouth and visual marketing that connects the blog authors and blog consumers.*

Key words: *blog, blogger, fashion, style, fashion bloger, marketing*

1. INSTEAD OF INTRODUCTION

In the time when Internet rules the world, there is no area of life that is nor virtualized and which, in one way or another, did not succumb to global phenomenon.

The power is slowly but surely covers and fashion industry, and the day a wider range of information always very mysterious world, reserved only for the chosen - the fashion world. growing number of blogs dedicated to fashion, a forum intended for discussion of the same, and sites full of various topics on the latest trends and publications, many of which are, first hand, led by prominent fashion experts.

Will magazines be replaced by their online like vogue.com? Are we more for a classic shopping ,with a therapeutic effect, in the form of visits to boutiques and an endless combination of trying replaced online shopping? And finally, if you will, in addition to sites that are popping up every five minutes and blogs every five seconds, the mode will be able to retain its distinctive splendor and luxury?

Will We be a fashion copy of bloggers, or we ourselves conceive of our outfits and give a personal touch every fashion combination?

2. WORD OF FASHION – A WHOLE “NEW WORLD”

Fashion (from the Latin. Modus - way, rule, rhythm, time) is a term for popular styles in the various spheres of human activity and thinking, at any time in history. Styles can be changed quickly and in the present day of the term fashion means the latest version of the style and a certain area. Fashion changes in different areas can lead to a change of culture in general.

The terms "fashionable" and "unfashionable" are used to describe whether someone or something is in line with the current or some other popular fashion expression. The term "modern" is commonly used as a synonym for glamor, beauty and style. In this sense, fashion is a kind of art in the common culture which comes to the fore. However, the term is used in a negative sense, as a synonym for a fad, trend and materialism.

The world of Fashion is a vast ”New world” and encompasses every sphere of life and our activities. Fashion today has taken a front seat and is of topmost priority to every individual from every age group. The word fashion in itself covers a wide “New world” from cloting to our mode of education, to our way to communication everything today holds prefix to it in form of “out of” or “in” fashion. Though the impact is more on the youngsters that is form the teenagers to the working professionals its not that the others are left you.

All that we do today has got to be fashionable. In the past, fashion was only cloting, shoes, accessories, today, fashion is cover everything, from the way we communicate, to the way that we present ourself. Fashion is cover every sphere of our life , from the kind of furniture, the kind of cellphone, the format of our letter writing, the language we use on the email, the way we war make up…

3. FASHION BLOGS – GUIDLINES FOR STYLE

A fashion blog can cover many things such as specific items of clothing and accessories, trends in various apparel markets , celebrity fashion choices, street fashion trends. They cover fashion at all levels from the biggest names to the smallest indie designers

Many fashion blogs could also be categorised as shopping blogs, since "most of the conversation is shopping advice, liberally laced with consumer recommendations". This is very similar to the content of fashion magazines. Some retailers in the fashion industry have even started blogs of their own to promote their products.

Blogs that only occasionally mention fashion are not categorised as fashion blogs, although they may be labeled by the blogger as such.

Fashion blogs can be categorised in a number of ways. It may be written by insiders, outsiders or aspiring insiders.

Insiders are people who work (or have previously worked) in the fashion industry or for the traditional fashion media. In addition, some fashion insiders blog occasionally as guest on larger sites. For example, the fashion designers.

Outsiders are people who know a lot (or at least have strong opinions) about fashion, usually by virtue of being very dedicated consumers of fashion.

Aspiring insiders are people who want to work in the fashion industry or media and believe their blog may provide a ‘back door’ entry into a mainstream fashion writing job.

Fashion blogs may be owned either by individuals or by companies.The types of individuals running fashion blogs are listed above.The types of companies now running fashion blogs include large mainstream media organizations and fashion retailers.” Conde Nast Publication” is a mainstream media organization with fashion blogs. Fashion retailers with blogs include “ Bluefly”, “Queen of Suburbia” and “Splendora”.

Fashion is a multi-billion-dollar industry that has considerable impact on the way ordinary people dress and present themselves. But there is more to fashion than the different articles of clothing, fashion is made up of designers, buyers, retailers, editors, and columnists. While all parties work together to create an image, all of these parties can simultaneously be affected by outside forces, especially blogs. Fashion is trend-driven and fashion blogs provide a new way to follow and oversee these fast-paced trends, it is likely that the blogoshepere will have a considerable long-term influence on the industry, as the number of fashion based blogs continue to grow.

Unlike fashion-focused magazines and television shows, fashion blogs are able to be updated more frequently, keeping up to date with the with new and up-and-coming fashion trends. Not only are fashion blogs easier to access, many fashion blog readers stated that fashion blogs are far more personable and are more 'up to date' on both local and foreign trends. Blogs are granting unlimited access to the fashion world to anyone that has a connection to a computer. Fashion blogs had helped share and promote new trends to a much greater extent than other fashion mediums. Unlike mainstream magazines and newspapers, which are constricted to what they write, blogs have the ease of writing about anything that interests authors, allowing for a more broad spectrum of focused fashion trends.

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At a time when the internet rules the world, there is no area of life that is not virtualized, and who, in one way or another, did not succumb to the global phenomenon.

Power is slowly but surely covers and fashion industry, and the day a wider range of information always very mysterious world, reserved only for the chosen - the fashion world. Growing number of blogs dedicated to fashion, a forum intended for discussion of the same, as well as various content sites full of the latest trends and publications, many of which are, first hand, led by prominent fashion experts.

A fashion blog popularity is measured by combination of the number of page views, unique visitors, number of followers, but it is also important how many visitors are blog related. Someone may have 70,000 fans on Facebook, but if the majority of its content has comments, like's, or association, the platform is not really influential. Also the quality of the content and integrity of the content is important, not only did the visitors of the blog active on the site. Someone may have a high number of visits but there are high levels of interactivity and this is more important than traffic.

A large number of comments on a website does not equals with affection this site.

It Is hard to say who is the most influential fashion bloger today. The reason is simple . Eaven in case that we were living under a rock, we will probably noticed that the influence of personal blogs about style and fashion is growing exponentially the past few years. More and more, brands waive the traditional PR methods and media, and instead turn to influential bloggers to take advantage of their viral effect and spread the brand message. But while the impact of online personal blogs about style not questioned, accurate measuring and quantifying the impact of a different story.

For fashion blog popularity, "interaction" is the right term, and it seems to be a new keyword in the blog industry. Measuring the number of visits, unique visitors and Facebook like it's simple, but accurate measurability engagement of readers is more complicated.Comments do not mean anything in terms of influence of blogs, but they also reflect the number of visitors. If we look at comments on other major blogs, they can be a little essays. On the one of the most popular fashion blog "Cupcakes & Cashmare", we can see hundreds of comments from readers on it, but they do not mean anything because most of the comments made by one or two words, with a link to blog commentators. If we look at comments on other major blogs, they can be a little essays. These comments, although fewer, are worth far more.

The Internet age and the dissemination of information through blogs, social networking sites, andtabloids is pushing fashion forward at great speeds. It's also exposing us to many more ideas simultaneously. Today, any runway designer or trendsetting celebrity, stylist, or fashion blogger can influence the fashion winds through our 24/7 media world.

Fashion blogging is rapidly becoming a highly profitable new media business, with a mixture of independent blogs and well-funded fashion blog networks competing to dominate the space.

Other commercially successful independent fashion blogs include The Budget Fashionista, which reportedly brings in $600,000 a year in revenue . And The Bag Snob, which "generates a six-figure income, mainly from advertising". By 2008 SheFinds.com was generating $400,000 in revenue per year.

There have also been a series of business deals have brought serious investor money into the fashion blogging space. In October 2006, Sugar Publishing Inc. raised Series A funding from legendary venture capital firm Sequoia, to a rumored value of $5 million. "Sugar's small" blog network includes "FabSugar", a fashion blog. In November 2006, Glam.com raised $18.5 million in Series C venture capital from a consortium led by Duff Ackerman & Goodrich Ventures, with other investors including "Draper Fisher Jurvetson, which helped launch eBay, Accel Partners, an investor in Facebook, as well as WaldenVC and Information Capital". In October 2007, Sugar Publishing purchased early fashion blog network Coutorture Media for an undisclosed sum.

4. THE TOUCH OF SCIENCE: WORD OF MOUTH AND VISUAL MARKETING

We are reading blogs every day. And then we talk about the blog, tell friend, sister, mom, then they tell their friends, and come to a new form of information or a new form of advertising, which is in fact the best. It's word of mouth marketing.

Word-of-mouth marketing, also called word of mouth advertising, is an unpaid form of promotion—oral or writtenin which satisfied customers tell other people how much they like a business, product, service, or event. According to Entrepreneur Media, word-of-mouth is one of the most credible forms of advertising because people who don't stand to gain personally by promoting something put their reputations on the line every time they make a recommendation.
Businessdictionary.com holds that the term "word of mouth advertising", which is a common term used in marketing, is "incorrect", as it doesn't match their definition of advertising which is limited to paid and non-personal communication.
According to the Journal of Advertising Research, 75% of all consumer conversations about brands happen face-to-face, 15% happen over the phone and just 10% online. This is backed up by research by WOM specialists, Keller Fay, who also claim that TV advertising creates the majority of brand related word of mouth, followed by PR.

Consumers are driven to promote brands by word of mouth due to social, functional, and emotional factors. Based on these drivers, Mitchell Lovett, Renana Peres, and Ron Shachar (2013). further identified thirteen brand characteristics that stimulate WOM, three of which are level of differentiation, excitement, and complexity. While social and functional drivers are the most important for promotion via WOM online, emotional driver is the most important offline.

We have a visual personality types. Looking outfits in the pictures bloggers, we conclude that the blogs promote by visual marketing.

Visual marketing is the discipline studying the relationship between an object, the context it is placed in and its relevant image. Representing a disciplinary link between economy , visual perception laws and cognitive psychology, the subject mainly applies to businesses such as fashion and design.

As a key component of modern marketing, visual marketing focuses on the studying and analysing how images can be used to make objects the centre of visual communication. The product and its visual comunication visual communication become therefore inseparable and their fusion is what reaches out to people, engages them and defines their choices . With visual merchandising that is one of its facets and more about retail spaces, here, Marketing gets customers in the door. Once inside, merchandising takes over affecting placement of products, signage, display materials, ambiance and employee staffing.

Harnessing the power of images and visuals makes a marketing plan more powerful and more memorable. Images when done, deftly can turn concepts and intangible things into something concrete. That helps people envision a brand and its message in their mind's eye and remember it when it comes time to buy.

Visual Marketing can be a part of every aspect of the Communication Mix. Marketing persuades consumer's buying behaviour and Visual Marketing enhances that by factors of recall, memory and identity.

Growing Trends in the usage of Picture Based Websites and social networking platforms like , Instagram, Tumbls, Timeline feature of Facebook justifies the fact that people want to believe what they see, and therefore, need for Visual Marketing.

Visual Marketing includes all visual cues like logo, signage, sales tools, vehicles, uniforms, right to your Advertisements, Brochures, Informational DVDs, Websites, everything that meets the Public Eye.

5. THE MOST POPULAR FASHION BLOGS TODAY

One of the largest independent fashion blog "Fashionista" is a finely curated collection of fashion news, criticism and career advice. As co mfortable on the catwalk as it is in the aisles of Target, Fashionista produces daily smartly written business stories on the biggest brands, lively interviews with industry personalities and guidance on getting into and succeeding in all facets of the fashion world. As one of the most influential voices in the industry, Fashionista is an agenda-setter for the industry as well as influential fashion-focused consumers. Fashionista is published by Breaking Media.

Emily Schuman who writes blog "Cupcakes and Cashmere" A mix of DIY, food, and most prominently, fashion, LA-based Emily Schuman's sincere and friendly approach to fashion blogging has made her the idol of women across the country. Last year, Emily Schuman signed a deal with Estee Lauder. She also published her first book in August 2012, which some loyal fans found to be too similar to the content on the blog. She repped by Say Media, the same company that sells ads for Fashionista .Although she undoubtedly gained thousands of new followers through its promotion.The site, founded in 2008, also does a bang-up affiliate marketing business.

Blair Eadie writes fashion blog "Atlantic-Pacific". Eadie, a former buyer at Gap and Old Navy who relocated to New York last year ,to work as a merchandising manager at Tory Burch, doesn't bother with bells and whistles. Her wildly popular blog, which garners 1.8 million pageviews a month, is straight-up outfit posts showcasing her East-Coast-preppy-meets-California-boho style. So it's no surprise Eadie is popular with affiliate marketers.

Aimee Song writes a fashion blog "Song of Style". With more than two million pageviews a month, brands love working with Los Angeles-based blogger Aimee Song. She's worked with Italian high-fashion boutique Luisa Via Roma, Schutz shoes and most recently starred in Botkier's spring advertising campaign.

Rumi Neely writes afashion blog " Fashion Toast" . Neely, much like her best friend Bryan Boy, has moved beyond the blog and into modeling, acting and plenty of brand partnerships , most notably Forever 21, Free People and Ralph Lauren. What's more, she has influenced thousands of new-generation bloggers. Her photo style laid back, not-really-posing poses will be forever copied around the web.

At the end one of our most popular blogger Zorana Jovanovic who writes a fashion blog "Zorannah' s Fashion Corner" . It can be said, without exaggeration that She is a new fashion icon with the greatest style impact on the most teenage girls in Serbia. Besides outfits pictures that publishes daily ,on her blog we can read about very helpful tips for beauty and style. She has her clothing and cosmetic line, fashion store in Belgrade and onlineshop.

6. INSTEAD OF A CONCLUSION

Harnessing the power of images and visuals makes a marketing plan more powerful and more memorable. Images when done, deftly can turn concepts and intangible things into something concrete. That helps people envision a brand and its message in their mind's eye and remember it when it comes time to buy. Consumers are driven to promote brands by word of mouth due to social, functional, and emotional factors.
The Internet age and the dissemination of information through blogs, social networking sites, and tabloids is pushing fashion forward at great speeds. It's also exposing us to many more ideas simultaneously. Today, any runway designer or trendsetting celebrity, stylist, or fashion blogger can influence the fashion winds through our 24/7 media world.

Fashion blogging is rapidly becoming a highly profitable new media business, with a mixture of independent blogs and well-funded fashion blog networks competing to dominate the space.

Some say it's time for personal style bloggers over. Today, a girl needs more than the looks, and the camera guy. Ninety percent of bloggers, that people talk about are bloggers who love to pose in front of the camera.Bloggers need to think about quality, strategy and advertising .But in the end, it all comes down to the camera.

Is all of that enough? Or good style needed for something else? . For example, something that you are you and only you ? The choice is yours…

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HISTORY OF THE HEADSCARF, ROLE, SYMBOLISM AND IMPORTANCE OF WOMEN CLOTHING

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Abstract: *The head scarf, as the part of the headstall, has a big importance in ethnologic sense, and especially with women clothing around the world. Its role is not only funcional, but estetic and simbolic. What differs the scarf from other headstalls is its multi usage. It was'nt only meant to cover the head or cheast, but also to be used as a cape, or apron. It represents a significant row of symbols, and represents ethnic identity of a nation. Non-verbal communication is rpesent here, because through clothing, we send information. Specific clothes represent important moments in the life of men. All this segments of life are marked with choice of clothes. What affected to its color, decoration and forms, is demographic, social, and cultural characteristics of a specific time.*

Key words*: Headscarf, symbolic of the headscarf, history of the headscarf.*

1. INTRODUCTION

In the first part of the work, I have tryed to show through a short historic analisys of the headscarf, and how it changed through women clothing. Its role and symbolism over historic cut from antient times to the modern clothing. My intention was to, by varius examples and photos to show its beuty, meaning, decoration, usage, and miss-usage. Today, its an indicator of creativity, personal esthetics, actual trends, luxury, and other social forms.

2. HISTORY OF HEADSCARF

Head scarf is one of the rear clothing elements that runs through the long hisoty of clothing, and which changed shape and purpose in time. The name „marama" leads from arabic „migrama", and we took it from turkish „mahrama". It could be from silk, wool, or coton, square, or triangle. Long stripe is worn around the kneck, over the shoulders, or around over the head as decoration.

Within this research, the greatest challenge was to define the headscarf widely. Is it only a square form, or is it more? Women through history covered their heads in different ways, which is chonologicly presented in this work.In antic period, Persian and Arabic people used the scarf as part of clothes. Egypt, as a desert country, forced people to use scarfs because of weather. It was a protector, and a more comfortable solution after shaving for man and women. They also used the klaft, which was a shaped scarf.

Around 230. BC on the east, warriors of the chinese emperor Cheng, used scarfs, as a military rank mark. This will remain as a practice. They took scarf from their loved-ones as charms.



Picture 1 Persian costume, Picture1. 2. Klaft scarf in Egyptian costume Picture 1.3. Greek costume

In the ancient Greece, clothing represented the beauty of the body. Women used to wear tunic of cotton, called hiton. First it was made of wool – peplos, hooked on the shoulders with fibulas. A vertikal fold was made on the middle, with ornamentic in color. Over the hiton, they put a short, wool cape, called himation. Over this, they hade oa wool type of scarf.

In ancient Rome, women had scarfs for hygiene reasons, to stop sweating on high temperature, and to protect themselves from the wind. Instead of wearing hats, they formed a hood with folding the cape. Women cape, Pala, wasn't colored, wool made. Women also had a veil (flameum, ricinium), made of thin, transparent fabric, and hooked to the hear, easily fell by the back.

Picture 2. Roman costume

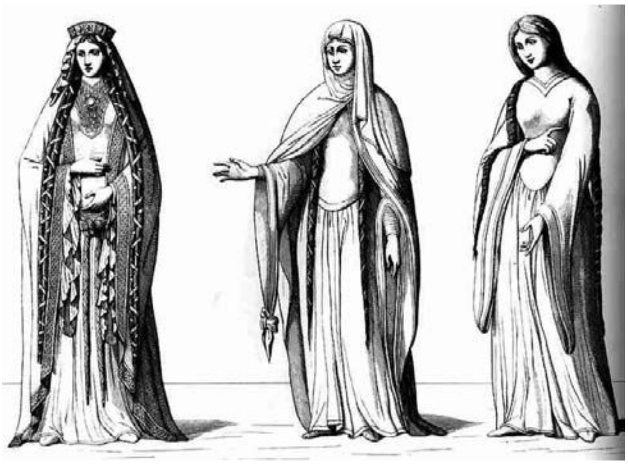
After the fall of the ancient Rome empire, and its division to the East and West, scarf takes a special place in clothing. Its religic role is significant untill today. In almost every religion, women cover their had with scrafs when entering temples. Women by that, covers its sexuality, like breast, hair...
Clothing after Roman empire, in the East was inherited. Instead of the ancient draped costume, that gave shape and beauty to the people, this costume was simple. Asian nations influenced it. Influence of Christian religion is also on the clothing of nations. It is strict, with clear form. Usage of silk was in the royalty. Costume included tunic, without lower suit and cape. Made of wool, cotton, and flax. Tunic – stola, was red, and looked like a long shirt, with long but tight sleeves. Later, it gets wide sleeves. Women tunic was simple in the beginning, but after recognition of Christianity, it is enriched. Women also had veils called mafors.

Male costume was also including a tunic, with tight sleeves, but various lengths. As the upper suit, they had an other tunic – tolaris, long and sleeveless. Cloths was the same for all, but the difference was in its quality and adding's. Through the mid-evil, the suit is also a tunic, made of hard materials, shorten, with tight trousers under. Pyramid system in ruling, was seen also in clothing. Capes were long, with hoods to protect from the weather.

Picture 3. Byzantine costume

Picture 4. Middle Ages

Married women start to cover their heads, with long, falling hear. Among European countries, there is a common fashion and clothing style. Christian women put scarf as a symbol of modesty. This custom is today widely used. Influence vary from time to time, from country to country. Every European country look to the more superior one, but, keeping its identity. In Italy, for an example, clothing represents richness. In Germany and Switzerland, clothing was hard and rough. In the Netherlands clothing was even more extreme. England evenly distributed elegance in clothing, with still present gothic elements. France was changing, always ready to offer something new.



Picture 5. Middle Ages

Hair style also changed, especialy with women. Men had short hair and beard. Women had loos hair, long, falling. In the beggining they use to hide it with veils. Poor women had wool or flax scarf, worn around the kneck. Royalty had long veils, that fell until the floor.
Through the 11. And 12 century, women wored deresses, with a cape. Cape becomes semy-round. Weared over the shoulders, with a buckle. In the mid-evil ages, cape is a regular part of clothing. Married women, based on religious customs, cover their heads.

In time of renesaince in Spain, hair is lifted up, and covered with caps. Women also wear heats, simmilar to mens, but also they wear fine scarfs and characteristic caps.

Discovery of the new continents contributed the exchange of goods, culture, religion…. Silk was paid with gold, and women loved it. The Silk Path, a term from the 19 century, is a cross-road of exchange. This is the road for Buddhism to China, and later, in 13th and 14th century, Marco Polo takes that path. Silk fabric was a symbol of wealth and richness. Napoleon ordered that cashmere scarf's from India, are to be sent to his loved one, Josephine de Beauhamais. During dinner, in Victorian times, women covered their heads with rich silk scarf's .


Picture 6. Mona Lisa *Picture 6.1. Eleonora di Toledo* *Picture 6.2. La Velata, Rafaelo*

Picture 6 shows Mona Lisa of Leonardo Da Vinci, a renesaince explorer and artist. She has on her head a subtle, thin, black veil, that freely falls over the head. On the picture 8.1 Angly Bronzina shows Eleonora di Toledo, with latest fashion clothing in the 16th century. She has a net on her head, with pearls, a widely used decoration in the high society.

In the 19th century, in costume history epochs like Ampir, Romantism, Victorian costume, La Belle Époque scarf remained to be a part of women clothing. Used in various ways, and falling on the shoulder. With civil society, it had a strong esthetic role. Made of fine fibers, with reach ornamentals. Enriched with feather, fur, bids, and other fine details.
Ampire style (1800-1820) got its name by crowning of Napoleon, and turning France from Republic, to Empire. This period fashion is influenced by ancient greek fashion, but more cleared in style, more addaptive to weather in western Europe.

Greatest influence to female fashion have queen Josephine, and her tailor Le Roa. Form is extended, waist is high, almost under armpit. Skirt receives a flat, thin line, hard to walk in.Sleeves are various, short, puff, tight, or combined [4]. Decolte is mouslty square, deep and wide, but it does'nt croos the sholder line. A short coat, in different color from the skirt, is used. Hats are diverse, with a stripe under the chin. In the evenings, turbans are worn.

2.1. The twentieth century, scarf and its role in society

20th century is specific when it comes to clothing, because many social forms influenced it significantly. Fast industrialization, wars, women rights, digital media, space programs and other, made clothing available to many social parts. Shopping is no longer the privilege of the rich. Scarf is only a square of silk, or other material intended to be worn around the head. It can be treated as art. It can be a collectable.

A modern shift dress in 50s may not have the right neckline, which should ideally be a slash or a shallow scoop. If you can't adjust the neckline, hide it with a knotted scarf. In the 1960s the scarf was folded into a triangle and knotted under the chin. Alternatively, a thin rectangular scarf could be wrapped around the head and neck. Hippies sometimes wore a long scarf tied around the head like a headband or a triangular scarf tied over the hair with the knot at the back of the neck.

Scarf is an important peace in the 20th century wardrobe, equal to gloves, or bag. For a designer, illustrator, and artist, the canvas is for innovation, advertising, and option to build ideas and trends. In many cultures, through the past and present, it is not modest for a women to show her hair, an so the scarf is an important instrument of the social bon-tone. In Europe and America in the first half of the century, scarf became very popular, informal alternative to the hat. Prominent public expected from a women to wear a detail in her hair.

3. CONCLUSION

Scarfs and sash represent a great additional fashion detail, and what makes them special is the ability to wear them in every occasion, in every time. It became fetish. Accessories were more important than ever, providing innumerable looks with the addition of a scarf, belt, or garlands of costume necklaces. It is very easy to express itself by this accessory. It is difficult to pinpoint the origins of the academic cap, but it is thought to have evolved as a variation on the ecclesiastic pileups cap and the medieval head scarf. Scarf is a detail that we can wear on the beach, wedding, on a business meeting, and other. They are a very interesting document of social history.

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THE ANALYSIS OF YARN CONSUMPTION IN A LOOP

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***Abstract**: This paper analyzes the consumption of yarn in one loop. Four samples knitwear of were made for this experiment. The first two samples are made of 100% cotton yarn fineness of 50 tex in 1x1 ribbed weave with a knitting machine of different fineness. The third and fourth samples were made of yarn of the same composition with machine of the same fineness. The difference is that the third sample was done in 1x1 ribbed weave and the fourth in 2x2 ribbed weave. From the results the differences in the consumption of yarn in a loop can be seen for all the samples. In preparation, the first and second sample was applied with the same interlacement and the same composition. The only difference was that these two samples were done on two machines of different fineness. The results show that the length of the yarn consumption is greater in the first sample. In preparing the third and fourth sample different interlacement was applied with the same composition and the same fineness of the knitting machine. The sample in the weave 1x1 shows that significantly lower values exceed the expenditure in the loop of the sample produced in 2x2 weave. This work has shown that machine and fineness of weave types significantly affect the value of consumption of yarn in one loop.*

***Key words**: consumption of yarn in the loop, Dalidovičov model Weft knitted, knitting machines.*

1. INTRODUCTION

The main feature of knitted products is that they are more or less porous materials. Porosity is caused by free spaces that are between the loop - what specifically affects the density of knitwear. In addition, the characteristics and composition of the yarn of knits also made a significant impact. The twist of the yarn is particularly significant.
The structure of textile products, including knitwear, is determined by the size, shape and mutual arrangement of its main elements. The basic element of knitwear is yarn, which makes a loop formed by bending. In addition to the loop elements knitwear can be a trap or some other form of yarn that is different from the loop and traps.

Knitted fabrics are made in the knitting process so that they will merge basic elements in a predetermined order. Predetermined sequence connecting basic elements is called the interlacement knitwear. The type of weave largely depend on the basic characteristics of knitwear such as dimensional stability, extensibility, tearing mode, density, weight, etc.. because forms of the loops, which are characteristic for each interlacement have a significant impact on the above mentioned characteristics. The type of yarn used for knitting largely influences shape of the loop.

Connectivity and arrangement of loops in knitting depend on the type of weave. A variety of angles under which each elementary parts are knitted in its structure allow knitwear to have the following good features:
• Excellent resilience, because usually after action of external forces loops keep its original form that they had prior to the action of these forces,
• Has no closed areas, as opposed to fabric, but with a slight action of force stretching occurs on the loop in the direction of the action of the force,
• It is good insulator because the air that is located between the loops retains the heat, but knitwear allow air permeability at the same time, which gives a pleasant feeling when wearing knitted garments.

Knitting is a shaping process in which yarns are made into knitwear. Knitted fabrics are flat textile products resulting from the large number of interconnected loops. Loops are the main structural elements of knitwear and their shape and size depend on the appearance and properties of knitted products. The woven product loops are connected in different ways with each other and intersect at different angles. This position of the yarn in knitting knitwear seems to get excellent elasticity, porosity and ability to adapt to the shape of the body users. The layout and size of the loops enables it to obtain a large number of different weaves. Due to the exceptionally good properties of knits, as well as highly developed and economical production of knitted products on the market, today there are a lot of these products. In addition to making clothes these products have found their application in many other areas of human needs [1].

2. THE LENGHT OF YARN IN A LOOP

One of the most important parameters in the process of knitting is the length of yarn used for making loops. Length of the loop causes knitwear dimensions and its physical and chemical characteristics. This was observed already in 1914. by J. F. Tomkins's who understood the significance of the loop for quality and dimensional stability of knitted fabrics. The influence of the loop in 1956. was placed on a scientific basis by Doyle and Munden. Today, the most accepted view is that the analysis of knitwear is made through the length of the loop. If the length of the individual loops are more even this results in better quality knitwear. The length is usually expressed in millimeters, and depends on the width and height of the loop and the thickness of the used yarn.

When calculating the length of the yarn for the width of the loop the distance between the centers of two neighboring platinum head loop arcs is used. For the height of the loop the distance between the centers of the two loops that are located one above the other in the same row of knitwear is used. Parameters affecting the length of the loop are: the structure and properties of the yarn, the yarn thickness, uniformity of tension and hardness of yarn wound on the spool, the size of the yarn tension at the entrance to the knitting zone, the size of the friction between the yarn and the working elements of machines, weaving speed, speed of heat-tension knitwear etc..

The type of yarn that is used greatly influences the length of the loop and the weight per square meter of the knitwear. Loops of different lengths, if the same type of yarn is being used, give different weight per square meter knitwear. Thickness of the yarn, which also affects the length of the yarn in the loop, depends on the fineness and density of the yarn that is used. In determining the thickness of the yarn there are two different thicknesses: a theoretical thickness of the yarn (d /) that is characteristic of the tensioned yarn in which the tension of the space between fibers is reduced to a minimum and the actual thickness of the yarn (d), which depends on the fineness and twist level of yarn. The theoretical diameter of the yarn is determined by the equation:

$$d' = k' \cdot \sqrt{T_t}$$

the actual yarn diameter is determined by the equation:

$$d = k \cdot \sqrt{T_t}$$

k'-theoretical coefficient
k - coefficient of actual and
Tt yarn fineness used in [tex].

The values of the coefficients are shown in Table 1

Table 1: Values of the theoretical and the actual coefficient

yarn composition	theoretical coefficient k′	actual coefficient k
Raw Cotton	0,029	0,0393
Bleached cotton	0,029	0,0412
Wool	0,031	0,0430
Acetate	0,032	0,0430
Polyamide	0,033	0,0470
Polyacrylonitrile	0,033	0,0410
Textured polyester	0,030	0,0451

The equation to calculate the length of yarn in the loop has the following form:

$$l = xA + yB + zd$$

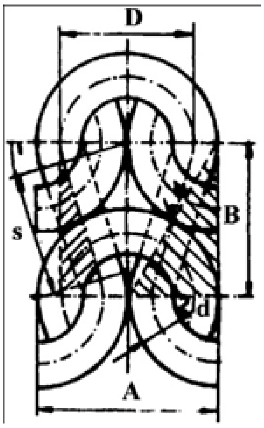
A - width of the loop, V - loop height, d-real yarn diameter and x, y, z - coefficients that depend on the type of weave

Previous equation is based on the assumption that all loops have regular geometrical shape. Variations in some cases the correct geometrical forms are taken into account, so the preceding equation changes its shape into a form that fits the case.
Calculating the length of yarn that is needed for the loop is not a simple process. Therefore, we set a large number of mathematical models that facilitate the calculations. Determination of this length is extremely important and a large number of science papers have shown when dealing with this issue. One of the first model, which is based on the observation of the loop in on an area, set by J. Peirce in a way that he assumed that the arcs of needle and platinum head are equal, round, that they touch each other and that they cross the arms tangentially. He took the diameter of the arc to be equal to the $D=3d$; trap height is equal to: $B=\sqrt{(4d)^2-(2d)^2}=2d\sqrt{3}$; width is equal to the traps $A=4d$. Labels correspond to labels in Pture 1 So he came to the following expression for the length of yarn in a trap:

$$l = 16,66 \cdot d$$

If the arcs head do not touch it the author establishes the following relations:

$$l = 2B + A + 5,95 \cdot d$$



***Picture 1:** The parameters of the length of the pitfalls of Peirce*

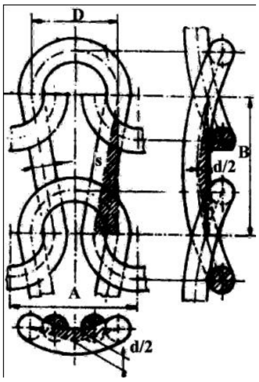
In the previous equation the other two researchers G.Fletcher -and M.Roberts have corrected the coefficient of 5.95, which multiplies the diameter of yarn for different cases. Their results show that the ratio ranges from 6.74 to 418.

Professor Dalidovič set his spatial model according to Picture 2. He assumed that the arcs of needled and platinum heads are equal and circular and in the leg cross by secants. This gives the relation:

$$l = \pi \cdot D + 2s \quad \text{with} \quad D = \frac{A}{2} + d.$$

If it is assumed that $s = B$, the result is:

$$l = 1,57A + \pi \cdot d + 2B$$



Picture 2: *Parameters length traps by Dalidoviču*

If we take $s = \sqrt{B^2 + d^2}$, then the result is:

$$l = 1{,}57A + \pi \cdot d + 2\sqrt{B^2 + d^2}$$

If instead of the A term we take 100/Dh then the previous expression to calculate the length of yarn needed for making traps has the following form:

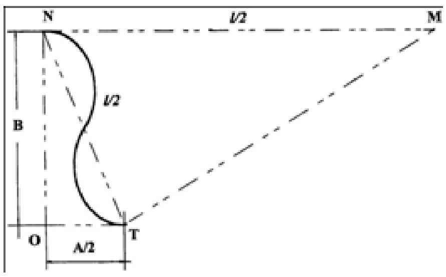
$$l = \frac{157}{D_h} + \pi \cdot d + 2 \cdot \sqrt{B^2 + d^2}$$

If we take into account the height of the loop V >> d then the previous equation can be written in the following form:

$$l = 1{,}57A + \pi d + 2B$$

If we include in the previous equation values of the ideal knitwear (assumed to be normally tight knitwear and the loop to occupy an ideal geometric shape, the value is: $A = 4d;\ C = \frac{D_h}{D_v} = 0{,}865$ i $B = 3{,}46d$, then the lenght of the loop will be equal to: $l = 16{,}34d$

The next way of determining the length of the loop takes into account its helical shape. Picture 3 shows the elements on which it is possible to determine the length of the loop.



Picture 3: *Helikoid model*

Picture 3: V - height of the loop; $l/2$- half the length of the loop and $A/2$ - half step loop.
The advantage of this model is that it is three-dimensional. In Picture 3, one may notice two triangles ΔNOT and ΔNTM. Since these two triangles are similar, the following variations are exepted:

$$\frac{l/2}{NT} = \frac{NT}{A/2} \text{ i } NT^2 = B^2 + (A/2)^2$$

From the previous two equalities follow:

$(l/2) \cdot (A/2) = B^2 + (A/2)^2$, so the lenght of the loop is equal to:

$$l = 2 \cdot \frac{B^2 + (A/2)^2}{(A/2)}$$

In addition to these models there is also a geometric model and a number of ways to determine the length of the loop. The significance of this problem stems to come from the fact that the length of the yarn needed to create a loop significantly influences many features of the designed knitwear. Primarily this affects the length of the horizontal and vertical density of knitwear. Therefore, this length must be accurately determined because otherwise afflicted by distortion of the structure in the made knitwear.

In fact, this structure would be different from that previously projected. This calculation, which is related to the smooth right-left weft knitted fabric, generally depends on the type of weave that is used for knitting the knitwear. For specific interlacement, coefficients are precisely determined. However, if the geometric shape of the loop deviates from the usual, then the equations must be taken into account and corrected separately in the equation.

3. MATERIALS AND METHODS

Ribbed knitwear, used in this paper were made on a circular knitting double bed needle machine knitting. Four samples were made. The first two samples are made of 100% cotton yarn fineness of 50 tex in 1x1 ribbed weave, and differ from each other in the refinement machine, where the first sample is made on circular machines fineness E15 a second sample of machines fineness E18. The analysis of these two samples can be seen as finesse machines affect physical mechanical parameters knitwear as well as the parameters for air permeability and water vapor permeability.

The third sample was prepared on a circular machine fineness E 18 in 1x1 ribbed weave, with the composition of the knitwear of 96% cotton fineness 20texa and 4% lycra fineness 44dtexa. The comparison of this sample with another sample we can see how the different composition (while finesse machines and interlacement remain the same) affects the physical - mechanical characteristics of knitwear and the permeability to water vapor and air.

The fourth sample was compared to the third sample. In this case, the difference between them lies only in the type of weave. The fourth sample is made of 96% cotton and 4% lycra, on circular machines fineness E18 applying 2x2 ribbed weave. Basic characteristics of all 4 samples are shown in Table 2

Table 2. Basic characteristics of the ribbed knitwear samples

Sample	Interlace ment, RIP	Raw material composition and fineness of the yarn tex	Fineness of the machine	Diameter of the machine
I	1:1	cotton 100% tex 20	E15	12”
II	1:1	cotton 100% tex 20	E18	13”
III	1:1	cotton 96% (tex 20) lycra 4% (dtex 44)	E18	18”
IV	2:2	cotton 96% (tex 20) lycra 4% (dtex 44)	E18	30”

4. RESULTS AND DISCUSION

The main significance of jersy knitwear is that they can be washed. To determine the consumption of the loop, a method was used for ripping the length of the thread. When the knitwear is ripped it stretches to the extent that the waved parts can straighten. Then the length is measured and the thread is let off of the pressure. Then the lengths of the loops are counted in a washed thread and the same numbers of threads are counted in the knitwear. For convenience in operation it is desirable that the number of loops from the ripped threads is a multiple of 10 Thus, mostly of 30, 40, 50, or 100 loops are ripped. One end of ripped thread is squeezed on the upper fixed forceps and the other end is pressured with 0.5 cN / tex. [9] In this case the 10 threads are ripped and on the basis of total length of ripped threads, consumption for forming a loop iscalculated.

$$l_{ei} = \left[\frac{\sum l_i}{(n \cdot n_p)} \right]$$

l_{e1}- consumption of yarn in one loop determined experimentally from ripped loops (mm)
l_i- the lenght of a single ripped thread
n - number of ripped threads
n_p - number od loops in a ripped thread

Table 3 Consumption of yarn in the loop of a ripped thread

		I			II			III			IV		
n	lenght of knitwear ripped (mm)	n_p	l_i (mm)	l_{e1} (mm)	n_p	l_i (mm)	l_{e1} (mm)	n_p	l_i (mm)	l_{e1} (mm)	n_p	l_i (mm)	l_{e1} (mm)
1.	100x100	187	584	3,12	222	649	2,92	215	634	2,95	195	712	3,65
2.	100x100	187	582	3,11	222	649	2,92	215	636	2,96	195	709	3,63
3.	100x100	187	583	3,12	222	650	2,93	215	633	2,94	195	708	3,63
4.	100x100	187	583	3,12	222	647	2,91	215	634	2,95	195	713	3,66
5.	100x100	187	583	3,12	222	651	2,93	215	635	2,95	195	714	3,66
6.	100x100	187	586	3,13	222	651	2,93	215	637	2,96	195	713	3,66
7.	100x100	187	583	3,12	222	648	2,92	215	633	2,94	195	712	3,65
8.	100x100	187	584	3,12	222	649	2,92	215	633	2,94	195	716	3,67
9.	100x100	187	586	3,13	222	649	2,92	215	632	2,94	195	713	3,66
10.	100x100	187	582	3,11	222	652	2,94	215	633	2,94	195	717	3,68
$\bar{X}$				**3,12**			**2,91**			**2,95**			**3,65**

The results in Table 3 are visible differences in the consumption of yarn in a loop for all the samples. In preparing the first and second sample the same interlacement and the same composition was applied. The only difference was that these two samples were done on two machines of different fineness. The results show that the length of the yarn consumption is greater in the first sample. In preparing the third and fourth sample, different interlacement but the same composition and the same fineness of the knitting machine was applied. The sample in the weave 1x1 shows that a significantly lower value exceeded the expenditure in the loop of the sample produced in 2x2 weave. This paper has shown that machine and fineness of weave types significantly affect the value of consumption of yarn in one loop.

5. CONCLUSION

One of the most important parameters in the process of knitting is the length of yarn used for making loops. Length of the loop causes knitwear dimensions and its physical and chemical characteristics. The importance of the consumption of yarn research in one loop is due to the fact that the length of the yarn needed to create a loop significantly influences many features designed knitwear. Primarily this affects the length of the horizontal and vertical density of knitwear. Therefore, this length must be accurately determined because otherwise it will be afflicted by distortion of the structure of the knitwear that is being made. In fact, this structure would be different from that previously projected. From the results you can see the differences in the consumption of yarn in a loop for all the samples.
While preparing the first and second sample the same interlacement and the same composition was applied. The only difference was that these two samples were done on two machines of different

fineness. The results show that the length of the yarn consumption is greater in the first sample. In preparation of the third and fourth sample, different interlacement but the same composition and the same fineness of the knitting machine was applied. The sample in the weave 1x1 shows that significantly lower values exceeding the consumption in the loop of the sample produced in 2x2 weave. This paper has shown that machine and fineness of weave types significantly affect the value of consumption of yarn in one loop.

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BASIC CHARACTERISTICS OF EUROPEAN UNION LEGISLATION IN THE FIELD OF INDUSTRIAL DESIGN PROTECTION

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Abstract: European Union as regional organization has rich normative activity in various fields of intellectual property and in the field of industrial design protection as well. The authors present the main characteristics of basic laws and regulations which regulate protection of industrial design in European Union. The accent is put on characteristics of two basic laws from this field: Regulations on Community Design and Directive on Protection of Industrial Design.

Key words: industrial design, legal protection, European legislation.

1. INTRODUCTION

The reason of legal regulation of industrial design is in economic value of esthetic shaping of goods. Economic value of esthetic shaping of goods cosisted of values of labour, time, knowledge, skilfulness and means invested in creation of industrial design as well as profits rising effects as a consequence of commercial use of industrial design. Nowadays, consumers search for the products that will satisfy their needs in the best possible way. For capacity of industry to make various products, especially in relation to quality level and usability, as well as to offer them to the market there is a competition among producers who produce products for the same purpose. This competition is present both on domestic and international markets. Consumers have more serious criteria at selecting and buying products. As for profit-related issues it is emphisized that the first impression on the products has being gotten upon their design that is in the marketing of immeasurable significance. Except that, industrial formating understands creation not any but nice-looking and likeable appearance of goods. Conferred to the area of doing business it means that products without any beauty are monotonous and they do not, that is from the marketing aspect the most important, attract attention of consumers. Therefore, since majority of people, more or less, feel natural need for esthetic, good-looking appearance of product serves to attract attention of consumers and influence their choice decision. Thereof the statement that "design can represent value for consumer and facilitate choosening". (Kotler, 1989)

By esthetic configuring of goods is possible to influence consumers decision on choice because, the same as with trade mark, industrial design in customers' conscience generates psychologic effect. While watching nicely shaped and fit out products people react emotionally, i.e. make a judgment which administer to the final decision making on buying. In respect to contribution of esthetic formation of goods to total marketing effects, work on creating and improving esthetic quality of products is the subject of increased commercial interest. (Ljubojev,Varga, 2010)

Industrial design in scientific and professional meaning is multidisciplinnary. Creation of new appearance of goods means application of knowledge from many areas such as: (applied) art, economics, marketing, psychology, sociology, esthetics, even ecology and customers security. Because of that esthetic formation of goods is economically very worthy and, at the same time, very complex activity. It is very true that for successful industrial design is necessary to employ various experts. In relation to all of that it is necessary to provide legal protection of holders of results attained with such endeavor against parasite practices of those who do not want to invest enough time, money and efforts in esthetic modeling of goods. (Ljubojev,Varga, 2010)

Nowadays, design represents a creative discipline considering almost all modern producers. According to some theoretic opinions design should give quality to products in technical, functional, esthetic, economic and ergonomic sense (Desnica, Nikolic, 2000). A product must function in optimum way, it must be good-looking and economically acceptable as well as ergonomic. If this is achieved a product attains success on the market. The role of design is to create quality and attractive product. According to theory, »design is a scientific, professional and creative discipline, the symbol of product`s quality as well as system, function, union of activities, organizational whole and the field of management in a company – oriented towards full satisfaction of needs, requirements and wishes of consumers, economic developing objectives of individual companies and the economy, enviromental improvement as well as progress of society as a whole.« (Vasiljevic, 2000)

Industrial design can be classified in different ways. But the most important divisions of industrial design are divisions made by criteria such as numbers of dimensions or nature of designed objects. (Varga, 2000) There is also a distinction between registered and non-registered design. Registered design is design protected with exclusive industrial property right granted in an administrative procedure by authorized state body. Non-registered design is particularly protected in EU. Non-registered design is protected for three years. One can design industrial or handicraft products, packing material, graphical symbols and typographic signs.

2. EUROPEAN UNION LEGISLATION IN THE FIELD OF INDUSTRIAL DESIGN PROTECTION

European Union as regional organization has rich normative activity in various fields of intellectual property and in the field of industrial design protection as well. Taken into account that European Union market is unique the final aim of these regulations is to create intellectual property right in European Union in this field. This process is performed through two forms of regulations - by Regulations on Community Design, which has supernational character and is directly applied in all European Union member countries a system of industrial design protection is being formed. By adoption of Directives EU, such as Directive on Industrial Design Protection all member countries are obliged to harmonize their national legislation in this field with this Directive. Directives are, in fact, instruments of harmonization of national regulations of member countries of European Union.

The significance of the Law of intellectual property of European Union for Republic of Serbia lies in the fact that even the countries which are not currently members of European Union take over solution from European Union regulations when forming their national legislation.

The main laws in this field are: Basic Regulation (CDR) Council Regulation (EC) 6/2002 of 12 December 2001 on Community Designs, (with introduction of New Member States in Article 110a and the link with Hague Agreement), Implementing Regulation (CDIR) Commission Regulation (EC) n 2245/2002 of 21 October 2002 implementing Council Regulation (EC) No 6/2002 on Community designs, Fee Regulation (CDFR) Commission Regulation (EC) n 2246/2002 of 16 December 2002 on the fees payable to the Office for Harmonization in the Internal Market (Trade Marks and Designs) in respect of the registration of Community designs, Regulation laying down the rules of procedure of the Board of Appeal , Commission Regulation (EC) No 216/96 of 5 February 1996 laying down the rules of procedure of the Boards of Appeal of the Office for Harmonization in the Internal Market (Trade Marks and Designs) and Directive, Directive 98/71/EC of the European Parliament and of the Council of 13 October 1998 on the legal protection of designs.

2.1. Community Designs Regulation

The Community Designs Regulation was adopted on 12 December 2001. Unregistered Community design protection has existed since 6 March 2002 and registered Community design protection has existed since 1 April 2003. A rule is a legal basis for design protection on the whole territory of European Union although there is a possibility of the existence of national design as well. It is not possible to limit the geographic scope of protection to certain Member States. Directive 98/ 71 EC preceded to this rule.

CTM system is based on a ‘basic Regulation’ of the Council of the European Union (Council Regulation (EC) No 40/94 of 20 December 1993 on the Community trade mark) (the “CTMR”), as subsequently and variously amended, and also on various Commission Regulations, also amended several times and establishing, respectively, the implementing rules for the CTMR, the fees payable to OHIM, and the rules of procedure of the Boards of Appeal of OHIM.

Protection right belongs to the author and to his/her legal successor. In cases when a design of a product is created by two or more persons this right belongs to all of them.

According to the Rule there is registered and unregistered design. Community design 1. A design which complies with the conditions contained in Regulation is hereinafter referred to as a "Community design".[3] A design shall be protected:

(a) by an "unregistered Community design", if made available to the public in the manner provided for in Regulation;
(b) by a "registered Community design", if registered in the manner provided for in Regulation.[4]

A Community design shall have a unitary character. It shall have equal effect throughout the Community. It shall not be registered, transferred or surrendered or be the subject of a decision declaring it invalid, nor shall its use be prohibited, save in respect of the whole Community. This principle and its implications shall apply unless otherwise provided in Regulation.[5]

A design shall be protected by a Community design to the extent that it is new and has individual character. A design applied to or incorporated in a product which constitutes a component part of a complex product shall only be considered to be new and to have individual character:

(a) if the component part, once it has been incorporated into the complex product, remains visible during normal use of the latter; and
(b) to the extent that those visible features of the component part fulfil in themselves the requirements as to novelty and individual character. [6]

A design shall be considered to be new if no identical design has been made available to the public:

(a) in the case of an unregistered Community design, before the date on which the design for which protection is claimed has first been made available to the public;
(b) in the case of a registered Community design, before the date of filing of the application for registration of the design for which protection is claimed, or, if priority is claimed, the date of priority.[7]

Designs shall be deemed to be identical if their features differ only in immaterial details.[8]

A design shall be considered to have individual character if the overall impression it produces on the informed user differs from the overall impression produced on such a user by any design which has been made available to the public:

(a) in the case of an unregistered Community design, before the date on which the design for which protection is claimed has first been made available to the public;
(b) in the case of a registered Community design, before the date of filing the application for registration or, if a priority is claimed, the date of priority. [9]

In assessing individual character, the degree of freedom ofthe designer in developing the design shall be taken into consideration. [10]

[3]Title, General provisions Art. 1 (1) Community design.
[4] Title, General provisions Art. 1 (2) Community design.
[5] Titlle, General provisions Art. 1 (3) Community design.
[6] Title, General provisions Art. 4 (1) (2) a, b Community design.
[7] Title, General provisions Art. 5 (1) a, b Community design.
[8] Title, General provisions Art. 5 (2) Community Design.
[9]Title, General provisions Art. 6 (1) a, b Community Design.
[10] Title, General provisions Art. 6 (2) Community Design.

Registered design enjoys protection for the period of 25 years, along with an obligation to be prolonged every 5 years. Unregistered design is protected for 3 years.

If a design is created within employment and is made by employee within regular working time and regular activities, the right on design protection belongs to employer unless it is predicted otherwise by a contract between employer and employee.

Registration is initiated by application. It is possible to request protection for more external forms by one single application if they belong to the same class according to international classification. The date of official registration is considered the date of submission of official registration. This date is relevant for determination of priority of protection right.

Registration can be submitted:

1. Directly to design registration office;
2. Central office for registration of industrial property rights in countries members;
3. Office for registration right on design in Benelux countries.

Upon application the Office examines if the application is in accordance to the conditions prescribed by the rule book and if it is, a design is registered. Submitter can demand that registered design is not to be published for the period no longer than 30 months from registration day. The right on registered design can be annulated on reasonable grounds and the procedure is performed before the Office. Appeal process is possible against the decision made by the Office and also protection procedure before EU Court of Justice.

In cases of unregistered design the rights of protection are somewhat smaller and they are reduced to prohibition of other persons to copy design while identical design which is the result of independent work of other persons will not be considered copying and against such design unregistered design will not enjoy legal protection. The rights of design holders are subject to limitations if unregistered design is used in personal and noncommercial purposes, in research, undisturbed international traffic and because of exhaustion. The right on design can be terminated by waiving the right, annulation or termination of the right holder if there are no successors.

2.2. Directive on Legal Protection of Design (Directive 98/71 EC)

Directive 98/71/EC of the European Parliament and of the Council of the European Union, 13 October 1998 on the legal protection of designs (hereafter: Directive 98/71 EC) does not contain provisions on the procedures od design protection. The aim of the Directive 98/71 EC is to equalize regulations of the countries-members of European Union in relation to legal protection of design. First of all, considering the conditions which external form of the product should fulfill in order to be protected by design, the content of rights that should be approved to design holder, limits, duration and end. According to Directive 98/71 EC definitions for the purpose of this Directive: (a) 'design` means the appearance of the whole or a part of a product resulting from the features of, in particular, the lines, contours, colours, shape, texture and/or materials of the product itself and/or its ornamentation. [11]

According to Directive EC 98/71 as conditions for protection of external form of product design originality and novelty are anticipated. Those external forms of products dictated by technical function of the product as well as their parts where the form and necessary dimensions should be excluded from protection. Novelty should ne absolute. According to Directive 98/71 EC Article 4 Novelty A design shall be considered new if no identical design has been made available to the public before the date of filling of the application for registration or, if priority is claimed, the date of priority. Designs shall be

[11] Art. 1 (a) Directiva 98/71 EC

deemed to be identical if their features differ only in immaterial details. [12]Article 5 Individual character 1. A design shall be considered to have individual character if the overall impression it produces on the informed user differs from the overall impression produced on such a user by any design which has been made available to the public before the date of filling of the application for registration or, if priority is claimed, the date of priority.[13]2. In assessing individual character, the degree of freedom of the designer in developing the design shall be taken into consideration.[14]

According to regulations of country members it should be anticipated that the right on design is achieved in national body for intellectual property or by registration in international bureau. The registration of a design shall confer on its holder the exclusive right to use it and to prevent any third party not having his consent from using it. The aforementioned use shall cover, in particular, the making, offering, putting on the market, importing, exporting or using of a product in which the design is incorporated or to which it is applied, or stocking such a product for those purposes.[15] By national legislation it should be predicted limitation related to holders of rights on design in cases when it is used in personal non-commercial purposes, in teaching and research, in undisturbed international traffic, exhaustion of rights and use of design created at the same time as the protected one. The rights conferred by a design right upon registration shall not extend to acts relating to a product in which a design included within the scope of protection of the design right is incorporated or to which it is applied, when the product has been put on the market in the Community by the holder of the design right or with his consent.[16]

Term of duration should be predicted to last 25 years from the day of submission of application. This right should be prolonged every 5 years with payment of mandatory tax. [17] The right can be terminated before deadline if it is determined later that in the time of design registration the prescribed conditions for the right recognition were not fulfilled.

By adoption of The Law on the Legal Protection of Industrial Designs Republic of Serbia a harmonization with the Directive 2004/48/ of EC of European Parliament and Council from April 2004 on inforcement of intellectual property rights (hereafter: Directive 2004/48) and Directive on Legal Protection of Design 98/71/EC of EU Parliament and Council. The significance of the Law of intellectual property of European Union for Republic of Serbia lies in the fact that even the countries which are not currently members of EU take over solution from European Union regulations when forming their national legislation.

3. CONCLUSION

The basic laws and regulations which regulate protection of industrial design in European Union is two basic laws from this field: Regulations on Community Design and Directive on Protection of Industrial Design. The Community Designs Regulation was adopted on 2001. A rule is a legal basis for design protection on the whole territory of European Union although there is a possibility of the existence of national design as well. It is not possible to limit the geographic scope of protection to certain Member States. Directive 98/ 71 EC preceded to this rule. Protection right belongs to the author and to his/her legal successor. In cases when a design of a product is created by two or more persons this right belongs to all of them. According to the Rule there is registered and unregistered design. Registered design enjoys protection for the period of 25 years, along with an obligation to be prolonged every 5 years. Unregistered design is protected for 3 years. The rights of design holders are subject to limitations if unregistered design is used in personal and noncommercial purposes, in research, undisturbed international traffic and because of exhaustion. The right on design can be

[12] Art.4 (a) (b) Directive 98/71 EC.
[13] Art. 5 (1) Directive 98/71 EC.
[14] Art. 5 (2) Directive 98/71 EC.
[15] Article 12(1) Directive 98/71 EC.
[16] Art 15.Directive 98/71 EC.
[17] Art. 10. Direcktive 98/71 EC.

terminated by waiving the right, annulation or termination of the right holder if there are no successors.

Directive 98/71/EC of the European Parliament and of the Council of the European Union, 1998 on the legal protection of designs does not contain provisions on the procedures od design protection. The aim of the Directive 98/71 EC is to equalize regulations of the countries-members of EU in relation to legal protection of design. Conditions for protection of external form of product design originality and novelty are anticipated. According to regulations of country members it should be anticipated that the right on design is achieved in national body for intellectual property or by registration in international bureau. By national legislation it should be predicted limitation related to holders of rights on design in cases when it is used in personal non-commercial purposes, in teaching and research, in undisturbed international traffic, exhaustion of rights and use of design created at the same time as the protected one. Term of duration should be predicted to last 25 years from the day of submission of application. This right should be prolonged every 5 years with payment of mandatory tax. The right can be terminated before deadline if it is determined later that in the time of design registration the prescribed conditions for the right recognition were not fulfilled.

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SIXTIES REBELLION FASHION CLOTHING AND HISTORY

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Abstract: *The paper analyzes methods and starting points of fashion as a social phenomenon the 20th century. It is interesting to analyze the clothing of the sixties of the twentieth century as a period of social and sociological changes. These changes are reflected in the style of dressing in Western society. When we talk about this period and its manifestation in the fashion and art, we have to mention that the changes occurred in the form of a burst. Rebellion instigated by young people which has unstoppable power of changing society and its original habits were reflected in art, social and cultural fields. Music played a great role in forming the style of dressing, and first simple geometrical peaces came out from the mode-appearance. The emergence of mini-skirts, role that jeans had, releasing bras, going to space, war in Vietnam, are just some of the theories that glorify the sixties. Fashion before this decade has been aimed at the rich and elite, therefore sixties became a turning point, because it becomes an essential taste and attitude of youth.*

Key words: *sixties fashion, mini skirt, appearance of jeans, music.*

1. FSHION CONCEPT

Fashion can be defined as a cyclic system that helps us to visually express ourselves. What is interesting with fashion is, that fashion is changeable by social influences, and its sphere of action is also in music, design, art, etc. Many try to express or to hold their identity with fashion, attract attention, or to functionally satisfy the role of clothing. Before, styles have slowly changed, by the influence of the high society. This trend stayed until industrialization which brought fashion to lower social parts of the society. For centuries, modern clothes was available only to the rich, but evolution and many social, cultural, political and technologic changes speeded up the development of the cities. By that, the need for clothing by the latest fashion rise.

Manufactural production of clothes in the 20th century slowly decipires, leting in the clothes which is more appropriate to wider consumer body. With these changes, clothes looses its unique touch, starts to look like kloned, and the ones who wear it look alike more in style. The rich and material status of some person we easy read with the „clothing language". Non-verbal communication and message that we send this way, is sometimes reverse of what we are. Man starts to put himself into more activities, sports development, fun events, concerts, where someone can express its power.
What makes the 60s interesting is the fact that some actions pulled a line of reactions, caused by the youth rebellion, and their un-satisfaction. Before 1960. From a young woman it was expected to be dressed like her mother, meaning there was no big difference in clothes between women and young girls then. As an example, we can use the Sears catalog from 1962. which shows mother and daughter like the same. They wore identical dresses, and nothing gave a hint about their age difference. Late fifties, brought the English designer Sally Tuffin to notice that: "There is no clothes for youngsters, all young women look like their mothers." (Steele 1997).

2. FEATURE IN CLOTHING THE SIXTIES OF THE TWENTIETH CENTURY

On the 60s world stage a fashion revolution has happened, that affected our fashion scene. Fashion starts to liberate itself, and to be less formal. Clothing in this period will become crucial for creating future fashion. To understand the 60s fashion better, it is needed to see for a moment the late 1950s. At that time, fashion was dictated by high fashion houses (Houte Couture) like Dior, Lanvin, Givenchy, Balenciaga,[1] etc. "S" silhouette was the only new thing in post-war fashion. For example, Balensiaga was a synonym for sophisticated fashion, starts to lose clients. Jacquie Kennedy[2], the fashion icon of the time, accepts the trend, eliminates the formal. Hats, gloves, and other details are lesser used. First half of the century was relieved of any esthetics. Traditional clothing is changed for appropriate. Because of this, Houte Couture was forced to bring in popular clothes to the market. Pier Cardin[3] and Ive Saint Loren were the first that adjusted to the new circumstances rapidly. Most of the designers started to sell in shops, which started to appear in every city. Street fashion for the first time starts to be the inspiration factor. Fashion houses no more dictate styles, but they check the pulse of youngsters and turn to their taste and needs.

Picture 1. Jacquie Kennedy

Names that arrived in that period are Christian Dior, Yves Saint Laurent, Pier Cardin, Paco Raban, and others. What made a difference is the appearing of the mini skirt which Mary Quant[4], English designer, has designed. She shortened skirts so high, that she started a revolution with one move with scissors. That 8-9cm above the knees, was its top, synchronized with the new music wave. First minis' meant release, a punch to the bourgeois taste and rules. Dresses had sharp lines, defined, and an "A" look. Haircuts were short, with lined eyes. Model Twiggy was relieved of the boy look, and started to represent the new beauty trend.

Picture 2. Mini skirt

Big changes also appear with men's fashion. Democratic character is accepted. Italian designers highly influenced men's clothing. Traditional suit is not used anymore daily. Suits are single, with

[1] Diora, Lanvin, Givenchy, Balenciaga, house of haute couture in Paris.
[2] Jacquie Kennedy, First Lady of America in the period 1960-1963.
[3] Pierre Cardin i Yves Saint LaurentThe famous French fashion designers, whose work was highly appreciated '60s.
[4] Mary Quant, English designer who created the mine skirt '60s.

short jacket and tighter pants. Turtlenecks where "a must" with the French intellectuals, Jean Paul Sartre, director Roger Vadim, and the feminist Simone de Beauvoir. Rapidly, youth accepts turtleneck instead shirts. Square design is combined with jeans, which also was treated rude. Men's hair was long.

2.1. Music

Music had a big role in defining the 60s style. In the 1950s, rock and roll, but in 1960s, bands like The Beatles[5], Rollingstones[6], and the Hue[7] revitalize the British pop. The Beatles, band of four Liverpool boys, always had the "neighborhood approach". They became the youth disobedience symbol. Familiar look, tight hair dress, and the new music style won the world fast. Beatle-mania was epidemic. Long hair, screaming girls, short skirts, represent a huge provocation for parents at the 60s. This was POP music revolution, which made the path for future music styles. Later, their clothes fell into the influence of drugs they have been using.

For a difference, The Stones preferred more tough sound, with provocative front man Mick Jagger. They had the rebellion look, different from the Beatles. From the USA, Bob Dylan and West Coust[7] made a big role, along with Mamas and Papas. The Woodstock festival of music and art, held in the part of the New York state, with the progressive artist like Jimmy Hendricks, Janise Joplin, and the Greatfull Dead[8]. A lot of young people had a new look at the world with this music, making the foundation for free word, rebellion, individualism… All of these artist created a recognizable style of fashion. Dylan had batik print, and hippie with country rocker style. The Beatles started in Pier Cardin. The Rolling stones were tuff delinquents. All of them were very expressional in music, and in clothing. Freedom and the need to be different, carried a message that young people can make their own style.

Picture 3. Fashion 60s in Italy

2.2. The hippie movement

The war in Vietnam made big changes in the American society, started a row of reforms in human and civil rights, and questioned the American society. Hippie movement as an answer to the Vietnam War

[5] Beatlesa, English band from Liverpool, who is regarded as the most successful rock band of all time Beatlemania name for the sensation that accompanied the band.
[6] The Rolling Stones, English rock band, founded in 1962. Their musical style was formed under the influence of American rock and blues. Sixties were right behind the Beatles' popularity. The band still exists and is very active.
[7] The Who, Bob Dylan, West Coast, bands and musicians who have made a major impact on young people and society with his music.
[8] Jimi Hendrix, Janis Joplin and the Grateful Dead, musicians, whose name is pronounced with awe, that her performances and individuality, failed to appeal to the masses.

and against the spending society, work and convencialism, was a yought movement at the states. The mission of the "Children of love" was to spread love and peace, and to fight the social clamps that the society started to take. During the 1967 "summer of love," hippies indulged in doing their own thing by dancing in the parks and streets, communing with nature, exploring new sexual experiences, and experimenting with recreational drugs. That year the Beatles sang, "All you need is love," They rose

against the comfort and materialism. They use drugs, listen to music, and wear highly colored clothes were their symbols. All was against the rules, so even fashion. They fought violence, had flowers in the hair, made a new world for them. With long hair, they identified themselves with people from India or south America, and with headbands like Indians. Floral prints, long dresses, wide pants and lots of colors is also their mark. Alternative hippie clothes had a lot of elements taken from non-west countries. Details from the Mexican and Indian clothes and jewelry now were ob both sexes. The "trademark" was the peace symbol, made of wire, metal… Now the maxi skirt arrived. Janis Joplin, The Doors, Pink Floyd, and Jimmy Hendricks brought their music to the public.
Hippie fashion was completely divers from the 60s fashion. Instead of straight lines, clean forms, and geometry, hippie anti-fashion is defined through all fashion elements, once characteristic for the west[9].

2.3. A man flying to the moon

Neill Armstrong was head of the cosmic ship "Appolo 11" which main task was to arrive on the Moon. He was the first on it. Millions followed this event. After this historical moment, many designers found their inspiration out it. Paco Rabanne[10] highlighted form, used unusual materials, like chains, glass, metal, paper, and other non-textile. New wave in fashion, in-forced by the landing on the Moon, was called the Space Style, and it combined futuristic elements with regular form. Discoveries like TV, music devices, better cars and more sophisticated machines, speeded up the development in total

Picture 4. Pier Cardin 1967.

3. MATERIALS AND PATTERNS

In the second half of the 1960s, geometric designs gave way to kaleidoscopic patterns with a lot fluorescent colors. The new chaotic and asymmetrical patterns of psychedelic colors formed a style known as "pyschedelia."[11] The designs drew inspiration from the highly glamorized drug culture.
PVC, siphon, and vinyl are moistly used in mass production. Black and white pattern in graphics is very popular. It announces Op-Art. Pop-Art and Op-Art, by Andy Warholl and Peter Blake had more and more followers. Pop-Art was a part of fashion, with strong influence. As an example we have Fiorucci shirts.

[7] The Who, Bob Dylan, West Coast, bands and musicians who have made a major impact on young people and society with his music.
[8] Jimi Hendrix, Janis Joplin and the Grateful Dead, musicians, whose name is pronounced with awe, that her performances and individuality, failed to appeal to the masses.
[9] Yvonen Connikie Fashions of a Decade: The 60s.
[10] Paco Rabanne, the Spanish designer whose work is specific. Uses unconventional materials such as metal working, plastics and paper. In 1966. founded the fashion house Paco Rabanne in Paris, where he lives today.

Op-Art is short for optical art, characterized with lines, geometry, black, white. Dresses, coats, and details are made of plastic. Emilio Puci made a collection in the late 60s with psychedelic patterns and colors, known as the Acid colors. Designers were experimenting with different materials such as metal, plastic, and leather. Metallic and neon colors were everywhere. In 1965, “Op art” became another trend, which used a lot of geometric shapes and contrasting colors to create optical illusions.

3.1.Fashion in Yougoslavia

Fashion in Yougoslavia was shy in orientation to the new trends. In the period of socialism and gigantic textile factories, no designers were mentioned. First designer from these places, higly ranked, was Aleksandar Joksimovic. He was called “The Youguslav Dior”, and ambassador of our fashion, best creator, king of scissors, etc. 2003. He was finally called by the press, as the King of Yougoslav Fashion for all times”[12]

Working in “Centrotextile” he had the honor to represent Yougoslavia on the first commercial expo in Paris, where he was praised for his work, and opened the fashion door in SFRJ. At 1969. He made the “Prokleta Jerina” show. “It was inspired by build-out of Smederevo, wars, and Serbian despot defenses, and Thessaloniki fighters from Serbia.”[13]

Picture 5. “Prokleta Jerina” Aleksandar Joksimovic 1969

4. CONCLUSION

In this rebellion decade, the female body has changed by the influence of new happenings. Slimmer figure is accepted, no attributes. Posing was innocent. Women start to practice sports. Mini skirt was not showing the legs, but searching for the holy Grale for female gender. It’s the freedom for millions of women. This was the decade of revolution in the way of life and sexual attitudes, followed by wide changes in music, fashion, art, and media. Liberal stands, and, most important, opinion was widely accepted as normal in mass structures. The counterculture generation had coined the slogan “Do your own thing,” which manifested itself in looks as diverse as those of the hippies, urban ethics, and suburban preppies. Also, very important is the fact that women were active and involved into all of this.

[11] Costume and fashion source books, Anne Rooney, The 1950s and 1960s
[12] M. Bernard, op.cit, p. 39.
[13] Daniela Velimirović, Aleksandar Joksimović Fashion and Identity, p. 76th

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ANALYSIS OF RIGHT KNITWEAR

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Abstract: *This paper analyzes the dimensional stability of the right - right knitwear. Four samples of knitwear were made for the test. The first two samples are made of 100% cotton yarn fineness of 50 tex in 1x1 ribbed weave of different fineness knitting machine. The third and fourth sample are made of yarn of the same composition as the machine of the same fineness. The difference is that the third sample was done in 1x1 ribbed weave and a fourth in 2x2 ribbed weave. The obtained results show that the shrinkage in width knitwear are significantly higher than the shrinkage in length for all samples except for the forth sample where it is the same. In first and second sampling results indicate that the samples from the machine, which had a greater subtlety and more likely to have shrinkage after washing in width than in length. In III and IV sample - a sample in the weave 1x1 showed significantly higher values of sample collection produced in 2x2 weave, and the width and length. This work has shown that machine and fineness of weave types significantly affect the value of the collection of knitted material.*

Key words*: cotton right - right knitwear, knitwear dimensional stability, shrinkage of knitted fabrics after washing.*

1. INTRODUCTION

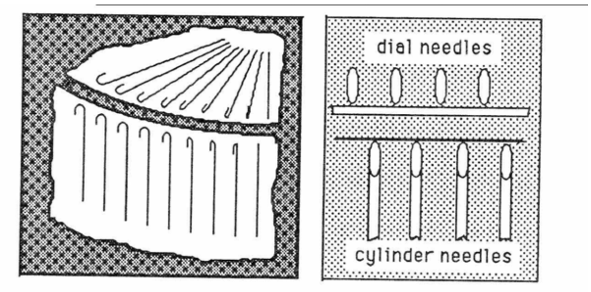
Yarn knitting is a procedure in which the design of the threads is made in knitwear. Knitted fabrics are flat textile products resulting from the large number of interconnected loops. Loops are the main structural elements of knitwear and their shape and size depend on the appearance and properties of knitted products. The woven product loops are connected in different ways with each other and intersect at different angles. This position of the yarn in knitting knitwear seems to get excellent elasticity, porosity and ability to adapt to the shape of the users body. Layout and size of the loop is to obtain a large number of different weaves. Due to the exceptionally good property of knits, as well as highly developed and economical production of knitted products on the market, today there are a lot of these products. In addition to making clothes these products have found their application in many other areas of human needs. The appearance on the market of a large number of different materials allows the range of knitted products to increases significantly.

Production conditions in which the knitted fabric is made plays an important role in achieving the desired quality of knitwear. Production capacity of knitting machines and their adjustment largely determined physical and chemical characteristics of knitwear and therefore usability of knitted products, all of which affect the very comfort while wearing clothes made of these knitwear. Therefore, it is necessary to properly design their structure for the desired purpose of clothing [1].

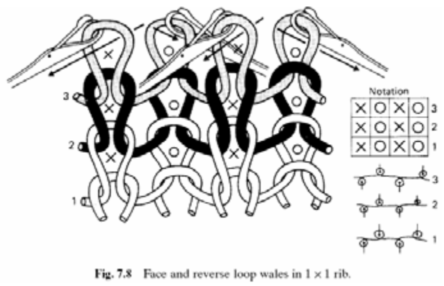
Comfort of clothing is a complex phenomenon that can be considered in its historical, cultural and social context [2]. Comfort of a garment is determined by the physical properties of textile materials, size and cut of a garment, psycho-physiological factors, such as the human physiological condition, lifestyle, fashion trends, and previous experiences of men and prejudices, biases, and expectations. In this sense, the business can be classified into three groups: psychological or aesthetic, thermal comfort and textile. Thermal comfort is related to the ability of textile materials that do not harm the thermo physiological balance of the human body and the environment through heat and sweat that is produced by the human body. Behavior of textile materials in the thermodynamic energy exchange of the dressed human body and the environment is influenced primarily by its ability to transfer heat and if it lets air and water vapor. Thus, thermal properties, air permeability and water vapor are the key parameters of textile materials, in terms of thermal comfort [3]. .

2. RIB KNITWEAR

Ribbed knits are a group of two-sided - right cultural knitwear. Their main characteristic is that on the one hand and on the other hand of the knitwear both the left and right loops can be seen. In these knitwear by using platinum loop sided knitwear for sampling, and thus using needles other fonture, loop transforms into a new needle or catcher loop. In the knitwear, one or more interspersed with strings of right loops with one or more strings of left loops [4].

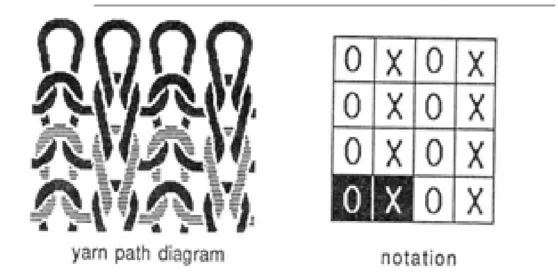


Picture. 1 The system of needles that form a rib knitwear



Picture. 2 The face of 1x1 rib knitwear.

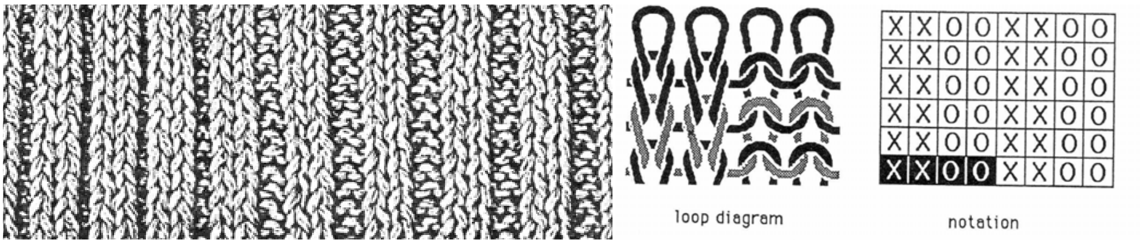
Right knits are made in double bed flat and circular knitting machines. They consist of open-loop form two inter-related parts in the thickness of fabric. On both sides of the knitwear only the right strings loop is visible. The simplest combination of right and left loop is 1x1 ribbed structure. Width report of this fabric is Rš = 2 and height Rv = 1 [4].



Right 1x1 knits have a well-balanced structure. Rotation moment in the yarn is neutralized by the loops which are formed on both sides of the knitted fabric alternatively. There is no curling at the edges. Elastic recovery ribbed knitwear 1x1 structure is very high along the entire width. When knitted into a relaxed state it shrinks so much that only the shorter loops can be seen on both sides.

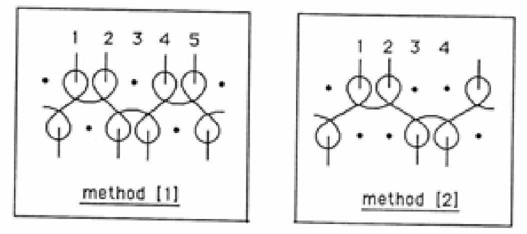
1x1 ribbed knits with flat knitting machine is mainly used to handle cuff and collar, due to its high elasticity and ability to retain its shape. They are also used for making men's underwear, sweaters and similar. For clothes that are cut and sewn, 1x1 ribbed knits are also applied in making sweaters in wool or acrylic socks as a renderer using the elastic. [5].

Similar to the structure of the 1x1, the 2x2 rib there is repetition in the structure. The main difference is that this structure consists of repeating of 2 front loops and 2 reverse loops. The rib structure is the most popular for making cuffs and waist.



Picture. 3 Appearance of 2x2 ribbed knitwear and schematic formation of 2x2 ribbed knitwear

There are two methods for making 2x2 ribbed knits on knitting machines (Figure 4).
Method 1: with every third needle out of order
Method 2: with every third and fourth needle out of order.
Knitwear created by these two methods are more or less similar. Method 1, however, gives a tighter structure and more elastic material.



Picture. 4: Schematic presentation of method 1 and method 2 forming 2x2 ribbed knitwear

The basic parameters of the knitted structure include:
- The width of knitwear
- The density of the row of the loop (Horizontal) (Dh)
- The density of loops in a series of twists (Vertical) (DV)
- Utoršak of yarn in the loop (l)
- Thickness of knitwear (Dp)
- Surface mass knitwear (m)

When we get a sample of knitted fabric for analysis, usually the first loop determines the density of row (Dh) and series (Dv). The sample is aligned and placed on a flat surface and light. On the sample there must not be any outside forces. The main problem that analysts face is where the measuring unit length to count the loop. Generally, the larger loops require a larger unit of measurement of length and smaller loops or finer knitwear require smaller unit length (Table 1) [6].

Table 1 Preferred units of measurement and accuracy of reading the number of loops in the analysis

Loop size (mm)	Number of loops per 1 cm in length	The unit of measurement in inches to determine Dh and Dv	The accuracy of readings in loops
from 0,5	more than 20	1	1
0,6 – 1,0	10 – 20	1	½
1,1 – 2,0	5 – 10	2	¼
2,1 – 10,0	do 5	5or 10	1/5 and more

Basically, with finer knitwear that have loop height of less than 1 mm are counted with a precision of one loop. Coarser knitwear intended for making sweaters, is analyzed with the precision of 1/2 and to 1/5 loops [6]. Density knitwear is determined by the SRPS F.S2.013.

Table 1 shows the proposed basic sizes for simple, practical, everyday analyzing samples of knitwear. The analysis also determines the density of loops in a row and a row in a sample of knitwear. For such counting is always recommended that you take the same length measurement unit. For example: If the density of loops in a row around 11cm-1, while that 9cm-1 an experienced analyst will utilize the 1 cm as a measuring unit for determining the number of loops. The loop will be read with a precision of ½ loop. If the analyst uses 2cm as a measuring unit, then there is the danger of greater fault and fatigue of the analyst because he should double the count of the loop [6].

According Munden [7], the overall density of knitwear can be expressed by the equation:

$$D = D_v \cdot D_h = \frac{K_1}{l^2} \quad (1)$$

$$D_v = \frac{K_2}{l} \quad (2)$$

$$D_h = \frac{K_3}{l} \quad (3)$$

D – total density of knitwear, cm^{-2}
D_v - vertical density, cm^{-1}
D_h - horizontal density, cm^{-1}
l - lenght of the yarn in a loop, mm

K_1, K_2, K_3 - constant values that the shape of the loop depends upon.

From the above equations were derived following relation:

$$K_2 \cdot K_3 = K_1 \quad (4)$$

$$\frac{D_v}{D_h} = \frac{K_2}{K_3} = K_4 \quad (5)$$

Parameter K_4 Munden [7] describes a form factor of the shape of a loop, because it is a measure of the proportionality of the loops width according to height. Loop model suggests that this factor must be constant for knitwears stable configuration, yet it is affected by deformation of knitwear, for a rise of one parameter relative to another. The reciprocal of this parameter yields a density of loops C:

$$C = \frac{D_h}{D_v} = \frac{K_3}{K_2} = \frac{1}{K_4} \quad (6)$$

By understanding the geometric structure of the knitwear it is possible to predict and control the quality of knitwear during the knitting process [2].

Laboratory procedures for testing knitwear is based on methods that take into account that the wet processing procedures leads to relaxation of knitwear. Knitwear immersion in water at a temperature of 40C, which is 0.1% of a wetting agent in a time of 48 hours is achieved by wet static state of relaxation. After this knitwear is squeezed by centrifugation, dried at a temperature of 60C and leaves for some time to sit out in the standard atmosphere. In addition to wet static relaxation there are: full and complete relaxation.

If knitwear is washed with detergents for 15 minutes at 40C there may be a need for full relaxation. Then knitwear is squeezed by centrifugation, dried for 1 hour at a temperature of 70C and left to sit out for some time in the standard atmosphere. Pure knitting relaxation is achieved after the wash in a time of 20 minutes with detergents at a temperature of 40C. Then knitwear is squeezed by centrifugation, dried 5 hours at a temperature of 70C and left to sit out for some time in the standard atmosphere. Complete relaxation of cotton knitwear is possible with a chemical process of - soaking cotton knitwear in 12% solution of sodium hydroxide at a temperature of 60C for 1 hour.

After this it the knitted fabric has to rinse, drain and spin dry and left to rest in a standard atmosphere for some time. Also, in this type of testing the fact that knits have a lower density and a greater distance between the loop allows them to shrink more. With the shrinking of such knitwear, an increase of their thickness thereby increases their volume, which leads to greater porosity. This causes increased heat insulation properties which favorably affects the qualitative characteristics of garments.

These kinds of knitwear, with lower density, are more difficult to dimensionally stabilize than the knitwear with higher density. A significant affect on the shrinkage of knitwear has the composition of the yarn, its fineness and the number of twist. This is particularly evident when the yarn has different diameters, and the same delicacy and the same composition. In this case, there are a number of different yarn twist and friction between the fibers in it are not the same. In the case of a small number of twist yarn has more free spaces and elasticity.

For the dimensional stability of knitted fabrics the process of relaxation is very important and, because of the applied, but inadequate relaxation procedure, shrinkage may increase. If we want to predict how much shrinkage will be of knitwear, the dimensions of knitwear in the relaxed state must be calculated [1]. The two main states of relaxation are defined Munden [7]:

- Condition of dry relaxation, where after knitting the knitwear has not undergone any wet process
- Condition of wet relaxation, which allows relaxation of knitting in a wet medium until it reaches balance.

Wet fabric relaxation of hydrophilic yarns (cotton, wool) leads to shrinkage in length and width, which is caused by the change of the loop shape, due to the transition from the dry relaxed knitwear in wet conditions [7]. In high humidity in cotton yarn comes to swelling of fibers and thus an increase in cross-section. It then comes to a contraction of fiber length and yarn, causing knitwear collection. If the knitwear are not exhibited to a proper relaxation or relaxation finishing, it will be prone to shrinkage or changes in size and up to 30% [8]. Shrinkage of knitwear is determined by F.S2.020/1958 and ENISO3759 standards.

3 MATERIALS AND METHODS

Ribbed knitwear, that were used in this experiment, were made on a circular double needle knitting machine. Four samples of knitwear were made. The first two samples are made of 100% cotton yarn fineness 50 tex in 1x1 ribbed weave, and differ from each other in the refinement machine, where the first sample is made on circular machines, fineness E15 and second sample of machines fineness E18. The analysis of these two samples shows how the finesse machines affect physical mechanical parameters of knitwear as well as the parameters for air permeability and water vapor permeability.

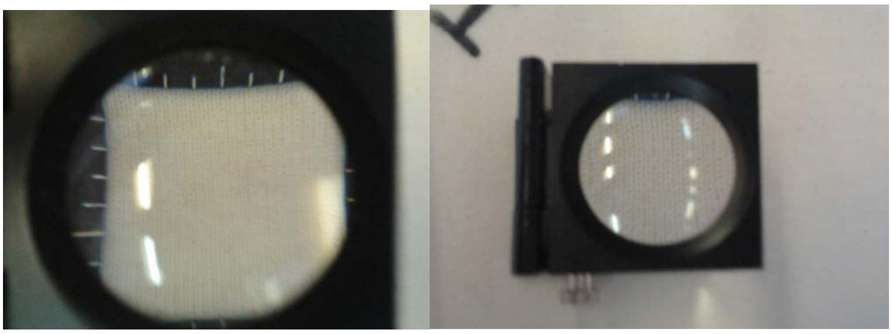
The third sample was prepared on a circular machine fineness E 18 in 1x1 ribbed weave, but the composition of the knitwear of 96% cotton fineness 20texa and 4% Lycra fineness 44dtexa. The comparison of this sample with another sample can be seen as a different composition (while finesse machines and interlacement are the same) affects the physical - mechanical characteristics of knitwear and the permeability to water vapor and air. The fourth sample was compared to the third sample. In this case, the difference between them lies only in the type of weave. The fourth sample is made of 96% cotton and 4% lycra, on circular machines, fineness E18 applying 2x2 ribbed weave. Basic characteristics of all 4 samples are shown in Table 2

Table 2 Basic characteristics of the ribbed knitwear samples

Sample	Interlacement, RIP	Material composition and fineness of the yarn tex	Fineness of the machine	Machines diameter
I	1:1	cotton 100% tex 20	E15	12”
II	1:1	cotton 100% tex 20	E18	13”
III	1:1	cotton 96% (tex 20) lycra 4% (dtex 44)	E18	18”
IV	2:2	cotton 96% (tex 20) lycra 4% (dtex 44)	E18	30”

A magnifying glass was used for determining vertical and horizontal density of loops by counting in rows . Samples were tested according to SRPS F.S2.013 in atmospheric conditions that are defined by ISO 139

Test sample must be large enough to allow the counting of rows of loops from five different places, chosen to better represent the entire knitwear. Samples for testing must be without edges of knitwear.



Picture 6. Magnifying glass with a ruler for determining the density of loos

4. THE RESULTS AND DISCUSION

The analysis of selected samples knitwear obtained the following parameters:
• loop density (density of horizontal (Dh), the density of the vertical (Dv), the density per unit of an area (D), density ratio (C), the height of the loop (B) and step loop (A)
•shrinkage

Table 3 shows the number of loops measured by the verticalD_v and by horizontalD_h, the average aritmetic value(x) , deviation degree(s) and loop density per unit of an area(D) of a sample after it's been washed at 40C.

Table 3 Loop density of crude knitwear by vertical and horizontal (D_h) *and* (D_v), loop density on the surface by density unit ratio (C) , step loop(A),, the loop height (B)

	I		II		III		IV	
	Dh cm^{-1}	Dv cm^{-1}	Dh cm^{-1}	Dv cm^{-1}	Dh cm^{-1}	Dv cm^{-1}	Dh cm^{-1}	Dv cm^{-1}
1.	18	13,5	21	13	21	16	19	18
2.	18	14	20,5	13,5	21	17	20	18
3.	18,5	13	20	13	22	17	19	18,5
4.	18,5	13	20	13	20,5	17	19	18,5
5.	18	13	20	13,5	21	16,5	20	17,5
Σ	**91**	**66,5**	**101,5**	**66**	**105,5**	**83,5**	**97**	**90,5**
n	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
$\bar{x}$	**18,2**	**13,3**	**20,3**	**13,2**	**21,1**	**16,7**	**19,4**	**18,1**
D	**242,06** cm^{-2}		**267,96** cm^{-2}		**352,37** cm^{-2}		**351,14** cm^{-2}	
C	1,36		1,54		1,25		1,07	
A	0,54mm		0,49 mm		0,47 mm		0,51 mm	
B	0,75 mm		0,75 mm		0,60 mm		0,55 mm	

To calculate the number of loops per square inch (D) use the following equation:

$$D = D_h \cdot D_v \qquad (13)$$

To calculated density in knitting (C) following equation is used:

$$C = \frac{D_h}{D_v} \quad (14)$$

To calculate the step of the loop and the height of the loop the following equation is used:

$$A = \frac{10}{D_h} \;, \; B = \frac{10}{D_v} \quad (15,16)$$

After machine washing raw knitwear at 40C with the time of washing of 30 min the shrinkage of fabric was measured horizontally and vertically. Shrinkage of knitwear was determined by F.S2.020/1958 standard, and can be determined by the ASTM D 3759 standard. The shrinkage can usually be determined in the following equation:

$$S = \frac{l_0 - l_1}{l_0} \cdot 100[\%]$$

S - shrinkage of knitwear in %
lo - lenght of the sample before washing in cm
l1 - lenght of sample after washing in cm

Since this is raw knitwear, after washing at 40 for 30 min. there is a large shrinkage of knitwear, and therefore a change in density of the loop. The density of loops in the washed knitwear, after washing is given in Table 4

Table 4 The density of the loop knits after washing, by the vertical and horizontal(D_h) and(D_v), loop density on the surface unit(D), density ratio(C) , loop step(A),, the loop height (B)

	I		II		III		IV	
	Dh cm-1	Dv cm-1	Dh cm-1	Dv cm-1	Dh cm-1	Dv cm-1	Dh cm-1	Dv cm-1
1.	20	15	21	17	20,5	21	21	20
2.	18,5	16	20,5	16	21	22	21	20
3.	18,5	16,5	20,5	16	21	22	21	19
4.	20	15	20,5	16	21,5	21	21	20
5.	19	16	20	16,5	22	22	21,5	20
Σ	96	78,5	102,5	81,5	106	108	105,5	99
n	5	5	5	5	5	5	5	5
$\bar{x}$	**19,2**	**15,7**	**20,5**	**16,3**	**21,2**	**21,6**	**21,1**	**19,8**
D	**301,44** cm-2		**334,15** cm-2		**457,92** cm-2		**417,78** cm-2	
C	1,22		1,26		0,98		1,07	
A	0,52mm		0,49mm		0,47mm		0,47mm	
B	0,64mm		0,61mm		0,46mm		0,51mm	

The results in Table 4 are presented in the Table 5. The table shows the values of shrinkage for all samples in length and width.

Table 5. Shrinkage of knitwear horizontally and vertically

	I		II		III		IV	
	h	v	h	v	h	v	h	v
1.	-0,5	-3,3	0	-3,5	0	-6,0	-2,5	-3,5
2.	-0,7	-3,3	-0,2	-3,8	-1,0	-6,0	-2,5	-2,2
3.	-1,4	-2,7	-0,2	-3,4	-0,3	-7,0	-3,1	-2,7
$\bar{x}$	**12 %**	**3 %**	**14 %**	**0,5 %**	**16 %**	**9 %**	**7 %**	**7 %**

h - shrinkage horizontally (by width) of sample in mm,
v - shrinkage vertically (by length) of sample in mm.

The results in Table 5 show that the shrinkage in width of the knitwear is significantly larger than the shrinkage in length for all samples except for the sample IV where it is the same. In the preparation of the first and second sample, the same interlacement was applied and the same composition. The only difference was that these two samples were done on two machines of different fineness. The results show that the samples with a machine had a greater subtlety and more shrinkage after washing in width than in length. In preparing the third and fourth sample different interlacement was applied in and the same composition and the same fineness of the knitting machine. Sample of 1x1 weave shows substantially higher values of sample collection produced in 2x2 weave and width by length. This work has shown that machine and fineness of weave types significantly affect the value of the collection of knitted material.

5.CONCLUSION

The dimensional stability of knitwear is an important indicator of their quality. It creates difficulties in finishing of garments and later during use or wear and maintenance of jersey knitwear garment. Dimensional stability of knitwear depends on their structural and constructional solutions, as well as the technological requirements of making the knitting process. In addition, the most important role of the material have the structural, physical and mechanical properties of used yarn, horizontal and vertical loop density, depth of cooling, finesse of machines and applied interlacement of knitwear. Knowing the connections of structural and mechanical properties of knitwear is the possibility of their proper design depending on the future use. This paper therefore analyzes the dimensional stability of the right - right knitwear after washing. The present study showed that after washing, significant changes of the sample dimensions. This work has shown that machine and fineness of weave types significantly affect the value of the shrinkage of knitted material.

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ANALYSIS OF THE STRUCTURE OF KNITTED FABRIC

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Abstract: *This paper analyzes the structure of knitted fabric and its effect on water vapor permeability. Four types of samples of knitwear were made for the test. The first two samples are made of 100% cotton yarn fineness 50 tex in 1x1 ribbed weave with a knitting machine of different fineness. The third and fourth sample were made of yarn, of the same composition with the same fineness of the machine. The difference is that the third sample was done in 1x1 ribbed weave and a fourth in 2x2 ribbed weave. Based on these results it can be concluded that the structural parameters as well as physical and mechanical properties of the composition have a big impact on water vapor permeability of the samples. The more absorbent structure of knitwear, which has a lower density loop, has better water vapor permeability which affects the very thermo physiological comfort of clothing made from these types of knitwear.*

Key words*: structure of knitted fabric, water vapor permeability, thickness of knitwear.*

1. INTRODUCTION

The basic function of clothing, such as function and protection of the body, isn't enough to satisfy the today's buyer. The chosen garment is expected to meet the demands of fashion and the shape, color and material, to thereby better depict the style of the individual. One of the main criteria for the evaluation of the value of certain clothing is comfort that is felt when wearing clothes. New approaches improve the comfort of the thermo physiological achievements of clothing: 3D scanning of the body, the measurement of the human body and the development of appropriate model layers of clothing as the heat exchanges between the body and the environment.

The exchange of heat between the surface and the environment takes place in three ways. If the skin temperature is higher than the temperature of the surrounding air, heat passes from the skin surface by a conduction process (transmission) and convection (heat-crossing). The amount of heat liberated in this case depends on the temperature and speed of the surrounding air. The second part of the heat passes from the skin surface in the form of thermal radiation, which depends on the temperature of radiation in the environment.

The human body uses the cooling mechanism, which is activated when the release of heat by breathing and dry heat is not enough, during stress or in a hot and dry environment. In this case, sweat glands start to secrete water on the surface of the skin, which evaporates and thus the skin takes excess heat, which is discharged into the environment through the resulting water vapor. The heat of evaporation depends on the size of apparel and clothing thermal resistance of the flow of water vapor.

Knitted fabrics are fabrics that are structured, made up of fibers of different characteristics. The structure of the material is made of holes that directly affect the fundamental properties of textile materials, including the transfer of heat and water vapor. In the design of flat textile products and garments, it is the knowledge of the mechanism of heat and water vapor through the fabric that makes the design and then produces piece of clothing that will have satisfactory properties of comfort 'due to its intended use.

"Heat transfer through the system" means the analysis of changes in the energy state of the considered system. Since the fabric is a fiber structure, it is possible to conduct various transfer mechanisms, depending upon the material, design parameters of flat products and environmental conditions. Heat transfer through textiles is possible using three physical mechanisms: radiation, transmission and running.

From reference literature, sources show that the research of thermo physiological comfort of clothing, one of the fundamental questions that we want to answer is: do the parameters of knitwear affect the change in resistance of knitwear's passage of heat and water vapor, and is there a correlation between the two traits?

2. MATERIALS AND METHODS

For the purpose of the testing of the comfort of clothing, in this paper the permeability of water vapor through the knitted fabric is considered. For the purpose of our examination ribbed knitted were used. They are made on a circular knitting double needle machine knitting. Four samples were constructed for the test. The first two samples are made of 100% cotton yarn fineness 50 tex in 1x1 ribbed weave, and differ from each other in the fineness of the machine, where the first sample is made on circular machines with a fineness E15 and the second sample of machines has fineness E18. With the analysis of these two samples, fineness of the machines affects physical mechanical parameters knitwear as well as the parameters for air permeability and water vapor permeability.

The third sample was prepared on a circular machine fineness E 18 in 1x1 ribbed weave, but the composition of the knitwear is of 96% cotton fineness 20texa and 4% Lycra fineness 44dtexa. When this sample is compared with another sample a different composition (while finesse machines and interlacement same) affects the physical - mechanical characteristics of knitwear and the permeability to water vapor and air can be seen.

The fourth sample was compared to the third sample. In this case, the difference between them lies only in the type of weave. The fourth sample is made of 96% cotton and 4% lycra, on circular machines, fineness E18 applying 2x2 ribbed weave. Basic characteristics of all 4 samples are shown in Table 1

Table 1 Basic characteristics of the samples ribbed knitwear

Sample	Interlacement, RIP	Composition and fineness of the yarn in tex	Fineness of the machines	Diameter of the machines
I	1:1	cotton 100% tex 20	E15	12"
II	1:1	cotton 100% tex 20	E18	13"
III	1:1	cotton 96% (tex 20) lycra 4% (dtex 44)	E18	18"
IV	2:2	cotton 96% (tex 20) lycra 4% (dtex 44)	E18	30"

Thickness was measured on all the samples. Thickness of the knitwear was tested according to ISO 5084:1996, and is determined by the SRPS F. S2.021/1986. This standard defines a method to evaluate the thickness of textiles and textile products under defined pressure. The thickness of textile materials is the vertical distance between the two reference panels that put pressure on the textile of 1kPa or less. Equipment for measuring the thickness consists of interchangeable pressure plates with an area corresponding to the type of knitwear to be tested. It is recommended for the pressure plate surface to be (2000 $\pm$20) mm^2, which corresponds to the diameter (50,5 $\pm$ 0,2) mm. Reference board of flat surfaces must be at least 50mm diameter greater than the pressure plate. The device must have a mechanism to load the upper plate, and to allow such a pressure of (1 $\pm$0,01) kPa and(0,1$\pm$0,001) kPa on the set pattern. The measuring device should enable the reading of the thickness with an accuracy of 0,01 mm. Before the test, the sample is conditioned in accordance with the requirements of ISO 139

Picture 1. Textie thikness measuring device

The material is placed on the bottom plate so that the meter is measuring the surface of the material at least 50 mm away from the edge. Measuring surface must be free of bumps and creases. Then the top plate is dropped straight down to the measurement surface and reads values.

Water vapor permeability is determined according to ASTM E 96-95. For the testing two tubes of the same sample are used. Material required for the performance of this analysis is:

- a glass bowl, height h = 12,5 cm and radius R = 6,5 cm. The hole aria in the cup is $P=33,16625x10^{-4}m^2$.
- distilled water
- water bath temperature to 50, with the possibility of regulation 0,2C
- Thermometer increments from 0 to 100 degrees.
- Pipette of volume V = 150ml
- psychrometer
- IS-diagram
- Rubber seal and metal clamps
- Chronometer

Picture 2 The measurement of water vapor permeability

The sample to be tested (R = 15 cm) is placed over the opening of the cup, which previously fit 150ml of distilled water using a rubber gasket to ensure closure. Cups are placed in a water bath which was heated to 40C which provides the water temperature in the cup at 37C. At the beginning of the measurement the relative humidity of the room is examined where samples are tested and the procedure is repeated every 2 hours. The examination procedure lasts 8 hours. After 8h is the volume of the remaining water is measured by a pipette and on the basis of calculating the amount of evaporated fluid.

3. THE RESULTS AND DISCUSSION

Table 2 shows the measured values of thickness of all knitwear samples.

Table 2 Thickness of the knitwear samples

Thickness of the knitwear in mm				
	I	III	VI	VIII
1.	0,86	0,89	1,05	1,35
2.	0,90	0,93	1,04	1,40
3.	0,86	0,88	1,03	1,45
4.	0,89	0,90	1,05	1,34
5.	0,92	0,89	1,06	1,41
Σ	4,43	4,49	5,23	6,95
n	5	5	5	5
$\bar{x}$	**0,88**	**0,89**	**1,04**	**1,39**

Table 3 shows the measured values of water vapor permeability of knitwear samples.

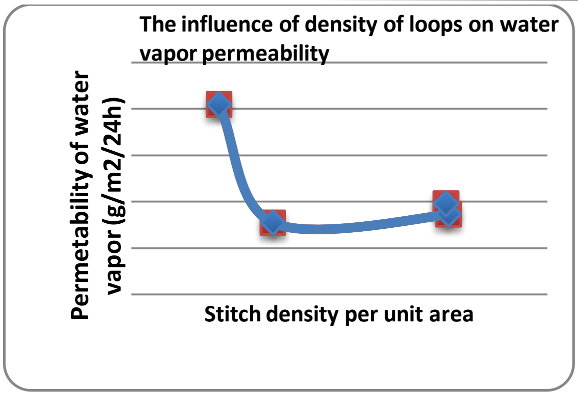
Table 3 The water vapor permeability of knitwear

The water vapor permeability, ($gm^{-2}/24h$)					
	before		after		The water vapor permeability
	sample1	sample2	sample1	sample2	
I	494,7	487,6	492,5	485,7	8181,8
III	466,2	459,3	464,6	457,5	3090,9
VI	463,6	455,6	462,0	453,4	3454,5
VIII	482,6	488,7	480,7	486,3	3909,1

Based on the obtained results it can be concluded that the major influence on the physical - mechanical properties of knitwear have: their composition, fineness of the machines on which they are made and the type of knitted weave. Considering the fact that the first two studied samples differ only in the refinement machines which they were woven in, it can be concluded that the density of the loop in the second sample is greater by approximately 11% of the density of the first sample, as a result of using a higher fineness machine for creating the second sample.

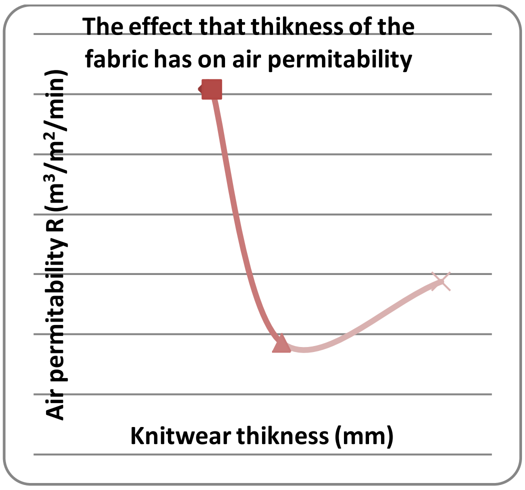
The big difference in the density of loops per unit area was found between the second and third sample, for even 31%. This is a consequence of different materials that applications have by adding 4% Lycra in the third sample, which unlike the fineness machines, has a greater impact on the density of knitwear in this case. The third and fourth samples differ only in the type of weave, and the difference is insignificant and amounts to only 0.3%. So it can be concluded that the composition has greatest impact on the density of knitwear, in this sample the insertion of the 4% Lycra into the structure of the knitwear.

When it comes to water vapor permeability it can be noted that the lower density of loops in knitting, the more water vapor permeability. If we compare the first and second sample, it is evident that the water vapor permeability is higher in the sample that is made on machines of less fineness. Also by comparing the second and third samples it is seen to be the composition that significantly influences the permeability to water to vapor, where the sample which has Lycra, has more permeability for water to vapor. Finally comparing the third and fourth sample it is noted that the sample that has a 2x2 ribbed structure is more permeable to water vapor than the sample with 1x1 ribbed structure which has the same composition.



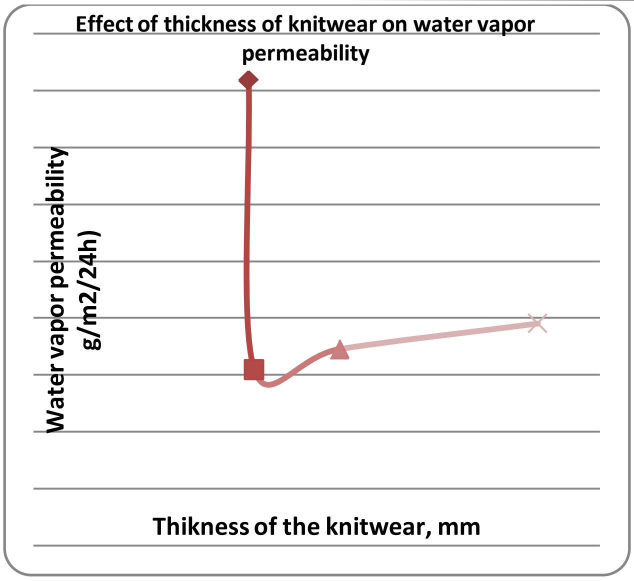
Picture 3 The influence of density of knitwear on water vapor permeability

As for the thickness of the fabric, based on the results it can be concluded that the composition has the greatest affect. If we analyze the first and second sample, it is seen that the thickness of knitwear in this case is caused by the fineness of the machines, and that in the event of a higher fineness of machines with which the knitwear is made, thickness is slightly higher (1%). Also comparing the second and third sample shows that the knitwear that has Lycra in its fiber content, the greater its thickness is (16%). Finally comparing the third and fourth sample shows the material that has a 2x2 ribbed structure is up to 33% thicker. The greater the thickness of the material the less air permeability is, which can be seen in Picture 4.



Picture 4 Effects of thickness of knitwear on air permeability

As for the water vapor permeability, it is shown that the water vapor permeability is higher in materials with less thickness. It is noted that the water vapor permeability is higher in sample IV, which has a 2x2 ribbed structure compared to the third sample with 1x1 ribbed structure of the same composition.



Picture 5 Effect of thickness of knitwear on water vapor permeability

5. CONCLUTION

Based on the results obtained from the research, it can be concluded that:
- If the two differ only in the fineness of the machines on which the knitwear are made, there are differences in the physical and mechanical properties, which subsequently influences the properties related to the comfort of clothing such as water vapor permeability. Knitted fabrics that are made on machines with less finesse, less dense loops per unit area, causes a higher water vapor permeability unlike knitwear made with machines with a higher fineness.

- Knitted fabrics that differ in composition but have the same interlacement (1x1) and are made on the machines of the same fineness (E18) show a greater contrast with each other in terms of physical - mechanical properties, water vapor permeability. This difference is much larger than in the case when the knitwear differ only in the refinement machine on which they are made. Sample (II), which is made of 100% cotton fineness 20tex has less dense loops, affects the water to vapor less than the sample that is made from yarns of mixtures of 96% cotton and 4% lycra (sample III). This is to certify that the composition has a major impact on water vapor permeability as on the physical - mechanical features as well.

- Comparing the third and fourth samples that are made on machines E18 fineness of the same composition (96% cotton and 4% lycra) but of a different weave (sample III - 1x1 rip, and rip 2x2 pattern IV) differ in terms of permeability vapor, where the water vapor permeability is higher in the sample with a porous structure, ie. 2x2 ribbed interlacement than in the sample with a 1x1 ribbed structure.

Based on these analyzes and the results suggest that the structural parameters such as physical-mechanical characteristics and composition have a big impact on water vapor permeability of the samples. Porous structure of knitwear, which has a lower density of loops has better water vapor permeability which affects the very thermo physiological comfort of clothing made from these types of knitwear.

Acknowledgements

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PLANNING FASHION COLLECTION USING ECO-FRIENDLY MATERIALS

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Abstract: *Realistic assortment planning for a particular market or product has become a difficult task in today's consumer environment. Sustainability and eco-friendly become very important fundamentals that ultimately are followed by almost of the fashion world. In this paper are represented new materials for season fall/winter 14/15. This new materials, beside new colors and new textures, has a very important properties, which is reflected in eco-friendly procedure of production.*

Key words: *Fall/Winter, fashion collection, eco-friendly fabric*

1. INTRODUCTION

Realistic assortment planning for a particular market or product has become a difficult task in today's consumer environment. Market competition has increased, consumers want more product variety, and consumer needs from a product have become complex and various. Assortment planning for textile and clothing products is especially complex due to the unique structure of the production pipeline.

Several times a year in the world's fashion capitals, willowy models in dazzling outfits sashay down the catwalk to present the coming season's trends. Each year a handful of designers set the tone, says what's in and what's not. Chain-stores and mass retailers then adapt their ideas for the man and woman in the street. Fashion feeds a growing industry and ranks textile and clothing as the world's second-biggest economic activity for intensity of trade ($353 billion in 2001). However, stiff competition forces down costs while working conditions, more often than not in developing countries, are far from ideal. The Environment pays a heavy price too. To improve conditions for workers and stem pollution, textile producers, manufacturers and distributors are launching thefirst initiatives built around sustainable developm ent: who knows, ecology may be the next new trend!

The great commitment is the spirit that characterizes the fall autumn/winter season 2014/2015. Creative and cultural engagement, with special focus on the quality, with initial philosophy "Beauty will save the world" (Dostoevsky), was fully interpreted by all exhibitors at Milan Unica. Rich texture, sophistication and aspirations to beauty and harmony, divided in two themes: ARISTOCRATIC TRAIT and BARBARIAN CHARM.

2. FABRIC SELECTION FOR NEW COLLECTION BASED ON ITALIAN COMPANY

Materials selection will influence how the garment is valued and used throughout its life. Materials have different inherent impacts and so should be selected with care. For fall /winter collection are selected materials with rich texture, sophistication and aspirations to beauty and harmony, divided in two themes: ARISTOCRATIC TRAIT and BARBARIAN CHARM.

2.1. Aristocratic trait

DIAPHANOUS- Pale chromatic. Veils of jersey, tulle with slight transfer opalescent, chenille and lurex veils, delicate "tone-on-tone" floral jacquard, micro " plisse" on tulle, organza with reliefs like waves. Ribbons in voile, with effect in angora and shiny embroidery. Micro buttons in mother -to -pearl and strass.
VELVETY- Soft eco-furs in 100%PE, heavy fabrics with the long ruffled coat, stretch cotton with softly "peach" finish effect, velvet 2000 in double-face with vichy pattern fabric. Small chenille trimmings, hemed with fur. Buttons covered with chenille yarns. Neutral colours.

ESSENTIAL- Classical tonality, timeless. Chic with much innovative double face: patterned jersey with plain fabrics, eco-leather with jersey melange, drapery with neoprene, breathable membrane with flannel. Micro jacquard patterns for ribbons.
ROMANCE – Chromatic of Renaissance, colours of baroque in devorè velvet, floral pattern printed on gobelin, printed brocade fabrics, gold-laminating arabesque pattern, also on the silky taffeta, micro paisley printed on the shirt fabrics. Jacquard zip ribbons, pullers of zip with micro coats of arms, buckles with decorations from historical heritages.
NIVEO- Many shades of white, with padded jersey, tulle embroidered with mohair yarns, silk gauze with embroidery white to white, transparent voile with Lurex yarns. Pearls embroidered on the lace. All-white for zip ribbons.

2.2. Barbarian charm

RURAL - Colours of wood and colourful touches. Jacquard in the raw wool with folk- patterns, patch in tartan dubbed with neoprene, boiled wool fabrics with floral pattern of naive art, flannel for shirts with quadrates " woodman", heavy fustian like oiled, cross stitching on the eco-doeskin fabrics. Leather labels. Wooden frogs button and buckle a lot of leather.
METALLURGICAL - Laminations oxidized like bronze, steel and aluminium on the structured fabrics, jersey and eco-leather, metal embroidery with rust effect on denim, metallic prints. Various ribbons and applications. Metallic chains and buttons with PVC insert rainbow zip teeth.
CHAOTIC- Chromatic multicolour mixed . Artistic disarray with prints and jacquard, mix of stripes and floral pattern on neoprene, abstract prints in bright colours, maxi pied-de-poule and deformed quadrates. Colourful patches on ribbons and borders. Zip with rainbow teeth in PE.
AGRESSIVE – 'Animalier' patterns and fluo touches. Jacquard and camouflage prints on nylon and eco-furs, effect of reptile scales on jersey, various interpretations of dappled pattern on many different materials, whole and quilted neoprene. 'Animal' spirit and camouflage effect on many textile accessories, buttons, buckles
OBSCURE – Nocturnal colours and luminosity – real black varnished leather, translucent jersey, eco-leather or fabric with laser effect, bright pile fabric, black lace with laminate overprint, furs with dark shades. Shiny black embroidery on opaque. Metallic studs, zip double cursors with teeth, 'all black'

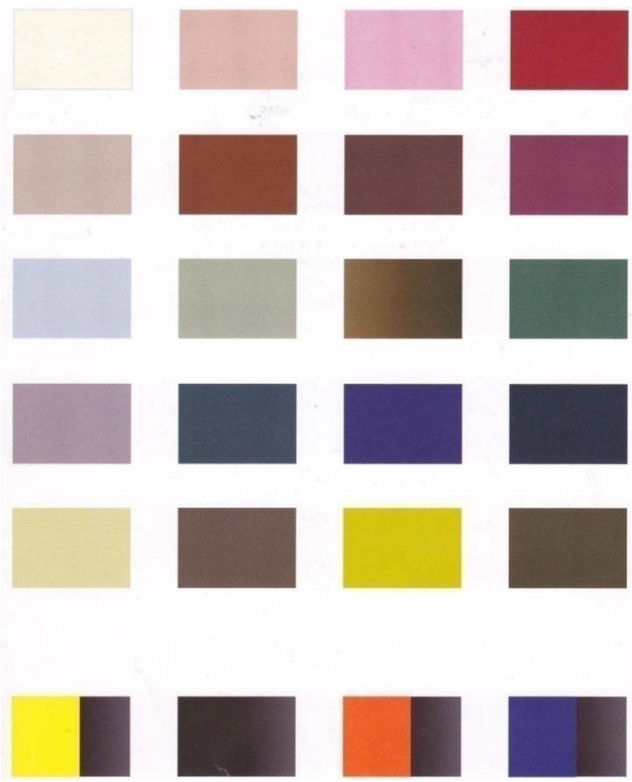

Figure.1: colours of Autumn/Winter 2014-15

The focus of edition is on the:

- Puffy effects with quilting, meatless, embossing.
- Fuzzy surface : plush, velvet, eco-furs, pile.
- Luminosity of oxidized metal, glazed.
- Artistic disarray with prints and jacquard.
- Decoration with revitalized historical heritage.
- Rich accessories with material experimentation and sense of detail.

3. ECO-FRIENDLY MATERIALS

Organic textiles are grown in controlled settings with no pesticides, herbicides, or other chemicals. Only natural fertilizers are used and the soil and water are monitored. If a fiber is “certified organic” its growing conditions have been monitored and certified by an agency from one of the several organic trade associations worldwide. A fabric can be called organic as long as 95% of the fabric contains the organic fabric.

Eco-friendly fabrics are made from fibers that do not require the use of any pesticides or chemicals to grow. They are naturally resistant to mould and mildew and are disease free. Hemp, linen, bamboo and ramie are eco-friendly fibers.

Some reasons why designers should use Organic or Eco-Friendly fabrics:
· Social responsibility: Chemicals and pesticides invade drinking water and groundwater, polluting its fish and even reaching human consumption. Organic and eco fibers grow without any pesticides or chemical fertilizers.
· Biodegradable: Eco and organic fabric biodegrade naturally over time. Synthetic fibers eventually become waste and let off harmful toxins when they degrade.
· Health: Many people are allergic or dislike wearing synthetic textiles. Eco fabrics have all the properties of the new synthetic breathable fibers with added softness and drape. They feel better against the skin.
· Absorption: Not only do its chemicals reach into our groundwater, conventional clothing is worn next to our most porous organ- our skin. Organic and eco-fibers are natural and do not contain irritating chemicals. Many of them are also considered
Hypoallergenic and naturally anti-bacterial.
· Popularity: Organic foods have been around for awhile and it is a natural evolution that organic and eco friendly fabrics will also gain popularity. Eco and Organic fabrics once considered an alternative are now entering into the mainstream.

3.1. EKO Quality Symbol

Another symbol that we will see on some of Organic fabrics is the EKO Quality Symbol.

Figure 2. Eco-friendly symbol

The square EKO quality symbol is an international quality symbol for Control Union Certifications sustainable textile products. It is used when raw materials originate from organic cultivation and is processed using the sustainable textile production methods.

When the EKO quality symbol is attached to fabric, it means:
1. The fabric's fibers come from inspected, organic farming, from organic production methods or from NOP certified cotton.
2. The fabric complies with the Control Union Certifications Standards.

3.2. Eco- friendly dyeing process

The dyeing process also plays a role in the qualifications of organic and eco-friendly fabrics, as the entire production process is taken into account when given certification. Eco-friendly dyeing process is certified with the Oeko Tex Standard 100, product class II, for products with direct contact to skin. Along with the fact that eco-friendly and organic textiles are usually non-allergenic and cause little or no irritation this standard allows customers to know that our textiles are safe and skin-friendly

4. CONCLUSION

Textiles could be one of the most un-sustainable products in the world. In their entire lifecycle from growing the raw material or creating it from oil to manufacturing and selling and final disposal they can create a serious problem. There are benefits at different life-cycle stages of the organic and eco-friendly fabrics trade, both for consumers and producers however, in the larger scale of things it is important to see that ECO-FRIENDLY TEXTILES AND CLOTHING may travel half way around the world to reach the ethical customer. As the demand of SUCH ECO FRIENDLY Garments is increasing there exist a great scope for new entrepreneur to enter into this field.

The fair of Milano Unica also coincides with the inauguration of the Campaign for Wool, the project of eco-sustainability, strongly wanted by The Wool mark Company and sponsored by Prince Charles of England, which aims to educate consumers to choose the product of natural origin such as wool and eco-compatible, under the banner of "Live Naturally, Choose Wool."

Sustainability and eco-friendly are very important fundamentals that ultimately are followed by almost of the fashion world. Just to give some example: for the stone-wash of denim, to create a vintage look, and to achieve the desired result, it was usually used several chemicals and treatments. As we know today, the trend is still going strong. We can admit that these techniques are dangerous both for the human health and the environment. The consequences of that encouraged some important brands to use also “clean”, inspected, homologated chemicals, and to introduce the process of “water less” garment production, and other recycling experiments.

Furthermore, innovative experiments are in progress and the results are very good in terms of appearance and lifetime. Italian companies wishing to maintain their leading position in the international market will have to focus on research, respect, attention to the environment, strict controls and quality.

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STUDENTS PAPERS

3D DESIGN AND MODELING CLOTHES

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Abstract: *This paper describes the achievements of 3D design and modeling clothes that have an impact on the further development of the technology in the clothing part of the technical preparation of production. The development and application of CAD systems in design, construction and modeling clothes is described. Also a laser scanner that determines anthropometrical characteristics is described. An overview is given on the modeling of the human body based on physical characteristics, with the described modeling and segmentation of the human body, determining the characteristic points, the design of a dress on a woman's figure, an overview of the system structure model of the human body model, a model form is given and parametric design of a model of a human body. Featured is a commercial CAD system - the Japanese system LookStailorX.*

Keywords: *3D design, modeling clothes, segmentation of the human body, the laser scanner.*

1. INTRODUCTION

The use of CAD systems in apparel technology means their application in the design of clothing. CAD - Computer Technology deals with the special problems of modeling a flexible material. Parts of garments are assembled according to certain rules different from the usual, meaning that the garment is constructed with the help of 2D cuts, with the quality and suitability checks of cuts on the 3D model of the human body.

The original CAD programs used to chart clothes and modify 2D patterns. Techniques of making cuts in 2D CAD systems generally consist of two parts: the performance-based design cut and editing of cuts with gradation. Since the clothes are more flexible than other industrial products, limitations in performance and grading patterns are different from case to case and depend on the experience of the tailor related to different clothes. Some of the commercial 2D CAD software for apparel are made in France Lectra, Gerber in the U.S., Assyst-Bullmer in Germany, Toray-Acs in Japan, Investronica in Spain and so on.

To relieve the need for experienced experts in the creation of the 2D system, the proposed solution is the introduction of 3D systems in which the study measures the human body, 3D simulation of fabric, cut and construction of 3D shapes. Two well-known 3D software for clothing are Assyst-Bullmer Dessingsim in Germany and in Japan.

2. MODELING THE HUMAN BODY BASED ON PHYSICAL CHARACTERISTICS

With the advancement of 3D scanning has become possible to represent and model each human body as a 3D wire mesh. It is needed, subsequently, to add the physical characteristics to this network to see the behavior and appearance of the cut on the body. On Figure 1 were used two types of parameters for size in order to characterize the human body: height **h** are the cross-section plane and they are parallel to the plane of the fundamental model, and volumes were measured in **g** sections of the plane of the body. Straight sections are used to classify the vertices, edges and surfaces in wireframe so that each of them are linked to a specific part of the body (head, neck, shoulder, chest, waist, hips, leg, foot, etc..). Also with this segmentation it is easy to obtain accurate measures of body parts.

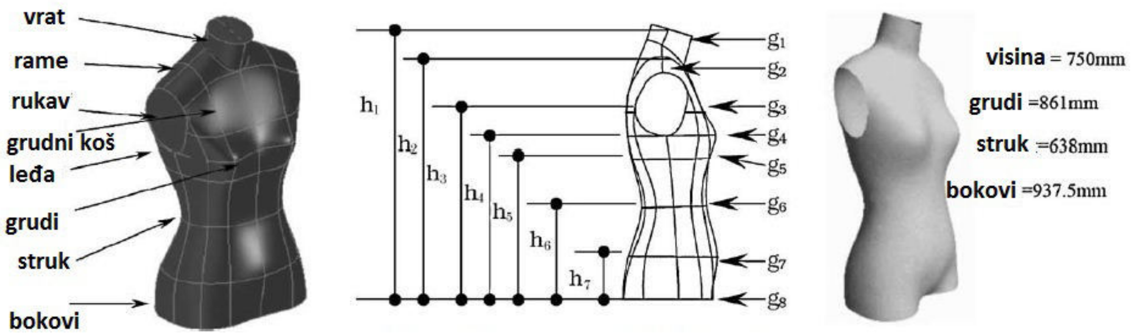

Image 1: *Modeling and segmentation of the human body*

The process of determining the plane of section usually has some basic rules, such as: anthropometry shows that body height is equal to the height of eight heads. Special physical characteristics also help in determining the plane of section. These characteristic points neck, chest, belly, groin, etc.. For example, the groin point is the point where the cross-section of the body changes from one circle to two. So the simple way to determine the groin point is the division of the body by 5/8 of heights of the peak. The cross section in Figure 2, the intersection points are allocated and they determine the maximum distance between two adjacent points (Pl and Pr) that separate the left from the right leg. In the middle distance Po = (Pl + Pr) / 2 gives the administrative level. The lowest point of intersection of the plane and the body is the point groin.

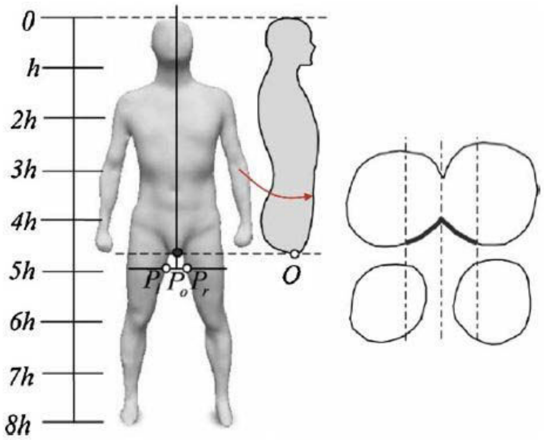

Image 2: *Determination of the groing point*

Since the 3D models of the human body is very detailed, cutting procedures by computer can be imitated. Figure 3 shows the design of women's dresses.

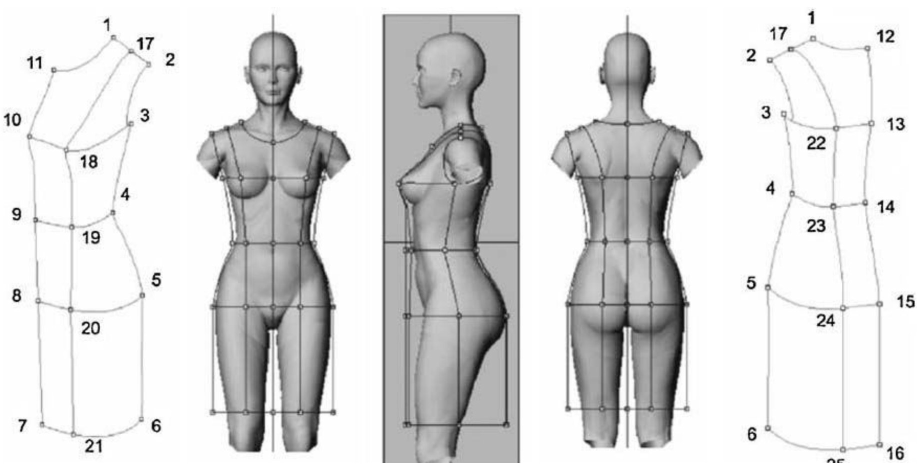

Image 3: *Designing a dress on a woman's figure*

The body is oriented so that it stands on the xy plane, xz plane cuts the body to the left and right parts, and yz plane intersects the anterior and posterior parts. The shoulder seam is defined as part of the line connected to points 1 and 2, located at the intersection of the body and the side of the plane P that is parallel to the yz plane and moved back for 20mm. The same plane Pbok defines the point 3,5,6 on the side seam garments. Item 4 is defined by the waist curve and moved forward for 20mm. Points 3,10,18 are on the breast curve, 4,9,19 on the waist and 5,8,20 are on the hips. More precisely, every point is related to the characteristic of the body. Closed curves on the crossed sections of the volume of the chest, waist and hips of the dress are obtained by increasing the curve of the corresponding sections of the body. Increasing the parameters gives tightness or sets the width of the dress. The final dress is obtained by adding curves and points that are specific to existing items and appearance of the models. This dress by these rules can be obtained for every entered specific model of the human body.

3D model of a garment can also be modified with virtual scissors in the appropriate software. Users can choose a point, edge or surface of the model and may also draw arbitrary curves on the model and on the garment. This tool allows you to create arbitrary creations over the existing model of the human body.

3. MODELING OF THE HUMAN BODY

With laser scanners it's now possible to easily transfer characteristics of a specific body into a 3D model in point format system. There are three types of transformation of these points in the model: implicit, parametric and triangular method. In the design of clothing it is especially important for the system counts to be properly translated into the bodily characteristics, so the clothes can realistically be set on a model. The proposed system consists of three phases: data preparation, model construction and execution of physical characteristics - image 4. Auto-locating the three key points in the armpits and groin the system first divides the whole body into six parts: the root of the head, torso, left arm, right arm, left leg, right leg. Characteristic points are roughly found by observing changes in the closed circles of successive cross-sections. In order to build all the characteristic parts of the model of the body, three key points must be determined: neck, chest and belly button. The rules are as follows: the point of the neck on the 7/8 level model by looking at the front, the chest point is the point on about 3/4 of the height looking from the right side, the navel point is about 5/8 of the height by looking on the right.It is advisable to build a model based on the standard sizes, the advantage of this is easiness of modification of the pattern for any other size automatically.

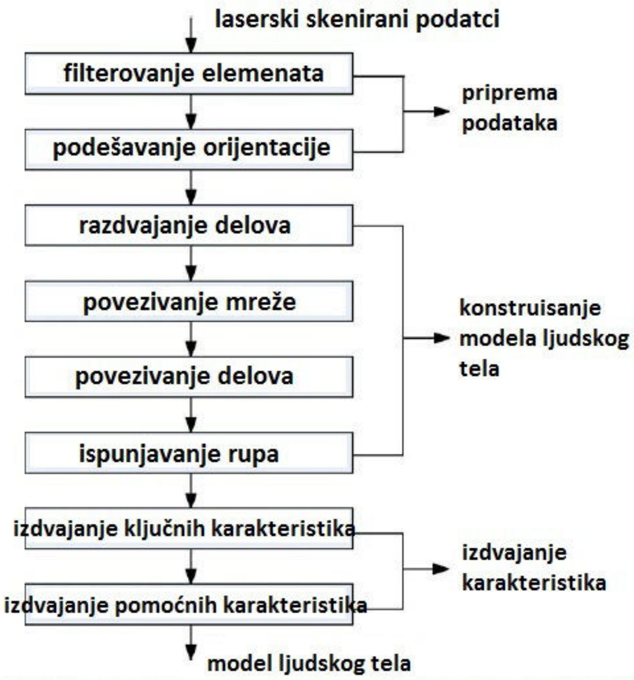

Image 4: *Overview of the construction system of the model of the human figure*

The research of the volumetric shape of the human body is especially present in developed countries such as

Japan, England, Germany and others. The aim of this study is to facilitate the taking of body measurements and to then send it via computer networks in companies in apparel production. The whole process from making clothes to the delivery of the finished garment to the customer lasts several days and in some cases even less - about 24 hours. Therefore, there is an increased interest in the measuring of individual body measurements in the sales division. The aim is the fit and comfort of clothes. Image 5 shows the non-contact method of determining body measurements.

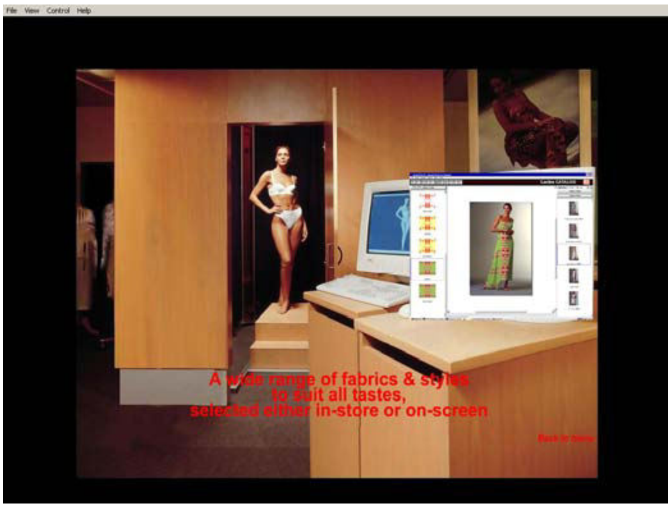

Image 5: *Non-contact measureing of the body*

For this purpose the laser technique and analysis of video and computer graphics processing is used. Non-contact method of taking body measurements for the purpose of making a unique garment is based on the application of methods of active optical triangulation with the use of 4-miniature laser with a diffraction of line optics. The principle of operation consists of three steps: measuring, obtaining a three-dimensional set of measurement data and making a "wired" model of the human body.

3.2 Other ways of transferring body figures in a 3D model

Laser scanning is not the only way of obtaining information about the body. There are two other popular methods, based on the photographs and the system size. In the photographic method, the body is photographed from the orthogonal projection, front and side. The method of file system allows the user to enter specific measures of body and thus create a unique virtual model. This is useful when designing over the Internet.

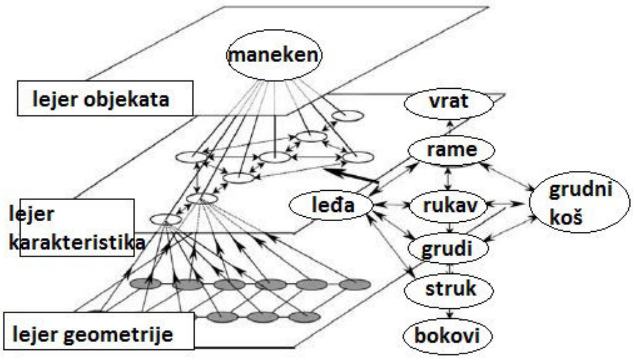

Image 6: *Model of shape characteristics of a human model*

With this method, 3D images of different body shape are stored on the server so that when the user enters their actions, first selection of similar body proportions are adjusted so that the measures are equal, then the model is sent to the user. Image 6 shows a model of shape characteristics of a human model.

3.2 Setting the standard position of the body

True human bodies are in different positions, so the existence of certain CAD techniques that change the position of the body in the standard position is necessary. One technique consists of finding the key points and cutting the body with the xz plane, and then transferring the mirror symmetric parts, resulting in a standard pose. This method is very useful for the body, whose position is close to the standard. However, in the body that is far from symmetrical, there is a rigorous technique, which improves the symmetry of the minimal model by changing its form.

3.3 Modeling of the body characteristics

In the system of 3D modeling of clothing two approaches are used: identifying characteristics of the body and the design according to characteristics. Methodology of recognition of characteristics recognizes the particular characteristics of the geometric model of the characteristic patterns from the data library. When the user enters the physical characteristics of the program, typical clothing is made from combining the characteristics of this library.

At the most abstract level, the objects in engineering applications are characterized by a regularly shaped objects and sculpted objects. The human body is a typically sculpted object. Semantic characteristics of the object model, shown in Figure 7, consist of three levels: the level of the object, the level of performance and the level of geometry. Configuration of the sculpted object is represented by chart characteristics. The chart uses a language feature, which consists of two components: vocabulary and grammar, where grammar is a series of rules that controls the words.

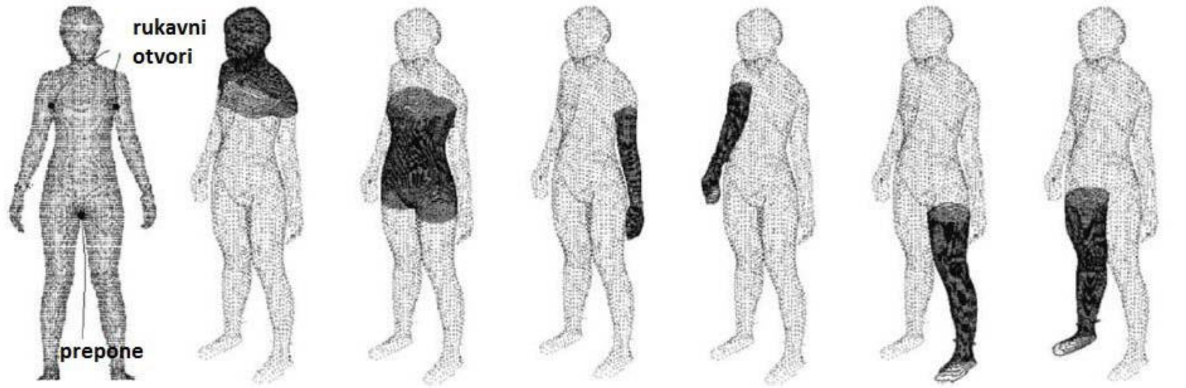

Image 7: *Three key characteristic points (two points and one point sleeve groin) and associated partition*

With the human body, the dictionary consists of constitutional characteristics (neck, shoulder, chest, back, arm, waist, hips) and sets of dimensions. The great advantage of this approach is the possibility of modeling of sculptured objects to the configuration level, regardless of the endless variations in shape, which makes it a very flexible approach.

3.4 Parametric model design of the human figure

In this approach, the dimensions can be easily performed via the physical characteristics and determine the five key points: neck, armpits, breasts, navel and groin points. With these points, using design and intersecting planes realize a full set of body characteristics. Geometric models feature an excerpt consists of key points, characteristic curves and characteristic snippets. According to the definition of physical characteristics, the characteristic points can be translated into curves by which certain parameters values are defined. To convey the design of a garment on the human figure with standard sizes, it is necessary to bring in the cuts on a typical model body.

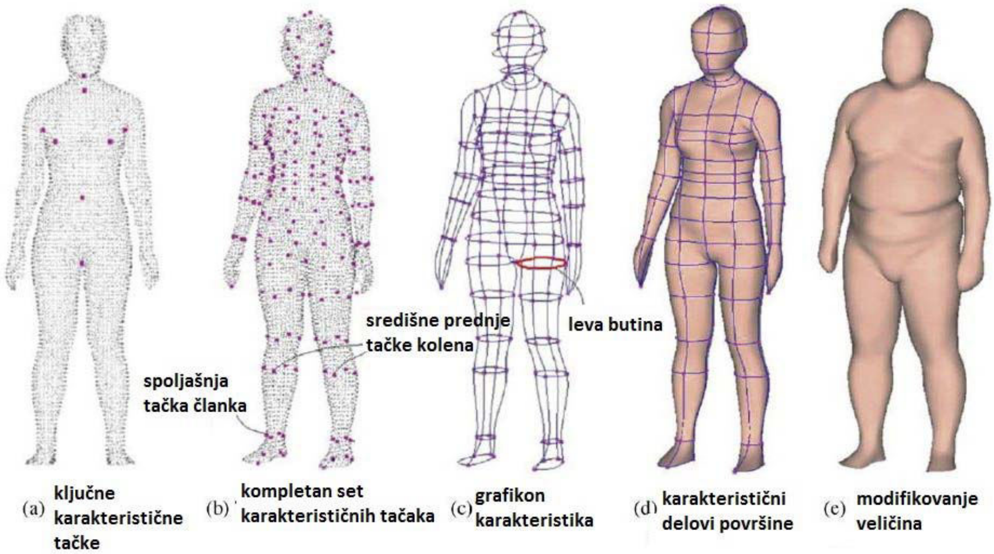

Image 8: *Parametrical design of the human body*

3.5. Limitations od existing methods

In the existing methods of modeling the human body there are two major problems. The first relates to the taking of the measures the body. In each method, including laser scanning and photography, the subject has to wear tight clothes in order to have clear lines of the body. But this is not a comfortable or relaxed method, so the measure the thermal radiation (infrared radiation) could help. With this method the subject can wear anything they feel comfortable in. Another problem lies in the automatic detection feature. While there are many rules to handle this, in the end it takes a lot of human intervention and work to pinpoint the positions of key points. We are currently working on finding strong and automatic methods to solve this problem - Image 9.

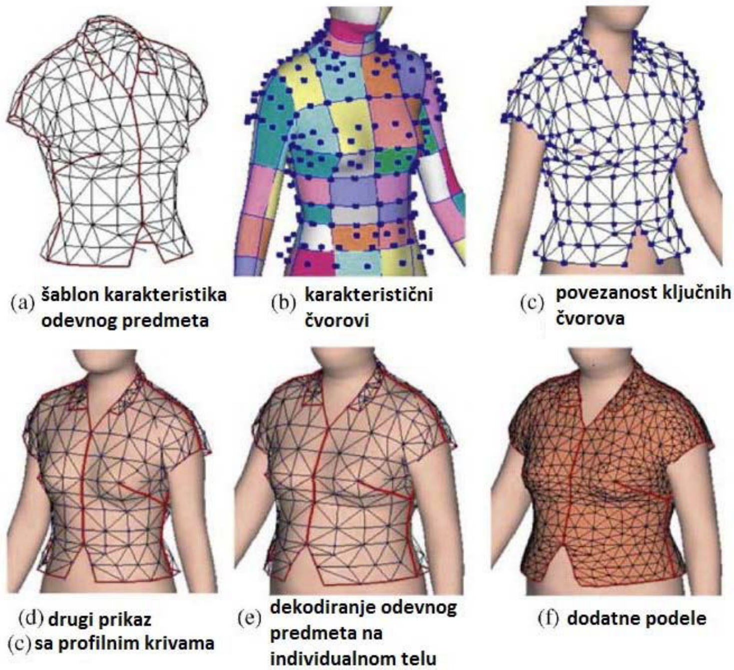

Image 9: *Coordinating and decoding patterns of a garment*

4. DESIGN OF GARMENTS

Based on the parameterization of the human body, the physical design methodology features are applied to construct a variety of clothing patterns, each of which represents a particular form of clothing style. Pattern is directly related to the graph-parameterized model of the human body, such as established relationships with additions for comfort. When the user modifies the model by entering the dimensions of the body size, the ratio of extras will automatically remodel the garment so it is a good fit on an each individual body. This avoids the problem of 2D grading which is based on experience.

The clothing pattern consists of nodes on specific parts of the body, curves, and of the rules of surface treatment. A reference model of the human element defines each node. The reference element may be a center, edges or surfaces of the model. The curves in the patterns are used to control the shape of the final look of a garment. Using the Bezier curve of the fourth order, the rules for processing surfaces provide information about the surface appearance of a garment. It is important that the key nodes and curves associated with a model that is below are used for correction so as to obtain the following benefits:

• Preserving details. Tampering with the local reference planes, high-frequency details of clothing are separated from the main form. When changing an existing shape, the basic shape of a garment will also change but the details will be decoded and reconstructed through the reference plane.

• Surface texture. When a user changes the shape of the body figure, the surface of clothing will be changed from smooth texture.

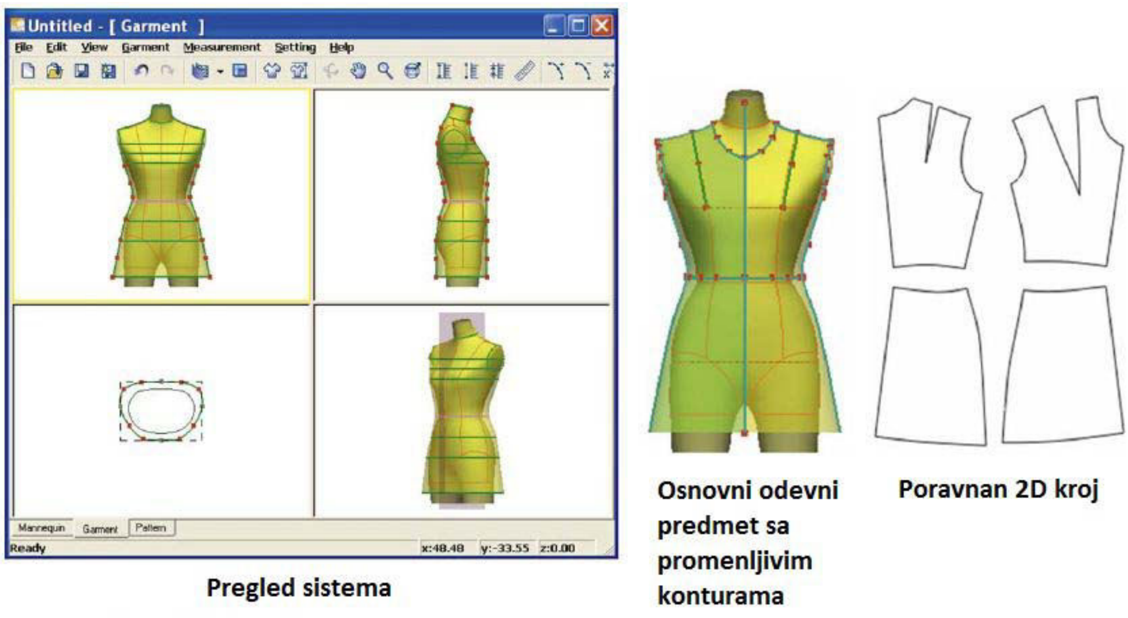

Image 10: 3D apparel design system LookStailorX

One of these commercial CAD systems is the Japanese system LookStailorX shown in Image 10. This system of apparel design usines characteristic patterns of body and clothing patterns. It creates a basic 3D shape of clothing automatically based on body shape. Body shape is obtained with the help of dummy mannequin or scanning the body. It makes the basic 3D form, automatically creates contour lines according to the characteristic points of the body. It then creates a surface of a garment with the help of the contour. The contours can be changed interactively and thus changes the shape of clothing. This basic form is used to create 2D cuts that are needed to make a garment.

5. CONCLUSION

These days it's a race against time meaning that there has to be a quick response to market demands, and that is the challenge for all companies. To win this race the companies must be trained in creativity, quality and reliability, flexibility, cost and speed. To successfully embrace these challenges, apparel companies must constantly change, adapt and improve their infrastructure and organization.

Therefore, the introduction of new and ongoing innovations of existing CAD / CAM systems foundation is crucial for business success. The technology of making clothes, stage of product development and production preparation last up to six times longer than the production itself from garment tailoring stage to the final finishing stage.

In order to shorten the work in the technical preparation of the product and to respond quickly and flexibly to market demands and very frequent changes in fashion trends, using a complex CAD-CAM system is necessary. Today there are a number of programs and software tools with a variety of design features. In combination with sketch so-called two-dimensional programs, presentations displayed in colors, designs and materials appear on the scanned image of the human body.

Preparation steps such as tailoring, grading, scheduling and automatic cutting is achieved by the use of computers. 3D design apparel remains an active field of research. In the future, it is expected the implementation of artificial intelligence and intelligent machines to design clothes.

Acknowledgements

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ANALYSIS OF QUESTIONNAIRE ATTITUDES OF DIFFERENT AGE GROUPS ABOUT THEIR ATTITUDES TOWARD DRESSING UP

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Abstract: *Fashion is a synonim for beauty, and all of the significant fashion styles were widely accepted by different age groups. A style is a feature of expression, the dressing styles are numerous and yet a very small number of sressing styles eventually became fashion. A man always sought the best way to dress and therefore highlight the shape of the body. This paper deals with the choices of clothing items according to different categories (colour, motifs for shopping, fiber composition, etc.). The age groups surveyed gave different results, which are given in the tabels and thouroughly discussed. The younger age groups usually prefer fashionable clothes, the dressing is important for them (84%),they get informed about the fashion trend all the time (39%), and the means of payment are irrelevant for them (2%). On the other hand, the older age groups don't follow fashion that much, and tend to pick the comfortable and casual clothes (65%) that is cheaper to get (sales 14%, self-made or ordered 29% etc.).*

Key words: *Apparel, attitudes, fashion, questionnaire*

1. INTRODUCTION

A man noticed that it is possible to cover or highlight certain body parts, or some physical attibutes a long time ago. The recognition of someone's social status is possible by wearing certain type of clothes, if the person chooses exactly the pieces of clothes that can show the person's status. For instance, members of socially superior classes tend to show their position and social differences with their clothes etc. The clothes show the difference between men and women, children and adults, the rich and the poor, the stable and the instable, normal and deviant, supporters of traditional and alternative culture, of certain formal or informal groups, followers of different ideologies etc.

2. THE PRESENTATION OF RESULTS

This questionnaire covered the population age 15 to 55+, and the respondents come from all social strata, education levels, from all walks of life: housewives, pupils, workers, engineers, jurists, economists, clerks, craftsmen, enterprenuers, pensioners etc. Overall population covered by the queistionnaire consists of 67% women and 33% men. Out of 114 questioned persons 100 of them gave correct answers, 14 of them answered incorrectly and they were therefore excluded.
The poll was done in a secondary school where 54 pupils age 15 to 19 gave answers. 23 of them were male and 32 female. The poll covered 15 employees of the secondary school, all of them with higher education (economists, engineers, Serbian language teachers, mathematics teachers etc.), age 26 to 55. 6 of them were male and 9 female.

The poll was conducted on the street and covered 31 respondents from different social strata and education levels; housewives, workers, pensioners, entrepreneurs, etc. of which 4 were male and 27 female. The age of the respondents ranged from 36 to 55. Of 27 surveyed women, four of them had university education, ten had secondary education, five had primary education and eight were with third degree of vocational education. From four surveyed men two of them had university education, one had secondary education and one was with third degree of vocational education.

2.1. The Importance of Dressing

In the table shown below, to the question: *"Is dressing important to you?"* the respondents from both target groups gave the following answers. Desire to be likeable/liked and desire to stand out is characteristic for respondents aged 15 to 35. In this population, *"The importance of dressing"* is significant in the first three groups, and the percentage is over 83 %. Over 17% percent of respondents said that importance of dressing was of secondary importance for them, and 9 percent of them said that it was irrelevant. For the female population, dressing is of utmost importance, regardless of age, social strata or educational level.

Table 1. Respondents' answers to the question: "Hoe important is dressing to you?"

Is dressing important to you? (%)	2013			
	Age of the respondents			
	15-25	26-35	36-55	55+
Important	84	86	81	43
Secondary	14	13	15	28
Irrelevant	2	1	4	29
You dress up because you (%)				
Have to	16	15	28	40
Enjoy	57	71	59	46
Want to stand out	25	12	8	4
Want to feel good	2	2	4	10

To the question *"Why do you dress?"* the majority of those surveyed gave the answer they enjoyed and felt pleasure in dressing. Feeling pleasure in dressing gives the person a possibility to emphasize beauty and harmony and to cover up the imperfections. The majority of respondents from all four age groups enjoys and feels pleasure in dressing, which applies especially to the respondents from the second group of the table. 60% of respondents declared that they enjoyed dressing. To the question *"You dress because you have to?"* the answer was positive for 49% of the surveyed, most of them are over 50 years old. This percent is lowest in the age group from 15 to 35, which is understandable. To the question *"Do you dress to stand out?"* the answer was positive for 25% of the respondents in the age group from 15 to 25, while only 4% of respondents older than 55 gave this answer. When asked *"Do you dress to feel good?"* 10% of population older than 55 stated that comfort in dressing was important, while those from younger population did not attach any significance to this question.

2.2 The Elements by Which Clothing Item Is Chosen

From the table shown below we can deduct that the most important criteria for choosing the clothing item is its appearance, regardless of the age group of those questioned. Desire to be likeable and desire to stand out is characteristic for those people who want to present themselves in the best light and to give the viewer an image of inner harmony.

Table 2. Respondents' answers to the question: "What are your criteria when choosing clothing item?"

Choosing criteria for clothing items	Year 2013				
	Age of the respondents				
	15-25 26-35 36-55 55+				
Appearance	38	36	29	25	
Brand	12	10	5	3	
Fashion	22	19	8	6	
Fiber composition	20	21	28	25	
Means of payment	2	3	6	7	
Price	6	11	24	34	

The appearance of the clothing item is the most important factor for the younger population, around 34%, while in the age group over 55 years this percentage is around 25. These answers reveal that the appearance of the clothing item i.e. its aesthetic quality, is being noticed first and that is the factor that triggers emotional and psychological effects in a human being. The brand of product is of significant importance for younger population aged 15 to 35 and it amounts to 10-12%, while for older population it amounts only to 4%. The fiber composition is an important factor while choosing the clothing item. Polyester and cotton are most used raw materials in knitwear, especially the mixed fibers with a high percentage of cotton, but natural fibers still hold primacy and it is expected that its usage, often for price and maintenance purposes, will still grow. Fiber composition is of importance to all four groups, and in average it is around 24%. Means of paying and price are important to older population of respondents and it makes 6 to 7%, and 24 to 34 %.

2.3 The Presence of Colours in a Clothing Item

Table 3. Respondents' answers to the question: "Your favorite colours in textile and clothing items?"

Favorite colours in textile and clothing items	Year 2013			
	Age of the respondents			
	15-25	26-35	36-55	55+
Black	27	30	32	20
White	10	7	9	8
Grey	9	7	7	6
Ten	4	3	9	16
Navy	7	10	14	7
Green	3	11	5	5
Brown	1	5	7	6
Blue	14	8	5	11
Maroon	2	-	4	10
Purple	1	1	1	-
Red	4	3	1	-
Pink	4	5	2	1
Light Blue	5	1	1	-
Beige	2	3	2	5
Yellow	2	3	1	3
Every	5	3	-	2

From the shown table it can be concluded that the colour as an aesthetic quality is of crucial importance while choosing and buying clothing item. When asked *"what is your favorite colour of cloths?"* large proportion of those questioned, from all four age groups, chose black colour, 27 %. Other colours are represented as follows:

- white 8.5 %
- grey 7.25%
- tan 8%
- navy blue 9.5%
- green 6%
- brown 4.75%
- purple 0.75%
- red 3%
- light blue 1.75%
- beige 3%
- yellow 2.5%
- maroon or dark red 4%
- all other colours 2.5%

2.4. The Criteria for Choosing Colour

Table 4: Respondents' answers to the question "Why do you choose certain colour?"

Favorite colours of textile and clothing items	Year 2013			
	Age of the respondents			
	15-25	26-35	36-55	55+
It suits me fine	26	22	18	22
It's fashionable	15	10	9	2
It is easy to combine	25	27	30	32
I fell good in it	32	38	42	42
I love/like it	8	3	1	2

From the given answers, which are shown in the table below, it is obvious that choice of colours is under heavy influence of various factors: economic, social, demographic, psychological etc. The influence of the psychological factors is mostly visible in answers such as *"suits me fine"* or *"I feel good in them"*, while the economical ones can be seen in the answer *"they are easy to combine"*. This is understandable because of the economical crisis, when people don't have enough means for frequent purchases, but they rather make combinations with clothing items they already own. The answer *"It's fashionable"* was mostly given by younger population in the age group from 15 to 25 (15%), whereas that answer, in the oldest group, age over 55, amounts merely to 2%.

2.5 The Fiber Composition of Clothing Items

Fiber composition of clothing item represents one of the main factors of its use value. Today, special fabrics and fibers, with high performances, are being made, to satisfy fashion or style function, as well as the clearly defined need for a certain quality. The use of synthetic materials such as polyester and polyamide in clothes making is dropping nowadays, and primacy is taken by natural materials: wool, cotton, silk, etc. From the table below, it can be seen that all four groups prefer their clothes made from cotton, from 39 to 45%, while the wool chooses from 6 to 17% of the surveyed. Lycra is an elastic fiber which is added to any fabric or cord, hence giving these materials long-lasting quality of stretch. Nowadays, the lycra is used in making of woven and knitted materials for outer clothes what makes process of sewing easier, and contributes to a better outlook, and reduced creasing. Today’s materials are mostly being made from a mixture of cotton, wool, polyester, polyamide etc., and in their new forms they find wider application in the making of clothes. Consequently 17% of respondents have chosen this fiber composition.

Table 5. Respondents’ answers to the question "Which fiber composition do you prefer?"

Fiber composition of clothing items (%)	Year 2013			
	Age of the respondents			
	15-25	26-35	36-55	55+
Cotton	45	42	39	42
Wool	6	5	14	17
Silk	11	13	15	10
Polyester	2	1	1	2
Polyamide	2	1	1	2
Lycra	8	7	4	-
Viscose	8	11	11	9
Mixed	16	20	15	18
The rest	2	-	-	-

2.6 Types of Textile Materials

From the given table it can be concluded that the older population of respondents chooses known and trusted materials such as webbing (26%), tweed (14%), linen (10%) etc. while younger generation prefers materials such as denim (33%), materials with lycra (18%), or leather (12%). Main course of development in a domain of fabrics is still mixing stretch-elastics with other cords. Lycra is still added to a wide range of fabrics, for fashion effects, but also for comfort. Because of its practicality, elasticity, cosines, and easy maintenance, knitwear takes significant place when choosing materials for clothes. In the older age group, knitwear is represented with 25%, and in younger groups with 15 %. It is obvious that the info on type of textile material would increase the efficiency of new fashion lines sales.

Table 6. Respondents’ answers to the question: "Which type of textile materials do you prefer?"

Types of textile materials (%)	Year 2013			
	Age of the respondents			
	15-25	26-35	36-55	55+
Linen	11	15	13	10
Denim	33	25	15	5
Tweed	2	5	10	14

Leather	12	9	10	8
Webbing	3	8	14	26
Lace	4	4	6	4
Knitwear	15	10	16	25
Materiales with lycra	18	21	11	4
The rest	2	3	5	4

2.7 Dressing Styles

Harmony and beauty of dressing differ in time and place. What was once considered beautiful and harmonious can be completely changed in a short period of time. The concept of beauty is given in cyclical changes of taste, place and time. Many dressing styles from the past did not live to modern time. On the other hand, the 20th century was deeply marked by the phenomenon of fashion. A style is defined with typology of the clothes, for example classical, elegant, nautical, military etc. It is characterized by use of certain materials, lines of clothes, colors, designs and fashion details which change or become more often used in certain periods of time. A style represents the way of expressing of its creator, i.e., of the fashion designer who designs clothes in an individual way that is recognizable and has specifications of built up style. From the answers in table it can be seen that all styles are equally represented: sporty 14%, elegant 11%, practical 23%, classical 20%, individual 19%, modern 7%, sporty-elegant 5%.

Table 7. Respondent's answers to the question: "Which style do you prefer?"

Dressing styles (%)	Year 2013			
	Age of the respondetns			
	15-25	26-35	36-55	Over 55
Sporty	25	17	11	5
Elegant	11	9	13	12
Practical	21	20	25	28
Classical	14	13	19	33
Individual	11	24	20	20
Modern	16	8	5	-
Sporty-elegant	2	9	7	2

The change from formal to non-conventional dressing style is evident, and it can be seen in concepts:

- sporty
- practical
- sporty-elegant etc.

Individuals want to express identity and their personality with their dressing style. Consumers are still looking for fashionable items, but they are also searching for unaccented styles that combine reality, comfort and practicality.

2.8 Role Models in Dressing

The greatest influence on the dressing style comes from:
- TV personalities, 17%
- public life personalities, 10%
- fashion designers, 12%
- friends 14%
- parents 3%
- all of them 3% and no-one 39%.

The importance of role models is especially noticed in younger population of respondants.

Table 8. Respondents' answers on question: "Who are your role models in dressing?"

Your role model in dressing is (%)	Year 2013			
	Age of the respondents			
	15-25	26-35	36-55	Over 55
Public life personalities	12	14	6	7
TV personalities	23	15	12	19
Fashion designer	10	13	14	12
Friend	15	19	16	8
Parents	4	2	1	1
All of them	6	12	-	1
No-one	30	25	51	52

2.9 What TV personalities influence your dressing style

The most influencal of given professions are TV presenters with 28%, actors with 19%, musicians with 10%, whereas politicians and folk singers have very little influence on dressing style of respondents, which is a bit surpirising.

Table 9. Respondents' answers to the question: „What TV personalities influence your dressing style?"

Which TV personalities influence your dressing style	Year 2013			
	Age of the respondents			
	15-25	26-35	36-55	55+
Politicians	1	2	-	-
Presenters	30	25	35	24
Actors	22	24	21	10
Folk singers	5	9	2	-
Musicians	17	13	6	4
Everyone with style	2	7	6	3
No one	23	20	30	59

2.10. The Features of Clothes

Table 10. Answers of the respondents to the question : "What kind of clothes do you like to wear?"

Your clothes is (%)	Year 2013.			
	Age of the respondents			
	15-25	26-35	36-55	55+
Tight	12	10	2	-
Follows the body line	52	42	34	21
Casual	23	41	57	65
Baggy	9	5	5	10
Various	4	2	2	4

In the table above when asked *"Your clothes is....?"* respondents gave following answers: both populations think that the clothes should follow the body line (37%), comfortable clothes were preferred by 46% of overwhelmingy older population, and wide clothes is a choice of 7% of the respondents. The younger respondents generally tend to choose tighter clothes, made of denim, elastane etc. which gives clothes the desired harmony, style, elegance and prominent body line.

2.11. The Favorite Clothing Items

The analysis of the gathered data shows that trousers are the favorite piece of clothes for both populations (22%). The younger respondents prefer jeans and other elastic materials (17 to 21%). Skirts (11-12%) and dresses (9-12%) slowly loose the battle in the younger population. Costume is the favourite of the older respondents (14 to 27%). The significant percentage likes knitwear (shirts, sweaters, sweatshirts etc.) because it is practical, cozy, easy and low maintenance. Shirt is the favorite of 12% (all 4 age groups), sweater is the favorite of 6%, and sweatshirt is the favourite for 5% and track suit for 4% of the respondents.

Table 11. Respondents' answers to the question: "What are your favorite clothing items?"

Your favorite clothing items are %	Year 2013			
	Age of the respondents			
	15-25	26-35	36-55	Over 55
Skirt	11	12	14	28
Dress	9	12	10	8
Trousers	18	25	24	21
Costume	-	5	14	27
Sweater	4	5	10	4
T-shirt	20	12	11	7
Denim	21	17	9	2
Sport T-shirt long sleeves	9	6	5	1
Track suit	8	6	2	-
Rest	-	-	1	2

2.12. Why Do You Wear Trousers?

When asked *"Why do you wear trousers?"* all of the respondents from all 4 age groups think that comfort, practicality, functionality and fashion are of utmost importance. 36% of the respondents answered that that they felt comfortable wearing trousers, 27 % stated that being practical was the most important thing, 13% is convinced that they look good wearing it, and 8%, mostly young people think that they are fashionable. A smaller percentage feels that by wearing trousers it's possible to conceal physical imperfections (3%), or to emphasize the body line (4%). To the question about preferred type of trousers, 35% picked flat, 18% chose slim, 15% flares and 14% chose baggy. 9 percent of the respondents prefer low waist, and 7 percent high waist. The majority of the surveyed age over 55 picked flat trousers, 55% of them.

Table 12. Answers of the respondents to the question: „Why do you wear trousers?“

Why do you wear trousers? (%)	Year 2013			
	Age of the respondents			
	15-25	26-35	36-55	55+
They are fashionable	15	10	6	-
Suit me fine	14	16	15	6
I feel fine	32	35	41	38
They are practical	27	29	30	49
I cover my imperfections	2	4	3	5
I highlight my body line	7	5	4	-
I don't wear them	3	1	1	2
Your favorite trousers are				
Pipes	25	22	19	7
Flat	21	25	39	55
Flares	23	22	9	5
Baggy	4	18	16	29
Low waist	19	14	3	-
High waste	7	7	12	4
All	1	2	2	-

2.13. Why Do You Wear Knitwear?

The main answers were: *due to easy maintenance, low prices, because it is fashionable, easy to wear, follows the body line*. All those factors make knitwear significant. Modern fibers that are being used in making of knitwear are made of mixture of wool, cotton, elastane, polyester, polyamide, etc, and are giving chords some special characteristics and properties.

Table 13. Answers of the respondents to the question: "Why do you wear knitwear?"

Why do you wear knitwear? (%)	Year 2013			
	Age of the respondents			
	15-25	26-35	36-55	55+
It feels fine	48	52	50	57
It's easy to maintain	16	22	28	28
Follows the body line	20	18	10	5
It's fashionable	15	8	8	2
It's cheap	1	-	3	4
It's warm	-	-	1	4
Your favorite knitwear item is (%)				
Sweater	14	15	26	37
Shirt	19	23	14	15
Blouse	10	7	15	22
Sweatshirt	12	10	18	4
T-shirt	10	8	5	3
Body T-shirt	5	4	2	-
Skirt	8	7	10	3
Dress	6	7	6	4
Turtleneck	15	16	12	8
Tunic	1	1	2	2
Costume	-	2	-	2

When asked *"Is knitwear comfortable to wear?"*, 52% of the respondents declared positively, 23% prefer it because it is easy to maintain, 13 % stated that it followed the body line, 8 % thinks it is fashionable, 2% says it is cheap and 1% says it is warm. When asked *"What is your favorite knitwear item?"* 23% answered sweater, 18% T-shirt, 13% blouse, sweatpants 8%, sweatshirt 6%, turtleneck 13%, body shirt, skirt and dress were chosen by 5 %, and tunic and costume were chosen by 2%.

2.14. Following and Accepting Fashion Trends

We can speak about fashion in terms of social phenomena, appearance of the people, and as a synonym of passing beauty.

Table 14. Answers of the respondents to the question: "What does fashion mean to you?"

What does fashion mean to you? (%)	Year 2013			
	Age of the respondents			
	15-25	26-35	36-55	55 +
Part of the culture	34	49	52	53
Synonym for dressing	20	17	21	19
Need to feel beautiful	37	19	18	15
Performance of economic wealth	9	15	9	13

Even though the sense of fashion reflects personal style, it was also highly influenced by social trends. Every period of time brings its own rules, habits, needs, regulations, and even prohibitions in sense of dressing *"new time always implied new fashion trends"*. With their appearances, persons state their attitudes towards themselves, towards environment, or belonging to certain social strata. Weather the persons accept fashion or not, they decide to show their personalities, group or individual identities. Fashion broke through in every aspect of social life, but also into the depths of human mind. From the table "*What fashion means to you?"* the majority of the respondents considers fashion to be part of the culture, 47%, that fashion is synonym for beauty 19%, and fashion is a need to feel beautiful for 22% of the respondents. Last but not least, fashion is the mark of economic wealth for 11% of the respondents.

2.15. Fashion Awareness

Table 15. Answers of the respondents on question: "How do you inform yourself about fashion?"

How often do you inform yourself about fashion? (%)	Year 2013			
	Age of the respondents			
	15-25	26-35	36-55	55+
All the time	39	29	20	14
Occasionally	47	63	67	49
Rare	11	8	13	37
Never				
Where do you get information on fashion? (%)				
Magazines	26	28	35	39
Journals	14	9	8	4
TV	32	29	24	34
Commercials	6	8	10	12
Mass fashion	4	10	6	2
Public life personalities	5	3	4	3
Boutiques	8	9	9	2
Clothing stores	5	4	4	4

From the data given in the table above we can conclude that all of the respondents from all four age groups inform themselves about fashion regularly or occasionally. 25% of the respondents inform themselves regularly, whereas 56% do it occasionally. Interesting fact is that 17% of the respondents in the older age group inform themselves rarely. The majority of the respondents inform themselves about fashion by TV, on average 30%, with magazines 32 %, journals 9%, commercials 9%, boutiques 7%, and a small proportion of the people surveyed inform themselves through public life personalities, mass-fashion, clothing stores etc. Lately, in Serbia, many fashion magazines became omnipresent in the market, such as *Cosmopolitan, the Best of Shop, Elle, Gloria* etc. In those magazines, mostly young people could find a specific clothing style, details, advices and models that fit teenagers, business people, elders, size plus people etc. Foreign magazines such as *Burda, Vogue, Lisa* etc. provide much information about fashion which imposes necessity and need to be constantly informed about variety of questions regarding fashion and clothing. Fashions trends tend to repeat, however, sometimes only certain elements of past trends become trendy once again which tells us that fashion never repeats itself. Fashion adapts to a lifestyle of a certain time and represents part of general design of a society.

2.16. The Acceptance of Fashion Trends

Table 16. Respondents' answers to the question: „Do you accept fashion trends? "

How much do you accept fashion trends? (%)	Year 2013			
	Age of the respondents			
	15-25	26-35	36-55	55+
Very much	9	11	2	-
Moderately	65	51	55	31
Little	21	35	34	32
I don't	3	2	7	33
The rest	2	1	2	4
The elements of the acceptance of a fashion trend (%)				

Colour	26	22	19	7
Quality	15	14	21	24
New materials	10	15	6	8
Fashion details	23	17	22	22
Shape	24	26	17	24
All of it	2	6	15	-
Nothing	-	-	-	15

As show in the table, the acceptance of a fashion trend is mostly moderate (50% on average), and it is widely accepted by 30% of the respondents. Fashion trends are not accepted by 11%, usually over the age of 55. Fashion trends are mostly accepted and followed by the youngest population. They also think that the colour of the clothing item is the most important (26%), fashion details are important for 21%, shape for 23% and quality is of utmost importance for another 18% of the respondents. New materials are crucial for 10% of the respondents, mostly the younger ones.

2.17. The Acquisition and Purchasing of Clothes

Table 17. Respondents' answers to the question: „How do you get clothes? "

How do you get clothes? (%)	Year 2013			
	Age of the respondents			
	15-25	26-35	36-55	55 i više
Buying in wholesale shops	4	5	16	18
Buying in boutiques	30	20	15	7
Buying in open markets	22	18	7	3
From abroad	5	8	10	3
Sales	4	7	2	14
I sew them by myself	1	6	5	13
Somebody makes them for me	9	5	9	16
Rearrangement	5	7	10	10
All of it	20	24	26	16
How frequently do you buy clothes %				
Often	27	25	12	5
Occasionally	53	51	59	30
Seldom	7	13	14	31
when I have to	10	10	15	34
the rest	3	1	-	-

As show in the table, the places of acquisition of clothes are various, including boutiques, street sales, sales, shops etc. Boutiques are preferred by 18% of the population, overwhelmingly younger. Street shopping was preferred by 12% of respondents, and shops by 11%. The sales were favorite of 7% of respondents, usually older. It is interesting that because of the long-lasting economical crisis, the diminished buying capabilities, unemployment etc. the respondents of older age group opt for rearrangements of clothes, they make their own clothes or they have them made, buy on sales etc. The fashion trends are not particularly strong in this segment of the population. Occasionally the clothes were bought by 47% of respondents, often 17%, and seldom 9%. The significant percent of older respondents buy their clothes when they have to, 24% of them. It is understandable considering the drop of their life standard.

2.18. The Motifs for Purchasing Clothes

Table 18. Respondents' answers to the question: „What are your motives for purchasing clothes? "

Your motif is (%)	Year 2013			
	Age of the respondents			
	15-25	26-35	36-55	55+
To have something the others don't	31	24	14	8
To have something the others do	10	8	3	6
Need	23	23	39	56
Pleasure	34	45	44	30
The rest	2	-	-	-
Who influences your choices? (%)				
Family	25	15	7	4
Friend	28	25	17	10
Colleague	-	6	3	10
Salesman	1	2	4	2
None	46	52	69	74
The rest	-	-	-	-

From the table shown above we can conclude that the motifs for buying clothes are different. For the 38% of respondents the main motif is pleasure, the next most important motif is to have something the others don't (278% of the younger respondents). The respondents usually rely on their own knowledge of dressing styles and fashion trends: 60% of them are not influenced during shopping. Family is a source of influence for 15% to 20% of the younger respondents, and friends are the source of influence for 25% to 28% of them. Interestingly, the salesmen have very little influence. It shows their bad knowledge of fashion trends, quality of clothes etc.

2.19. The Expectations from the Clothes Purchased

Table 19. Respondents' answers to the question: „Does the clothes shopping meet your expectations?"

Clothes shopping did not fulfill my expectations %	Year 2013			
	Age of the respondents			
	15-25	26-35	36-55	55+
Often	18	15	14	21
Sometimes	65	78	74	56
Never	15	7	12	19
The rest	2	-	-	4
The most frequent error on the clothes purchased (%)				
Inconsistent colour – washed away after few washings	24	23	26	30
Changes its appearance	19	19	21	22
Changes its dimensions	29	28	29	29
Gets unstitched	28	30	24	19

Sometimes the clothes purchased do not meet the expectations of buyers, 68% of the cases. That is a frequent occasion of 17% of the respondents. 11% of the respondents say the clothes never fulfill their expectations. The most frequent errors are changing dimensions (29%), unstitching (25%), colour bleeding (26%), and changing appearance (20%). The errors are attributed mostly to a bad quality of materials and inadequate way of clothes' producing.

2.20. Sizes

Table 20. Respondents' answers to the question: „What is your size? "

Your size (%)	Year 2013			
	Age of the respondents			
	15-25	26-35	36-55	55+
36	32	25	15	-
38	39	36	26	21
40	17	22	21	23
42	12	13	15	29
44	-	4	20	19
46	-	-	3	8
Does it suit you fine? %				
Yes	43	38	46	52
No because I	21	22	13	16
Wear 36/38	9	7	2	-
Wear 38/40	6	8	5	5
Wear 40/42	3	5	7	3
Wear 42/44	-	5	8	5
Wear 44/46	-	1	1	4
Short clothes	10	7	6	4
Long clothes	3	4	3	3
Wide clothes	3	2	2	2
Narrow clothes	2	1	1	1
The sizes differ	-	-	6	5

The table shown above proves that the average size 38 (30%), size 35 (24%) and size 40 (21%). The data according to which the confection sizes are calculated are out-of-date, because of the changed body proportions and dimensions, due to the changed life and eating habits. The younger population wears the sizes 36 to 40, and the older tend to wear 40 to 44. They all find them satisfactory. 18% of the respondents concluded that the sizes are "not satisfactory" and they tend to wear "something in between", e.g. between 38 and 42, which leads to the conclusion that the sizes should be more individual.

The data lead to the following conclusions:

- the respondents choose their clothes according to their aesthetic values, which are derived from the psychological factors
- The offer of clothes should be more valuable in an aesthetical way, since it stimulates the buyer to purchase the beautiful clothes, and it also educates a buyer.
- Having in mind the tremendous value of dressing, all the responsible factors in the society should think not only about the functionalities of clothes, but also about the other roles of clothes (aesthetic, economic, ergonomic etc.)
- it is evident that the fashion requires constant changes and the need of identification of products that consumers need, through permanent screening and reviewing of the needs of the current and potential clients
- the manufacturing of clothes is of utmost importance for each national economy, where marketing information slow down the process of designing and direct to the products that need to be made in order to satisfy the consumers' needs
- the sector of design is tightly connected with the marketing sector

- The marketing information has enormous value for forecasting of business in the future and creating short-term and long-term strategies.

3. CONCLUSION

Having examined the followings and the acceptance of fashion trends, as well as the styles and preferences of consumers, we have concluded the following:

- the favourite clothing item of the younger population is denim trousers (32% feel fine in them, 33% love denim) or trousers made of other elastic material which follow the body line (7%), including those with various patterns
- the favourite upper clothing item of the younger population are T-shirts (20%) that follow the body line (52%). These T-shirts are both for the everyday use and the special use.
- The respondents favour natural fabrics (cotton 45%, viscose 8%, silk 8% of the younger population) but also the mixed material (natural and artificial fibers made of elastane)
- The favorite colours are black (20-30%), blue (5-14%), white (8-10%), grey (6-9%) and increasingly red, rose, beige etc.
- The younger respondents most often wear the size 38 (36-39%), and the older wear 42 (29%).
- The respondents get information on fashion trends through domestic and foreign fashion magazines (40/43%). They use them to obtain information on fashion hits, new materials, technology of clothes manufacturing etc.

The male collection was not made since the poll concluded that they were much weaker buyers than women and they are far less interested in buying clothing items.

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TECHNICAL APPLICATION OF NONWOVEN FABRICS IN ACUOUSTIC INSULATION

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Abstract: *Nonwovens are used in an incresing number of components for the car, aeronautical and naval industries. Noise control has become an important issue for environmental improvement. Different types of acoustic materials are needed for noise reduction in different application sites such as office buildings, highways, or manufacturing facilities. Textile fabrics, particularly non-woven fabrics, have been commonly used for sound absorption because of a special fabric structural component – the mesopores formed by fiber and yarn in the fabrics. This paper shows application of nonwoven industrial textile in acoustic insulation, and describes characteristic of this materials.*

Key words: *non-wovens, acoustic insulation, tehnical application*

1. INTRODUCTION

Nonwovens are the fastest growing segments of the textile industry. Non-woven textile is only technical textiles, which provides cost-effective solutions for a wide range of applications, thanks to the numerous and diverse qualities [1].

Nonwovens are used in an incresing number of components for the car, aeronautical and naval industries. They offer variety of adventages, ranging from imrpoved sound insulation to the reduction of smells and of volatile organic components, to antistatic properties and to properties of air and oil filtration, to abrasion resistance, to flame resistance and mouldability, and offer incresing design opportunities. Recent developments include the use of supportable nonwoven composites owing to their low density, to the improved reclaiming possibilities and to relatively low costs. Nonwovens with 3D-structure are playing an increasingly important role as alternative to foams in specific applications[1].

Nonwovens are often used for buildings and roofs and as insulating materials and geosynthetics for projects of civil engineering, railroads, dams and channels. The use of nonwovens offers a variety of adventages, from the retaining of wastes – by protecting the soil from chemical contamination – to erosion control and to soil reinforcement and stabilization. Other adventages embrace thermal and sound insulation, the improvement of energetic efficiency through reduction of heat dispersion and protection against insects or temperature variations. The latest nonwoven innovations in the building industry include the development of materials able to transmit many physical qualities as permeability, liqiud transmission inside the material and barrier effect, as resistance to perforation and to chemical degradation. [1].

Nonwoven composites are often combined with a variety of other materials and can be used in an almost endless number of custom-made applications, for a wide range if industries. They offer a variety of functional adventages, from sound and thermal insulation to tensile strenght, perforation resistance and high indeformability. The use of nonwoven compositees made with vegetable materials and other natural fibers is now arousing great interest, in particular for applications in the car industry [2].

2. ACOUSTIC INSULATION

Noise control has become an important issue for environmental improvement. Different types of acoustic materials are needed for noise reduction in different application sites such as office buildings, highways, or manufacturing facilities. Textile fabrics, particularly non-woven fabrics, have been commonly used for sound absorption because of a special fabric structural component – the mesopores formed by fiber and yarn in the fabrics. In general, dry porous media saturated with air are capable of reducing the level of ambient noise. [3].

Nonwovens only had high sound absorption in the high-frequency range (above 2000 Hz) in comparison with other fiber materials such as glass fiber and rockwool. Lou et al. reported that the sound absorption efficiency

of non-woven composites at medium- and low-frequency levels could be improved by increasing thickness. However, this would also increase the size and weight of non-woven materials. [3].
Activated carbon fiber fabrics have two levels of porous structures: macropores among fibers and yarns; and micropores on the surface of activated carbon fiber. This unique fabric architecture renders a great potential for the activated carbon fiber fabrics to be used as high-performance and cost-effective acoustic materials. In particular, there is an industrial need to produce high-performance acoustic materials for absorbing low-frequency noises [3].
Acoustic non-woven materials, which are shown in this paper, was designed with a composite structure. This non-woven composite has two layers: a base layer and a surface layer (Figure 1). They were pure cotton non-woven, pure ramie non-woven, and pure polypropylene (PP) non-woven. Two different non-woven products were employed as the surface layer. One product was a rayon-precursor activated carbon fiber (ACF) nonwoven and the other product was a glass fiber web[3].

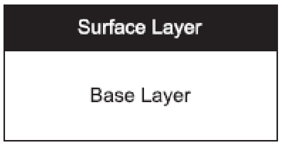


Figure 1 Acoustic non-woven structure.

The base-layer non-wovens were fabricated by a process of carding and needle-punching. The cleaned fibers were fed into a carding machine to make a non-woven web. To enhance the web uniformity, the fibers could be carded twice. The specifications of materials which are shown in this paper are listed in Table 1. Two different nonwoven layers are placed like surfice layer. One sample is from ACF and another is produced from glass fiber. [3]

Table 1. Fiber and non-vowen specifications

Non-woven	Fiber length (mm)	Fiber fineness (tex)	Weight (g/m^2)	Thickness (mm)
PP	50.8	0.7	236	35
Ramie	95.3	0.8	177	35
Cotton	19.8	0.1	62	35
ACF	–	–	44	3
Glass fiber	–	–	248	3

When a noise wave reaches the surface of an acoustical material during its propagation by an airborne path, it will be split into three different parts: reflected, transmitted, and absorbed. The ability of a material to absorb noise waves is evaluated by measuring the reflected noise wave strength compared to the incident noise wave. In many engineering practices, encapsulation of a noise source using an insulating material is often required. Under this case, because of the barrier material existing between the noise source and receiver, the noise wave arriving at the receiver is a transmitted noise wave with a certain level of noise intensity reduction (Figure 2)[3].

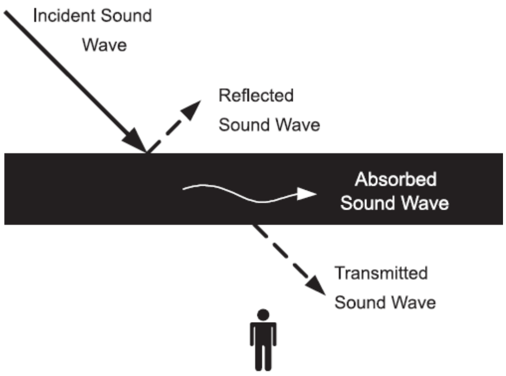


Figure 2. Noise reduction by a barrier material

The insulation performance of a barrier material is assessed by sound transmission loss (TL). This parameter is determined by the ratio of incident noise intensities (I_i) (W/m2) to transmitted noise intensities (I_t), defined as:

$$TL = 10\log_{10}\left[\frac{I_i}{I_t}\right]$$

The measurement of sound absorption of the ACF non-wovens was based on the method of ASTM E 1050 (Standard Test Method for Impedance and Absorption of Acoustic Properties Using a Tube, Two Microphones and a Digital Frequency Analysis System). This method was developed to determine the ability of materials for absorbing normal incidence sound waves. A Bruel and Kjær measuring instrument was used for this testing within the frequency range 0–6.4 kHz. The testing principle of this system is illustrated in Figure 4. A sound source is mounted at one end of the impedance tube and the material sample is placed at the other end. The loudspeaker generates broadband, stationary random sound waves. These incident sound signals propagate as plane waves in the tube and hit the sample surface. The reflected wave signals are picked up and compared to the incident sound wave. The frequency range to be tested depends on the diameter of the tube. A large tube (100 mm diameter) is set up for measuring the non-woven sound absorption in the low-frequency range from 50 to 1600 Hz. A small tube (29 mm in diameter) is set up for testing the material sound absorption in the high-frequency range 500–6400 Hz. Three specimens were tested for each type of the experimental acoustic non-woven composites [3].

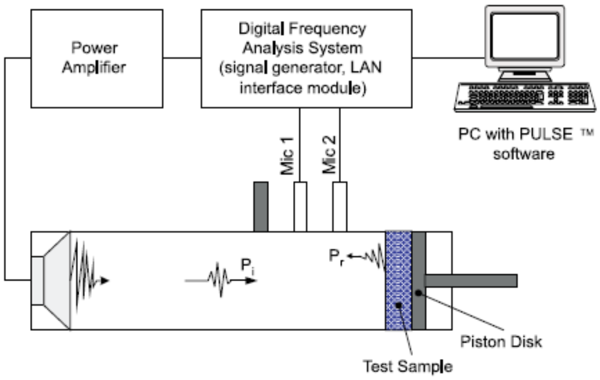


Figure 3. Measuring system configuration

After testing the three base-layer non-wovens and six nonwoven composites, the normal incidence sound absorption coefficients (α) of these materials were determined as a function of the sound frequency (*f*), as shown in Figures 4– 7. The plotted curves combine the measured data in the low-frequency range 100–1600 Hz and the measured data in the high-frequency range 500–6400 Hz[3].

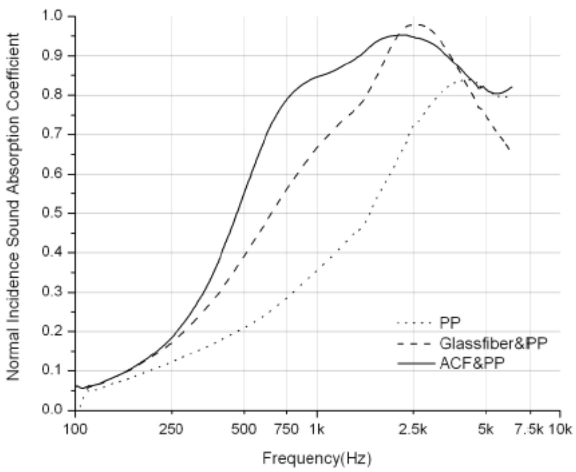


Figure 4 Absorption coeficients of PP-based composites

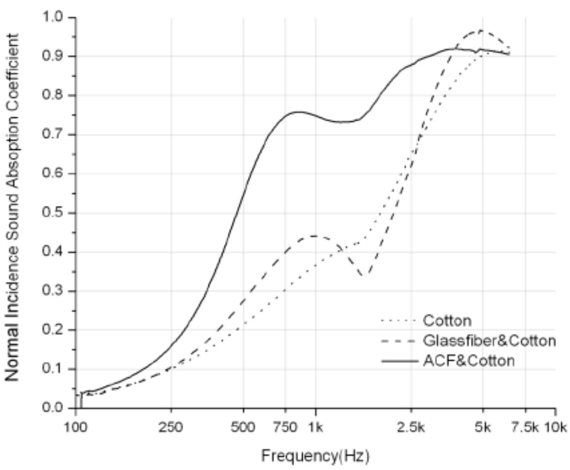


Figure 5. Absorption coeficients of cotton-based composites.

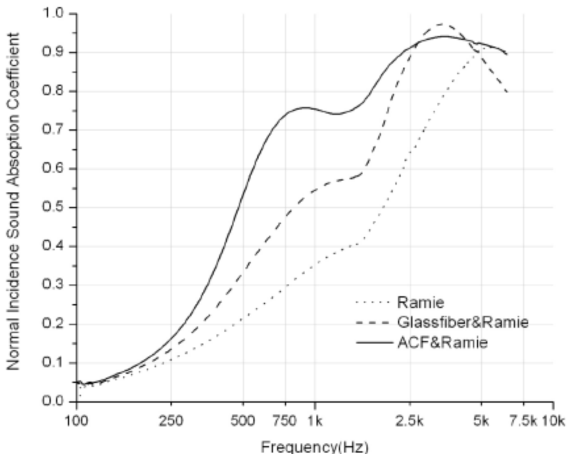


Figure 6. Absorption coeficients of Ramie based composites

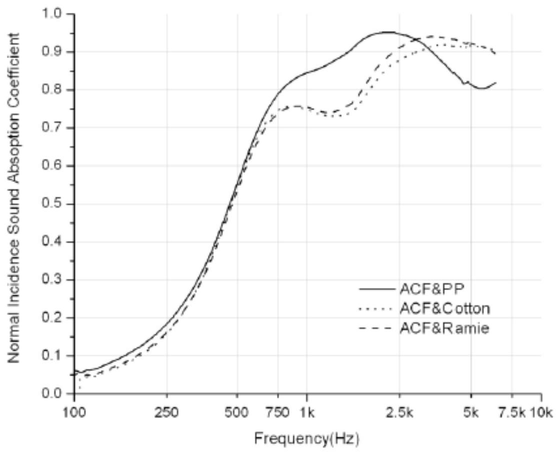


Figure 7. Absorption coeficients of ACF-based composites.

By examining the curves within the range 100–1600 Hz, it can be seen that the non-woven composites with the ACF surface layer, ACFand PP, ACF and Cotton, and ACF and Ramie, exhibited the highest ability for normal incidence sound absorption, superior to the glass fiber surface non-woven composites, Glassfiber and PP, Glassfiber and Cotton, and Glassfiber and Ramie. A primary reason why the ACF surface composites have significantly higher absorption coefficient may be understood from the highly porous surface structure of ACF. This contributes to a significant increase of the total porous areas inside the ACF non-woven. More porous areas mean a greater volume of air allowed to flow into the ACF nonwoven structure. When incident noise waves hit the nonwoven composite, air vibration would happen in both the macroporous areas and the microporous areas. As a result, the incident waves can be absorbed considerably [3].

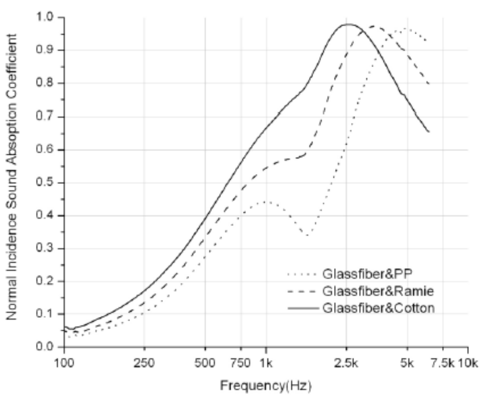


Figure 8. Absorption coeficients of glass-fiber-surfaced composites

Within the high-frequency range 1600–6400 Hz, the curve pattern of the normal incidence sound absorption coefficients is different between the ACF-surfaced composites and the glass-fiber-surfaced composites. As illustrated in Figure 8, ACF and Cotton and ACF and Ramie exhibit a very similar increasing trend of the sound absorption corresponding to the increase of the frequency, while the ACF and PP curve reaches a peak absorption coefficient (0.95 at 2150 Hz) and then decreases to 0.8 in proportion to the frequency increase. For the three base-layer non-wovens, the sound absorption coefficient curves are all similar but the maximum absorption coefficient for the PP base-layer non-woven is only about 0.85 (Figure 5). Examining the normal incidence sound absorption curves of Glassfiber& PP, Glassfiber&Ramie, and Glassfiber&Cotton (Figure 9), a common feature of these curves is that they all have a maximum absorption coefficient of around 0.97. This peak value happens at about 2500 Hz for Glassfiber& Cotton, at about 3400 Hz for Glassfiber and Ramie, and at about 5000 Hz for Glassfiber and PP.

2.1.SoundTex – acoustical nonwoven material

For sound absorption, the propagation of sounds is absorbed by converting sound energy into thermal energy. Materials with sound-absorbing properties are called sound-absorbing materials. SoundTex is a porous, thin acoustic nonwoven fabric which is using for sound absorption, while at the same time provides economical and ecological advantages compared to the competition. With porous sound-absorbing materials, sound energy is mainly converted into thermal energy by viscous friction between the oscillating particles of the sound-propagating medium (air) and the structure of the porous material. In practice, perforated ceiling tiles made of metal, wood, plastic or gypsum and provided with a porous sound-absorbing material (glued) on the back are used for absorption of air-borne noises. SounTex is produced by cellose and glass fibre. [4].

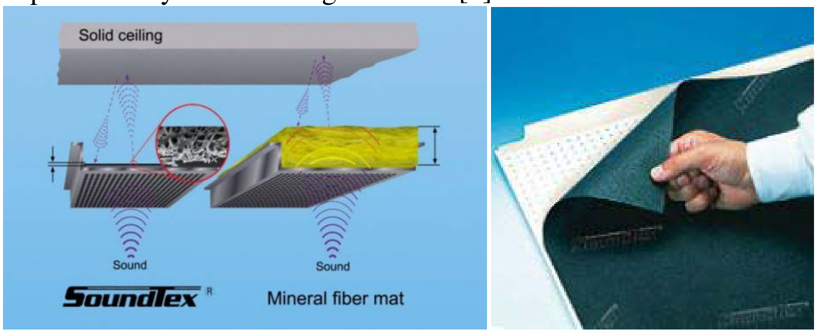
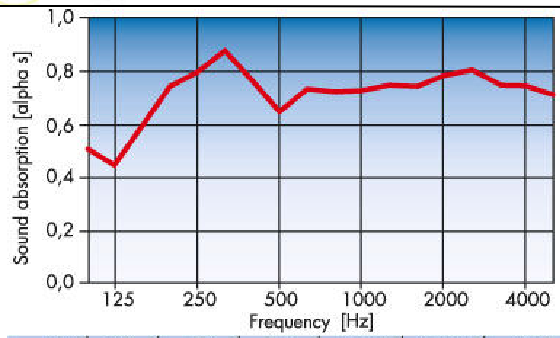


Figure 9. SoundTex

It is tested in accordance with all relevant international standards, acoustics, and examination proved that meets all the requirements and in some ways exceeds them [5] .

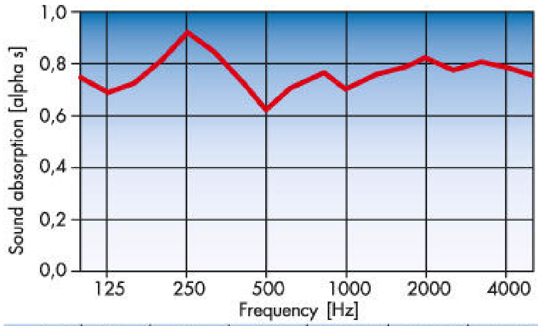
Fibres DIN 60 001 – T1	cellulose+glass
Bonding EN 29 92	synthetic resins
Surface mass EN 29 73 – T1	63 g/m2
thickness EN 29 073 – T2	0,27 mm
The maximum stretching force EN 29 073 – T3	80 N/50mm machine direction
	50 N/50mm transverse direction
Elongation at maximum force tensile EN 29 73-T3	2% in both directions
Flamability resistance	on-flammable and meets the demands of building materials according to DIN 4102/B1.
Storage Conditions	Store in cool, dry, and recommended that it be unlit room. Storage temperature is the maximum 40th avoid high humidity, condensation water and direct sunlight. Storage before processing should not exceed one year

SoundTex fulfills all important standards of service properties. It was tested according to the criteria usable properties that are current in the United States, Germany, England and China. Important results of all tests are presented with the diagram, Figure 1, 2i 3 The curves in the diagrams are based on measurements of noise in the room according to ASTM C423-90a and E795-93, DIN EN 20354 and BS EN 20354th The sound absorption coefficient (alpha-s) in the frequencies from 125 to 4000 Hz range from 0.6 to 0.8 [4].



[Hz]	125	250	500	1000	2000	4000
alpha s	0,45	0,80	0,65	0,72	0,78	0,74

Figure 10. Diagram of sound absorption SoundTex material obtained by testing according to ASTM C 423-90a and ASTM E795-93



[Hz]	125	250	500	1000	2000	4000
alpha s	0,70	0,93	0,61	0,72	0,82	0,79

Figure 11. Diagram of sound absorption SoundTex material obtained by testing according to DIN EN 20354

SoundTex modify the sound impedance of perforated plates at the level equal to the impedance of air. Sound waves are suppressed through untouched structure and friction creates heat. This friction causes the loss of kinetic energy. This reduces the size of the sound wave. Ultra slim profile SoundTexa (thickness 0.008 inch or 0.2 mm) for easy viewing and editing. It can be laminated onto the ceiling panel factory, reduces transportation costs and workload in the workplace. Ultra thin SounTex sticks directly onto the ceiling panel [5].

Besides the high sound absorption values, there are additional arguments in favour of SoundTex® acoustic nonwovens:

- Low material thickness of only 0.2 mm produces substantial savings in transport and storage costs.
- Can be customized in any desired delivery width.
- High running lengths of the material mean short machine make-ready times when handling roll goods.
- Cost-efficient installation when used in tiles and planks, since there is no need for cutting to size manually.
- Suitable for acoustic ceilings with integrated cooling or heating system, since no thermal insulation function is required.
- Reduces the risk of condensation water forming in the ceiling cavity, since dispensing with an insulation function supports a continuous exchange of air.
- Because they are permanently glued to the ceiling panel, they are particularly inspection-friendly; no need to shift voluminous insulation mats. Convenient and fast access to the ceiling cavity for maintenance.
- Reduced waste incidence on completion of useful lifetime, since the volume involved is many times smaller than that of conventional materials.

SoundTex is largely used for many applications where the acoustics main area of application. Typical examples include office, city hall of airport, theaters, conference rooms, underground stations, hotels and restaurants [5].

Figure 12. Aplications of SoundTex acoustic material a) Maglev Train Station, Shanghai, b) Airport, Munich, c) Theatre, Beijing

3. APPLICATION OF ACOUSTIC NONWOVENS IN AUTOMOTIVE INDUSTRY

Nonwovens are expanding rapidly in the automotive Sector. Over 40 significant applications have been identified and more new end uses are being developed on a continuous basis (Figure 14) [6].

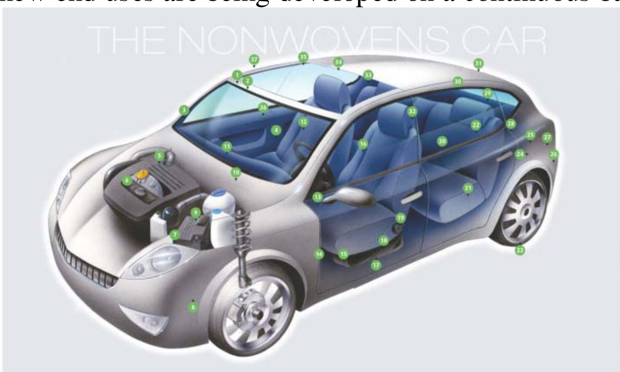


Figure 13. Application of nonwovens fabric in car

The consumption of Nonwovens is currently around 28m2 per vehicle and this is expected to rise to over 40m2 per vehicle in the future. At a recent financial summit in London, Tier 1 automotive supplier Faurecia showcased its latest technologies and materials that are enabling car makers to achieve up to 22kg in weight savings. These include the Peugeot 208's latest acoustic package that has cut the weight of this component by 60% and the injected natural fibre door panels now being employed in European C Segment cars that are 40% lighter than previous versions [6] .

Teijin's V-Lap lightweight, sound-absorbing polyester nonwovens have been selected for use in the floor carpet of the new Mitsubishi Outlander, a midsize crossover vehicle launched in Japan in October. The floor carpet was developed by Hayashi Telempu Corporation, a manufacturer of interior automotive parts. V-Lap was adopted as the sound-absorbing material for the carpet's back side. V-Lap's vertically oriented nonwoven structure performs as well as conventional sound-absorbing materials yet weighs only half as much, helping to improve fuel efficiency through vehicle-weight reduction. V-Lap is a nonwoven fabric comprising fibres that are oriented vertically (Figure 15). It is made by a unique manufacturing method to produce a structure that is bulky, lightweight and easy to mould. It was first utilized as a cushioning material for seating bedding, but its superior sound-absorbing property has led to its use in vehicles for sound proofing. Teijin is also developing V-Lap as a heat-insulating material for use in next-generation houses. Nonwoven products with added functionality can be produced through composite fabrication by bonding V-Lap to other films [7].

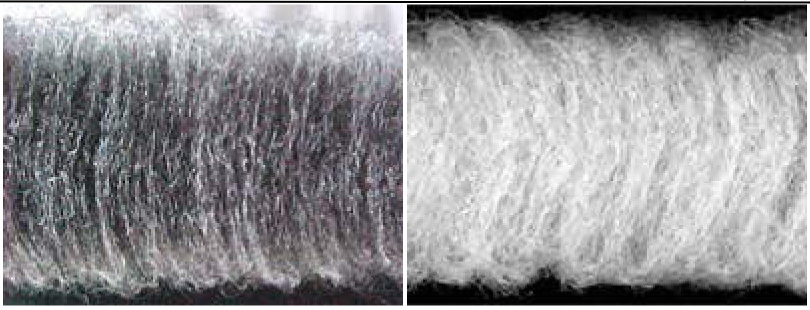


Figure 14. V-lap nonwoven fabric for automotive industrie

4.CONCLUSION

On the basis of this study it can be concluded that the use of nonwovens in technical use is very high. This paper describes the use of nonwovens to improve acoustic insulation. The areas in which these applied insulating materials is mainly in the auto industry, construction, agriculture and horticulture as protective clothing for firefighters.

Based on the results presented in this paper, we conclude that the non-woven materials, which are used for acoustic insulation generally have perforated structure that allows the retention of noise inside the macropores and micropores fibers. Activated carbon fiber and glass fiber, combined with other layers of non-woven materials, forming a composite material, with good sound insulation properties. It could be concluded from the diagrams shown in Figures 5 to 9. Based on the products used for sound insulation, it can be concluded that main purpous is to achieve the smaller thickness of the insulating non-woven material and a high efficiency in terms of retention and absorption of sound. Widely used in construction industry and the auto industry.

Acknowledgements

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TECHNICAL APPLICATION OF NON-WOVEN FABRIC IN THERMAL INSULATION AND USLULATION AGAINST FLAMMABILITY

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***Abstract**: Non-wovens offer variety of advantages, ranging from improved sound insulation to the reduction of smells and of volatile organic components, to antistatic properties and to properties of air and oil filtration, to abrasion resistance, to flame resistance and mouldability, and offer increasing design opportunities. Using thermal insulation in the building envelope can enhance roof insulation and thereby conserve energy. Most common insulation materials trap air to reduce convective and conductive heat transfer, but do not hinder radiative heat loss. Fibrous thermal insulations are widely used in building applications and some of it applications are showed in this paper*

***Key words**: thermal insulation, flammablity, nonwovens*

1. INTRODUCTION

Non-woven materials play a key role in hundreds of everyday products, from luxury cars to the well-known tea bags. Nonwovens are used in an increasing number of components for the car, aeronautical and naval industries. They offer variety of advantages, ranging from improved sound insulation to the reduction of smells and of volatile organic components, to antistatic properties and to properties of air and oil filtration, to abrasion resistance, to flame resistance and mouldability, and offer increasing design opportunities. Recent developments include the use of supportable nonwoven composites owing to their low density, to the improved reclaiming possibilities and to relatively low costs. Nonwovens with 3D-structure are playing an increasingly important role as alternative to foams in specific applications [1] [2].

Nonwovens are often used for buildings and roofs and as insulating materials and geosynthetics for projects of civil engineering, railroads, dams and channels. The use of nonwovens offers a variety of adventages, from the retaining of wastes – by protecting the soil from chemical contamination – to erosion control and to soil reinforcement and stabilization. Other adventages embrace thermal and sound insulation, the improvement of energetic efficiency through reduction of heat dispersion and protection against insects or temperature variations. The latest nonwoven innovations in the building industry include the development of materials able to transmit many physical qualities as permeability, liqiud transmission inside the material and barrier effect, as resistance to perforation and to chemical degradation. [3].

Nonwoven composites are often combined with a variety of other materials and can be used in an almost endless number of custom-made applications, for a wide range of industries. They offer a variety of functional advantages, from sound and thermal insulation to tensile strength, perforation resistance and high in deformability.

2.THERMAL INSULATION

Nonwoven glass and polyester fabrics are already widely used in roofing applications while other textiles are used as breathable membranes to prevent moisture penetration of walls. Fibers and textiles also have a major role to play in building and equipment insulation. Glass fibers are almost universally used in place of asbestos now. Modern metal-clad roofs and buildings can be lined with special nonwovens to prevent moisture condensation and dripping. [4].

Composites generally have a bright future in building and construction. Existing applications of glass-reinforced materials include wall panels, septic tanks and sanitary fittings. Glass, polypropylene and acrylic fibers and textiles are all used to prevent cracking of concrete, plaster and other building materials. More innovative use is now being made of glass in bridge construction. In Japan, carbon fiber is attracting a lot of interest as a possible reinforcement for earthquake-prone buildings although price is still an important constraint upon its more widespread use [4].
Some examples of where nonwovens are used

- Insulation (thermal and noise)
- House wrap
- Roofing
- Covers for acoustic ceilings
- Air infiltration barrier
- Vapour barrier
- Flooring substrates
- Facings for plaster board
- Pipe wrap
- Concrete moulding layers
- Foundations and ground stabilisation
- Vertical drainage

Technological and industrial development has increased energy consumption. Over the last four decades, the use of fossil fuel has continued to increase. This increased use of fossil fuels has had adverse climatic effects through global warming. Roof insulation accounts for roughly 50% of total residential energy consumption. Therefore, enhancing the efficiency of roof insulation can decrease residential energy consumption. Thermal insulation is applied to decrease the rate of heat flow by conduction, convection, and radiation. Using thermal insulation in the building envelope can enhance roof insulation and thereby conserve energy. Most common insulation materials trap air to reduce convective and conductive heat transfer, but do not hinder radiative heat loss. These insulators can be fibrous (e.g., down feathers and asbestos), cellular (e.g., cork or plastic foam), or granular (e.g., sintered refractory materials). The main effects of thermal insulation on thermal performance depend on material density and porosity, and the number and size of void in the material. Fibrous thermal insulations are widely used in building applications. Fibrous thermal insulation is typically easy to install and form, and possesses a low density, which provides a structure high in voids [5].

3. EFFECT OF PRODUCTION OF NON-WOVEN MATERIAL ON THE PROPERTIES OF THERMAL INSUALTION

Dry laid nonwoven fabrics are typically used for fibrous thermal insulation as the dry laid process can generate a high basis weight fibrous web. Furthermore, dry laid fibrous webs manufactured commercially are processed to achieve fiber-to-fiber bonding by chemical, solvent, or thermal means to produce a nonwoven fabric with sufficient dimensional stability [3]. Thermal bonding methods cause thermal bonded nonwoven fabrics to possess various bonding structures. Thermal bonding reinforces the fibrous web via two principal methods, an oven for through-air bonding and calendering through heat rollers. Thermal plate pressing is commonly used for curing in composite materials. Nonwoven fabrics consolidated via through-air thermal bonding possess a looser structure than that consolidated via thermal calendering or thermal plate pressing machines because of the various pressures in thermal bonding [5].

The properties of bonding elements in thermal bonded nonwoven structures with multiple variables were investigated by Winchester and Whitwell [5]. They demonstrated that bonding element content significantly affected all nonwoven characteristics. According to the bonding element content affecting the bonding structure in nonwoven fabrics, thermal conductivity is likely affected by the changing content of bonding elements. Furthermore, temperature during thermal bonding affects the

melting condition of bonding elements and the bonding structure of nonwoven fabrics. Thus, temperature during thermal bonding also influences the rupture of thermally bonded nonwovens [5].
Although inorganic fibrous thermal insulation has efficient thermal performance, the inorganic fibrous thermal insulation can cause health problems through installation processing. Therefore, tin this paper is showed using organic fibrous materials to substitute inorganic fibrous materials. In order to retard flammability of organic fibrous materials, flame-retardant polyester hollow fibers (FR-PET fibers) as a substitute for wool have been utilized and mixed with low-melting-temperature polyester fibers to generate flame-retardant nonwoven fabrics. Needle punching, thermal calendering, through-air thermal bonding, and thermal pressing comprise processes routes for consolidation of nonwoven fabrics. The different process routes produce various dimensions and compositions of nonwoven fabrics which influences on thermal insulation of non-woven material [5].

Table 1 The specification and thermal conductivities of the fabrics produced by different process routes.

	Pre-formation	Consolidation	Thickness (mm)	Density (kg/m^3)	Thermal conductivity (W/mk)
LNF (1 layer)	Thermal calendering	Thermal pressing	10	20	0.06560 ± 0.0032
LNF (3 layers)	Thermal calendering	Thermal pressing	10	60	0.06182 ± 0.0046
PNF	Thermal calendering	Thermal pressing	1.7	117.647	0.07164 ± 0.0050
NPNF	Needle punching	Thermal pressing	1.7	117.647	0.07243 ± 0.0042
NTNF	Needle punching	Through-air thermal bonding	2	100	0.06944 ± 0.0071

Table 1 shows the thermal conductivity of fabrics produced using different processes. Experimental data indicate that the effects of the three different fabrication routes on the thermal conductivities of PNF, NPNF, and NTNF were similar. However, the thermal conductivity of NTNF was slightly lower than that of LNF and NPNF. This experimental result resulted from the fact that NTNF was not pressure treated at the through-air thermal bonding process, thus the bulk density of NTNF was lower than that of PNF and NPNF. Thereby the porosity of NTNF improved, causing the gas content to increase and the thermal conductivity of NTNF to decrease. Thermal conductivity of PNF was lower than that of NTNF. This experimental finding resulted from the fact that needle punching made fiber orientation parallel to macroscopic heat flow. Therefore, thermal conductivity of NPNF was higher than that of PNF. In addition, thermal conductivities of LNF with 1 and 3 layers were lower than that of the other nonwoven fabrics [5].

These experimental results conformed to the experimental results in the literature. The experimental results in the literature indicate that when bulk density was lower than 60 kg/m3, thermal conductivity decreased with increasing bulk density; when bulk density was higher than 60 kg/m3, thermal conductivity increased with increasing bulk density. These experimental results also indicate that the bulk density of nonwoven fabrics possessed more significant influence on thermal conductivity than the others parameters [5].

4. NON-WOVENS AS INSULATION IN AGRICULTURE

Nonwovens are used effectively for optimizing the productivity of crops, gardens and greenhouses. Their protective nature means that the need for pesticides is reduced and manual labour is kept to a minimum [3].

The use of nonwoven crop covers on the land increases yields and improves the quality of the crops. Very light, flexible sheets are laid over seed beds, which create a microclimate in which the heat and humidity are controlled. The growth of the plants is accelerated and they are protected from adverse weather conditions and vermin[3]. In capillary mat applications, nonwovens promote the healthy growth of flowers and vegetables in greenhouses by using soil-less growing methods:
Some examples of where nonwovens are used:

- Crop covers

- Plant protection
- Seed blankets
- Weed control fabrics
- Root control bags
- Biodegradable plant pots
- Capillary matting
- Landscape fabric

The advantages of using nonwovens:

- Fabrics with high strength, durability and elasticity
- Frost and insect protection
- Apertures between the intersecting fibres of nonwoven sheets which are big enough to allow air and water to reach the crop but small enough to keep out insects.
- The protection allows plants and crops to grow without the use of pesticides and herbicides
- An earlier development and harvest of the crop, improved yield and a growing year which can be extended at both ends

5. PRODUCT FOR THERMAL INSULATION

Manufactured by Vita Nonwovens, EnGuard is a hypoallergenic alternative to glass fiber insulation made entirely from polyester—namely, recycled plastic bottles and fibers from pre-consumer content. The hydrophobic material will not absorb moisture and can be handled without protective gear [6].

Figure 1. EnGuard non-woven material for thermal insualtion

Pitex nonwoven is made from viscose used as underlay for glass fiber wallpaper. Main function of the textile is to improve insulation properties in building industri [7].

Figure 2. Pitex non-woven material for thermal insualtion

Ahlstrom glass fiber tissue is used underfoot, overhead and round about you. Our glass fiber tissues can be utilized as facers for various different building applications, such as acoustic or insulation panels, plasterboard or polyurethane insulation [8].

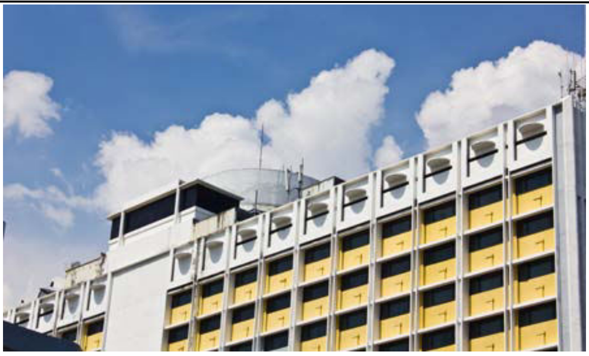

Figure 3. Ahlstrom non-woven material for thermal insualtion

Chomarat non – woven material has great performances and netkani materijal ima odlične performanse and durability of waterproof membranes. It provides dimensional stability. This material provides stability and tear resistance, resistance to heat and moisture [9].

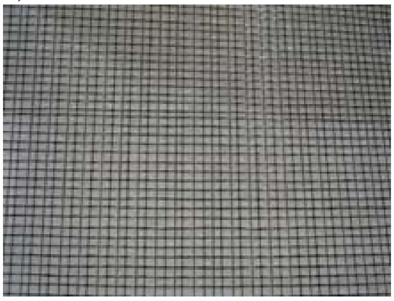

Figure 4. Chomart non-woven material for thermal insualtion

6. APPLICATION OF TECHNICAL NON-WOVEN TEXTILE AGAINST FLAMMABILITY

Nonwovens are used increasingly in applications where resistance to fire is needed, in the areas of transport, furniture, construction. In the field of protective clothing, the use of non-woven material is very large, including protective clothing for people at work, the police and the fire department. Non-woven materials such as Nomex and Kevlar blend material developed by DuPont showed great strength while at the same time have a low weight [10].

Flame retardancy of nonwovens can be achieved in two ways: additive (mechanically blending the FR chemistry with the polymer prior to extrusion) and topical (coating the fiber or fabric with the FR chemistry). Additive types are useful with thermoplastics, while topical treatments can be used with thermoplastics, thermosets and natural fibers [11].

Nonwovens play a significant role in roofing and construction applications to fulfill the demand for more energy efficient buildings [1] . However, fire safety is required in this application. The treatment method is a key issue to significantly improve the fire retardant properties of materials, and in particular in the field of textiles[12].

To provide low flammability to nonwovens, different approaches can be used. In the field of nonwovens composed of inherently fire-resistant fibers, fibers such as aramids, melamine, or carbon fiber offering high thermal stability and good flame retardancy can be used. As an example Duflot Industrie has developed Isomex®, a 100% virgin aramid fibers nonwoven for the protection of firemen (Figure 5) [12].

Figure 5 . Aramid non-woven material for flamability insualtion (Duflot)

Another company, Technical Fibre Products, has elaborated a nonwoven which expands up to twenty times its original thickness when it comes into contact with fire. The product is an intumescent nonwoven and is based on a combination of expandable graphite and mineral fiber. In the field of fire retardancy brought by incorporating flame retardant additives in commodity polymers before the processing of the fibers, Dong and Christine have developed halogen free flame retardant melt blown nonwovens using phosphorus based additives blended with polyester or nylon resins prior to the extrusion process. Raponi et al. patented a method describing the manufacture of fire resistant nonwoven fabrics containing polypropylene fibers and polyester fibers using the same blending approach [12].

Figure 6 . Non-woven material for resistant on flamability developed by Technical Textile Products company. This material provides insulation from 500 to 1600℃

7. CONCLUSION

On the basis of this study it can be concluded that the use of nonwovens in technical use is very high. This paper describes the use of nonwovens to improve thermal insulation and insulation agains flamabilaty. The areas in which these applied insulating materials is mainly in the auto industry, construction, agriculture and horticulture as protective clothing for firefighters.

It can be concluded that lately thermal insulation is very important in order to save energy with respect to climate change and the extensive use of fossil fuels. Non-woven materials for thermal insulation, are used for coating of whole buildings, from the walls to the ceiling and floor. They are also used in agriculture and horticulture to keep warm seed, reducing pesticide use and increasing yields. Besides the types of fibers used to produce non-woven materials, a great influence on the thermal insulation has the procedure of making nonwoven fabrics. This is confirmed by the results of measuring the thermal conductivity of non-woven materials produced by needle punching, through air thermal bounding and thermal calandering. AS it is shown in table 1, we can conclude that needle punching process for manufacturing non-woven materials, provides much better thermal properties then other manufacturing processes.

Acknowledgements

This work is part of research project „ Development of new and improvement of existing technological processes for production of technical textile materials", br. TR 34020, funded by the Ministry of Education, Science and Technological Development of Republic of Serbia.

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THE INFLUENCE OF KIMONO ON MODERN FASHION TRENDS

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Abstract: *In this paper, the authors analyze kimono by presenting the Japanese history of clothing, kimono forerunners, its basic shape, meaning, ways and occasions in which it is used. Special attention is paid to the ways of making kimono, materials, but also the maintenance of this garment, as well as the colours and patterns, along with the ways of their obtainment. Emphasizing the historical development of this Japanese national symbol, as well as the other cultures' influence on Japanese culture, the authors present the influence of kimono on contemporary fashion, and especially its influence on modern collections of the best-known fashion designers.*

Key words*: kimono, Japan, tradition, fashion.*

1. INTRODUCTION

Asian societies are among the world's oldest ones. The theory stresses that 'Even though they were developed and sophisticated just like the early Mesopotamian and Egyptian civilizations, they have been paid significantly less attention in all aspect of life compared to other civilizations (Pendergast S. Pendergast, 2004). During the last century, modernization of China and Japan has drawn the Western experts' interest and a wish to study these cultures. Studying these countries and their cultures, one can see that a lot has been achieved in all technology fields, but in the art field as well. Special attention will be paid to refined clothing tradition, which has evolved through time, along with these countries' development. In this way its influence on these great cultures can be understood and appreciated.

The samurai culture, characterized by strict laws of behaviour and dress, had a great impact on Japanese fashion. The most powerful samurai were called *shoguns* and their authority was of the same rank with the emperor. *Tokugawa* shogunate closed the country to 'the eyes of the west' in 1637 and this lasted for almost two hundred years. The shogun government ended in 1867, along with the return of imperial power. 'Emperor Meiji believed that Japan needs to become a modern nation'. (Pendergast, S., Pendergast, T, 2004.)

Today, the Japanese have embraced the Western dressing culture, but they also continued wearing traditional robes, out of love and respect for tradition. These are used only for special events and ceremonies.

2. KIMONO HISTORY, TYPES AND STYLES

The kimono form has been brought from China, where the garments of the shape were used as undergarments. Its use as regular clothes for both men and women dates from the *Muromachi* period (1392-1568). At the time given, the samurai have replaced the court nobles, who had always worn ceremonial robes and lived in castle towns. Over time, a need for more comfortable clothes, suitable for travel and a more urban, outdoors lifestyle has arisen, and kimono was optimal for this purpose. Since the middle of *Edo* period, women's kimono has become more decorative, in spite of luxury prohibition posed by *Tokugawa* shogunate at the time being. (Breward, C., et al.2005)

Traditionally, the Japanese clothing was not expensive or decorated by details, especially jewellery, hats or gloves, as it was the case with the Western culture of dressing. Instead of these accessories, the expression of taste and elegance was focused on the kimono itself, as main Japanese garment, and especially women's garment.

Expert fashion and historical public see kimono as the Japanese national dress. It is made from one-piece long bolt of silk, 35cm wide. Generally, it is shaped like letter 'T', with parts mutually bond by straight vertical seams. Compared to the Western dress, kimono is rather straight than slightly tailored. The colour, embroidery, patterns on the surface of the long material which the kimono is made of, are more important than the wearer himself.

Fig. 1. Kimono Irotomesode (Source: Irotomesode)

The mere name ***kimono*** means ***the thing to wear***, and its forerunner is *kosode – short sleeves* in translation. It used to be an undergarment, but in the *Edo* period it was converted into the basic dress code, extremely prone to style and fashion changes. This is the reason why it is important to stress that each kimono, according to its shape, pattern, length and other details, has a special role and significance in the Japanese society. In fact, as a part of a person's appearance, it has to show to everyone who its wearer is, from which class they come and which social status they have. Kimonos can be formal and informal and their formality depends on the fabric from which they were made, as well as the pattern and accessories accompanying them.

Women's kimonos are: Kurotomesode; Furisode; Irotomesode; Homonogi; Tsukesage; Iromuji; Komon; Edo-komon; Uchikake; Susohiki / Hikazuri. (3. What Kimono Signifies, 2013)

Men's kimonos are significantly simpler in comparison to the women's. They usually comprise up to five parts, without footwear. The most formal men's kimono is plain black, with five family crests positioned on chest, shoulders and back.

Kimono styles in Japan are roughly categorized according to the periods in which they emerged. Accordingly, the kimono styles are as follows: Kanbun style (1661-1673); Genroku and Yozen styles (1688-1704); late Edo-period styles (1603-1868); Meiji period (1868-1912); Taisho period (1912-1926); Showa period (1926-1989). (Pendergast, S., Pendergast, T, 2004.)

3. KIMONO MAKING, FABRICS AND MAINTENANCE

Men's kimono was made in various sizes, while women's was typically similar, in fact bigger and as such, adjusted to the body. The sleeves of an ideally sewn kimono are of wrist length when the arms are down. Men's kimono falls freely to the ankles, without further adjustments. (Kimono Encyclopaedia of Man, 2013)

Kimono is made of a single bolt of fabric, called *tan*. It is standardized in its dimensions – about 35-36cm wide and about 11,5m long, and is used in its whole to create a kimono. A finished kimono is made of four main panels – the two covering the body and two for sleeves, with additional small straps, forming the narrow lapels and collar. Since it is made from a single, uncut piece of fabric, a kimono can easily be resewn to fit to another person.

Traditional kimonos are hand-made and their very fabrics are usually hand-woven and decorated. The decoration is done in various techniques, like the *Yuzen* dyeing technique, applied directly to the fabric. *Yuzen* is actually the repetition of a single motif over the whole surface of the fabric. Traditionally, kimono and obi are made from silk, silk brocat, silk crepe like *chirimen* and satin fabric, *rinzu*. Today, kimonos can be found in cotton, cotton satin, polyester and other synthetic fabrics. In this way, they are more affordable to everybody. However, silk is still considered the ideal fabric for making a kimono. This seemingly simple garment is in fact very complicated for enrobing.

Old kimonos were frequently recycled in various ways - for instance, for making a children's kimono, patching a similar kimono, making bags and such. A kimono damaged under waist could be worn under *hakama* trousers, to cover the damage. Previously, the kimono was disassembled in order to be washed, and then was resewn by hand. This washing method was called *arai hari*. It was very expensive and hard for using, which resulted in the decline of kimono's popularity. Modern fabrics and cleaning methods were revealed in order to address this problem, even though *arai hari* is still being used, especially for the kimonos of the highest quality. Apart from that, just like for all other traditional Japanese garment, kimono also has its special way of folding. The aim is to protect the clothes whilst in wardrobe. The kimono is usually wrapped in paper while folded. Moreover, kimonos need to be aired at least once during season and before and after wearing. The majority of people prefer taking the kimono to the dry cleaner's. Even though this way of cleaning can be extremely expensive, it is not nearly as expensive as *arai hari*. It can also be impossible to dry clean kimonos of certain fabrics and colours.

4. THE INFLUENCE OF KIMONO ON CONTEMPORARY FASHION TRENDS

As previously stated, the introduction of foreign countries to Japan influenced the Japanese dress style, and vice versa, Japan has influenced the dress style of other countries. A dramatic change in dressing happened around the middle 19th century, when the Western powers forced Japan to open its trade routes towards the world and therefore broke its isolation from the rest of the world. The literature states that 'Changing of the shogunate government with the Emperor *Meiji* in 1868 led the elite to undergo a serious learning programme and accepting Western technology and practices, including the clothes. In 1887, Empress *Meiji* announced to the nation the condemnation of kimono wearing, describing it as harmful to female body and supporting Western blouses and skirts as a more practical form of women’s clothes. (Breward, C., et al.) However, only the wealthy women, who were in international circles, felt the need to wear Western clothes. While on one hand Western dress and culture were spreading over Japan, on the other, the West embraced kimono, so numerous portraits of Western women dressed in kimono emerged in the later 19th century.

This garment is still present in the latest fashion trends by the world's best known designers. The latest trend for spring/summer 2013 collections was the Oriental prints, which can be seen in the collections by Etro, Emilio Pucci and Prada.

Fig. 2. Miuccia Prada collection (Milan, 2013) Vogue

Miuccia Prada described her collection as 'Japan... and the sixties'. The collection had mini and medium-length dresses, tunics worn over ¾ trousers or knitted single-piece 'play clothes' (Vogue, 2013). Shady black, blue ink and dark green are present in the collection.

Japanese influence on the collection by creator Miuccia Prada is reflected in strict, yet feminine subtleness and overlapping of the fabrics. Furthermore, evening elegant jackets reveal the shoulders in the manner of draping the artistic kimono; fabric lengths are manipulated in the way to bend and define just like the obi (and in fact are really short skirts, revealing the entire leg length).

Moreover, the shoes were made in geisha style – flat shoes mainly looking like children's leather socks, of ankle length and with the separation between the big toe and other toes. Another type was placed on platforms just like the courtesans wore during the Edo period.

Fig. 3. Veronica Etro (Milan, 2013) Vogue

Just like Miuccia Prada, Veronica Etro turned to Japan as the source of inspiration for her spring/summer 2013 collection. She said: 'While I was designing (the collection), I was thinking of contemporary Madame Butterfly who chooses subtle decorative inspiration, full of oriental temperament. Rational romance. (Interview with Veronica Etro, 2013)

Her main inspiration was hand-painted floral motives with variations of kimono and judo garment. Also, she slightly leaned towards Japanese designers from the '70s - Kansai Yamamoto and Kenzo, whose influence can be seen in the shape of the garment.

5. CONCLUSION

From the simple undergarment, kosode, over a range of colours and patterns used in accordance with the period in which kimonos were made, as well as extending the length of kimono sleeves, the evolution came to an entire dressing tradition. The season, country sovereign, period and class of origin, the occasion for which kimono is intended, are all factors influencing the choice of colours, patterns, and length of kimono, in order to highlight and transfer kimono wearer's idea to the beholder. Colour, embroidery, patterns spread over the surface of the fabric, are more important than the wearer's figure. Traditional kimonos are hand-made, as well as the fabrics from which they are created. The decoration is done in various techniques, like *Yuyen* dyeing technique, applied directly to the fabric. Today, kimonos are rather made of cotton, cotton satin, polyester and other synthetic fabrics and therefore more affordable massively. Nevertheless, silk is still considered the best fabric for kimono.

Traditional knowledge transferred for generations and at one time completely deserted and almost excluded due to the concurrent situation in the world, finally returned to contemporary world, although shyly. This occurred as the result of the wish to revive the centuries-old tradition, and gave the kimono as National treasure of the Land of the Rising Sun. The expression of elegance, harmony, sometimes lifelike pictures, motifs and patterns, marked the centuries, times and occasions in and for which they were created.

Today, this piece of clothing is still present in the newest fashion trends by the world's best-known creators. The newest trends for spring/summer 2013 collections were oriental prints, which can be seen in collections by Etro, Emilio Pucci and Prada. Japanese influence on Prada's collection is reflected in rigorous, yet feminine subtleness and fabrics overlapping. Moreover, evening elegant jackets reveal the shoulders in the style of artist kimono draping, with the lengths of fabric manipulated in such a way that they look like obi, even though they are actually extremely short skirts. Just like Miuccia Prada, Veronica Etro turned to Japan as the source of inspiration for spring/summer 2013 fashion collection. Her main inspirations were hand-painted floral motifs with variations of kimono and judo garment. Also, she leaned slightly to Japanese designers from the '70s – Kansai Yamamoto and Kenzo, whose influence can be seen in the shape of the clothes.

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ARCHITECTURE AS INSPIRATION FOR A FASHION COLLECTION

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Abstract: *Inspiration for a fashion collection can be found everywhere. So it is no surprise that, very often, it is found in architecture. In this paper, the connection between architecture and creating a fashion collection is presented and described. Architecture and fashion have much in common. Much like architects, fashion designers create forms, structure, lines and shape. In this paper, the process from inspiration to the development of the complete fashion sketch based on the Chrysler building from New York City is shown and elaborated.*

Keywords: *fashion, architecture, collection, geometry, design*

1. INTRODUCTION

When architecture is the inspiration, the selected structure is deeply analyzed and it's form and details are studied. Generally, it is advisable to focus on a few details of the building: doors, roof, windows, stairs, decoration, color, texture and overall shape. The environment of the building can also be taken into consideration. Made sketches of details act as a guide in deciding which details will be used and which will be discarded when creating the collection. When architecture is the inspiration it is possible to detect very interesting textures, glamorous colors and some designers trademarks, which reflect their origin and represent a concept of their own style.

When a building or a detail of a building is used as inspiration for a fashion collection, a lot of useful ideas can be developed for garment creation. Fashion is considered to be transient and superficial with the use of soft materials while architecture is considered grand, vast in scale and lasting. Despite the obvious differences in size, scope and material, the source for fashion design and architecture is in fact the human body and both spread ideas about space and movement related to the expression of personal, social and cultural identity. A fashion designer should experiment with forms and shapes and at the same time ensure that the design and construction of clothes suit the human body.

2. ARCHITECTURE AS INSPIRATION

Architecture and fashion have a lot in common. Designers and architects create geometric form, structure, design, lines and shapes. One of the most famous fashion designers Coco Chanelonce said: "Fashion is architecture. It is a matter of proportions." Often, the fashion designers were inspired by architecture.

Geometric shapes can be clean and minimalist or bold and mind-blowingly wild. In any case, the key to good-looking clothes with geometric elements is good balance.

Over the past 30 years, fashion designers have considered textiles and clothing as architectural design but also architects have embraced new forms and materials. Technological advancement has revolutionized the design and construction of facilities and techniques such as knitting, folding, draping as a daily supplement the vocabulary of architects.

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. Inspiration for the design of the designer can be found everywhere.

In Image 1 the Taj Mahal is shown. It is the greatest example of Mughal / Persian architecture. It represents the eternal love of Emperor Shah Jahan for his wife Mumtaz Mahal. The structure is deeply rooted in Byzantine history. It is made using the finest white marble, decorated with intricate calligraphy, stone inserts and carved marble design.

The house of Chanel was inspired to create their Byzantine collection inspired by this very building in which prevailing elements are of luxury and richness (Figure 2).

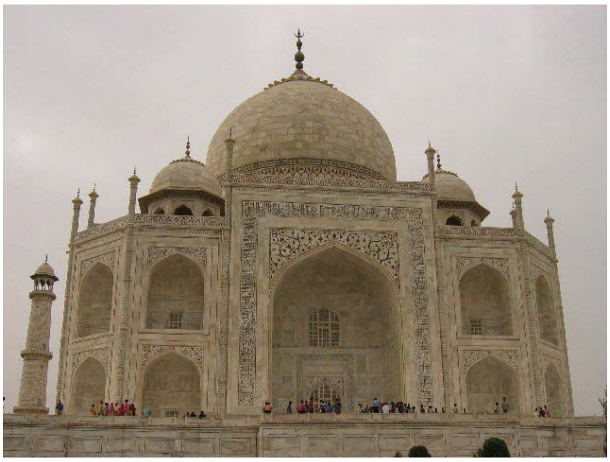

Figure1: Taj Mahal

Figure 2: Chanel creation inspired by Taj Mahal

Figure 3 shows the church of St. Basil's in Russia, which is a unique example colliding colors in architecture, spirals and complexity. The creation of Alexander McQueen causes similar feelings with because his inspiration was this building (Figure 4).

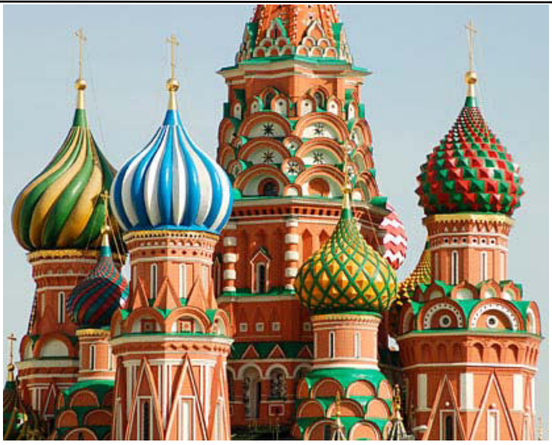

Image3: St. Basil's church in Russia

Figure 4: Lady Gaga in an Alexander McQueen's creationinspired bySt. Basil's church in Russia

Figure 5 shows a building of the architecture Ghery, which can be linked to Alexander McQueen's inspiration for his collection (Figure 6)

Figure 5: Hotel Marques de Riscal u Elciego, Spain

Figure 6: Alexander McQueen's creation

3. INSPIRATION FOR THE COLLECTION

For the inspiration of this fashion collection a very famous building from the USA is used - The Chrysler Building. It is an Art Deco style skyscraper in New York City, located on the east side of Manhattan.

The Art Deco movement is based on geometric patterns and shapes and came to popularity in Paris in the 1920s and 1930s. It was thought to produce a blend that was both modern and elegant. The style itself came from a blend of many art styles such as: Art Nouveau, Neoclassic, and Futurism.

Art deco is an eclectic artistic and design style. Its linear symmetry was a distinct departure from the flowing asymmetrical organic curves of its predecessor style art nouveau; and drew inspiration from ancient Egyptian and Aztec forms. It spans the worlds of architecture, fashion, interior, graphic and even product design by combining traditional craft motifs with the Machine Age imagery and materials. Rich colors, metallics, bold geometric shapes and a flare for the dramatic characterize the style. The Chrysler Building in New York City is a great example of Art Deco architecture and remains one of the world's most iconic buildings.

Figure 7: The Chrysler Building in Manhattan

The Chrysler Building was designed by architect William Van Alen for a project of Walter P. Chrysler. When the ground breaking occurred on September 19, 1928, there was an intense competition in New York City to build the world's tallest skyscraper.

Van Alen's original design for the skyscraper called for a decorative jewel-like glass crown. It also featured a base in which the showroom windows were tripled in height and topped by 12 stories with glass-wrapped corners, creating an impression that the tower appeared physically and visually light as if floating in mid-air. The height of the skyscraper was also originally designed to be 246 meters (807 ft).However, the design proved to be too advanced and costly for building contractor William H. Reynolds, who disapproved of Van Alen's original plan. The design and lease were then sold to Walter P. Chrysler, who worked with Van Alen and redesigned the skyscraper for additional stories; it was eventually revised to be 282 m (925 ft) tall.As Walter Chrysler was the chairman of the Chrysler Corporation and intended to make the building into Chrysler's headquarters,various architectural details and especially the building's gargoyles were modeled after Chrysler automobile products like the hood ornaments of the Plymouth; they exemplify the machine age in the 1920s.

Figure 8: The workers making the final inspection on the finished models of the Chrisler Plymouth automobile

Figure 9: Gargoyle on the Chrysler building (left) and hood ornament on Chrysler Plymouth automobile from 1920's

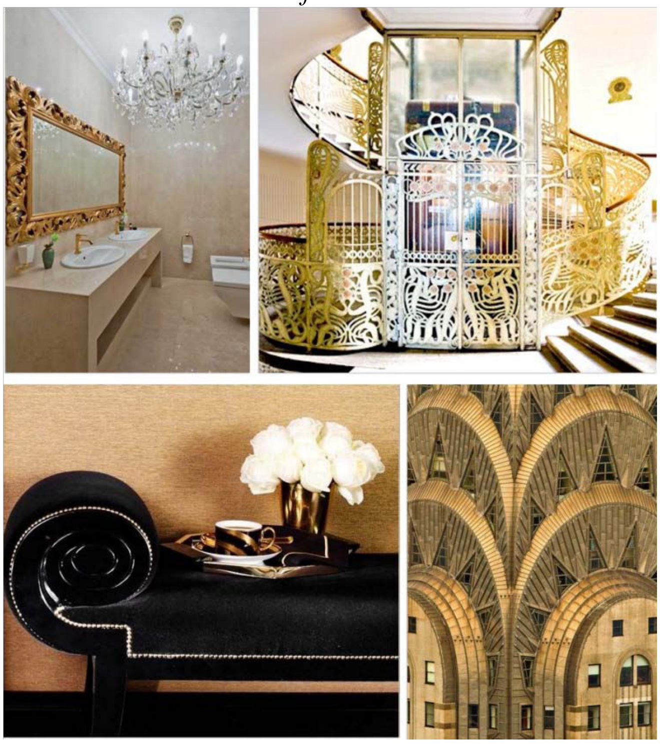

Figure10: Art Deco movement as an inspiration for the design of the Chrysler building

On the figures 9. and 10. the style and detail elements of the Art Deco movement, which were used on the famous Chrysler building, are shown.

4. MODEL DESCRIPTION

Analyzing the inspiration - the Chrysler building and the Art Deco movement in whole, the models that were created are of strong symmetric lines, forming triangle shapes as the lines are crossed. The decorative fabrics have a golden metallic shine and are in combination with softer matt fabrics that are the base of the model.

Model sketches

Model 1.

Model 2.

5. CONCLUSION

In this paper the relationship between architecture and geometry with fashion design is described.

From the work, we can conclude that architecture and fashion are very closely related and that many famous designers were inspired by the architecture. By using the famous Chrysler building from the iconic New York City as the inspiration, whose form and structure greatly contributed to the inspiration for a fashion collection, the collection was resulted in high glamour. The gowns from the collection, presented in the paper are for special occasions, which require special glamorous accessories. On both models metallic gold colors and geometric shapes dominateas they do on the inspiration as well.

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ROBOTIC HANDLING OF MATERIALS IN THE SEWING PROCESS

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***Abstract**: Handling of flexible materials is one of the biggest problems in the field of mechanic manipulators. Flexible materials are especially problematic because of the unpredictable mechanic behavior, deformations and expanding. Automation of the sewing systems is slowed by the fact that sewing is a sensitive operation dependent on materials which stretch and change shape under forces. But due to new materials, fast changes in fashion and great demand, it is extremely important to improve the clothes making system. This essay focuses on process of guiding the fabric through sewing machine by the automated robots.*

Key words: *robotic fabric handling, fabric manipulation in sewing process, autonomous robotic sewing*

1. INTRODUCTION

Flexibility and bending of fabric during its handling is the main reason for which the textile industry is behind other industries in automation. The problem is also in variety of fabrics and their characteristics. Current automated systems are specialized and can't be reprogrammed or changed and they also demand human intervention while changing sizes or types of fabrics. In the process of sewing, two robotic tasks require special control: fabric manipulation and control of fabric tension.

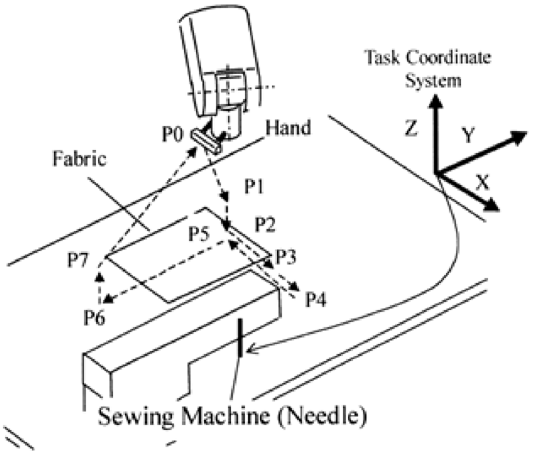


Figure 1. Robot trajectory in sewing process

Method of manipulating various fabric shapes is implemented relying on visual information. By defining the position of fabric edges through coordinates, the paths of robot movements are determined. This algorithm is used for polygonal and non-polygonal shapes, and the precision of seam line placement depends on camera resolution. But, this algorithm is based on geometric calculations, which have to be done manually for each fabric shape. Also this algorithm is made without considering fabric shearing and wrinkling during handling.

2. METHODS AND SYSTEMS

First advanced robotic sewing system studied by Gershon and Porat (1986;1988) is the FIGARO system, with developed integrated robotic sewing system. Components integrated in this system are: robotic manipulator with effector with two fingers, sewing machine, two miniature cameras placed on the machine and the force sensor placed on one of the fingers. Additionally , the controls of fabric

tension are calculated and set for each new fabric by the system of attempts and mistakes. This tension control provided a good seam quality.
Later, the separation of robotic sewing to several parallel tasks was considered (Gershon, 1990). Robotic arm is guiding the fabric to the desired position and controlling fabric tension during sewing. The sewing process consists of four simultaneous tasks. The control system is modeled as multiple spring – mass systems. The sewing process is divided into sewing of straight seams and seams that follow the edge contours. This complete system proved to be feasible.

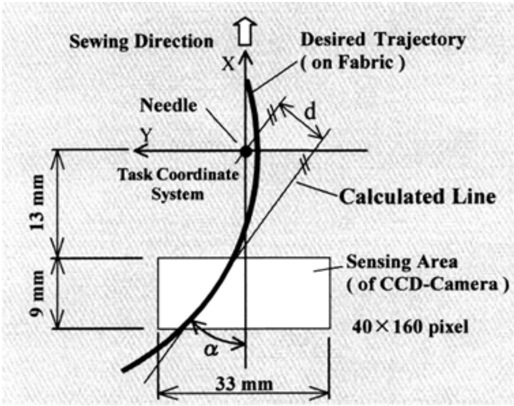


Figure 2. Visual control using camera

After the FIGARO system, the automated system has been developed, and it coordinated two robots which manipulated the fabric. Aside from coordinating the movements of robot arms, the fabric tension control and synchronization with the sewing machine speed have also been considered. A camera is set on the sewing machine to visually control the seam path. Experiments have been made for straight seams by using the pressure control, control of fabric tension and control of fabric placement manipulation. Experiments have been expanded to curved seams by using the controlled position / controlled forces. Efficacy of this system has been proved by further experiments with various sewing speeds, contours of the layers, layer counts and fabric types.

In the sewing process, the material has to be tight and without wrinkles. The seam quality depends a lot on tension variations that happen during sewing. These unwanted tension variations affect the product quality. Difficulties appear on spots where the material stretches more. Gershon justified the need of information feedback during controlling of forces and pointed out that the conventional methods are not adequate because of the non-linear behavior of fabrics. This highlights the need to develop more sophisticated, sensitive and intelligent methods of control.

Stelios (1996) described intelligent behavior as feeling, learning, processing and adapting to characteristics of the object handled by man, without previous knowledge of that object. In order to apply this to robotic handling, control systems should be designed, based on neural networks. Neural networks can work without previous knowledge of the controlled system, and their ability to learn from examples and adapt and modify resembles human behavior.

In the present, a robotic system is being developed for handling of flexible materials placed on the work table. The focus is on handling of flexible materials that are randomly placed and oriented on the table, and guiding them to the sewing needle and through the seam line, as well as tension control in order to achieve a constant high level of seam quality. Strategies for handling of different shapes of fabrics have been developed (convex, non – convex , with straight or curved edges). A fuzzy robotic controller has been made for guiding the fabric to the sewing needle, where rules for the fuzzy system have been taken from observing and studying of the ways in which people sew. The goal is to design a strong controller, which would determine robot's movements autonomously, regardless of fabric shapes and without the necessity for special geometric calculations. Neuro-controller would regulate the mobility of the robot and effectors in the sewing process, and the decision system based on fuzzy logic would determine the necessary force for fabric tension.

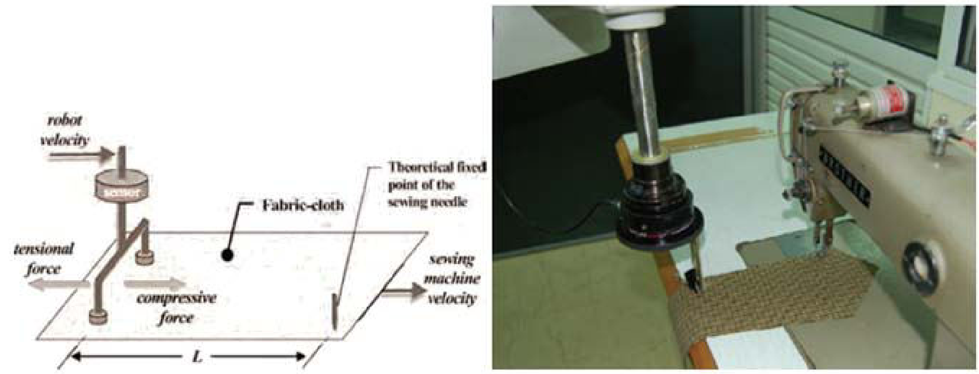


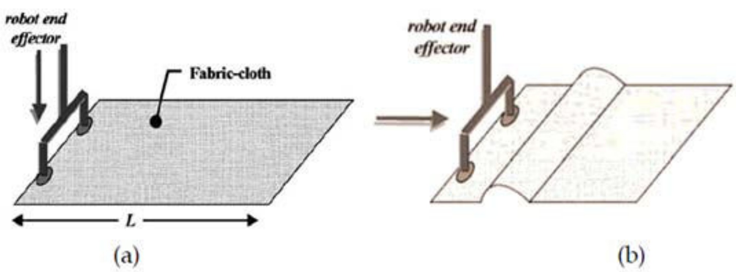
Figure 3. The concept of robotized sewing

3. PROBLEMS OF ROBOTIC SEWING

On figure 1 an experimental setup of the sewing process is shown. Machine feeds the material in its own speed, while the final effector of the robot follows it in its own speed, manipulating and tightening the fabric at the same time. Rubbery ends of the gripper slightly press the material on the sewing table. The force sensor placed on the robot's effector measures the tension force when the space between two active points is bigger than the length of fabric, or measures the compressing force when this space is lower than the length of fabric. The first situation happens when the sewing speed is bigger than the robot and effector speed, so the material stretches, and the second situation happens when the robot speed is greater than sewing machine speed so the material compresses. In order to avoid gathered seams, there has to e a constant tension force.

Characteristics and properties of the materials have to be considered in automated robotic sewing systems. These parameters determine the tension force, and the variations of this force affect the seam quality. For this reason materials have to be divided into categories (knits, wowens) depending on their physical properties. Another important factor is the fabric shape, which can be convex, non-convex, with straight or curved lines.

It can be said that the automatized sewing system demands setting of different fabric categories, and also of the preliminary scheme of the optimal path which the robot will follow in order to produce wanted seams. The aim of the robot controller is to guide the robot in order to apply a constant tension force while the effector manipulates the fabric in the sewing process.



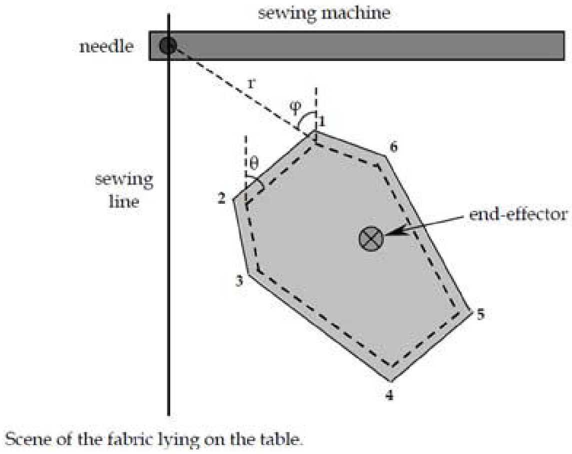
The buckling of fabric when L is larger than the critical length.

Figure 4.

4. ROBOTIC SEWING SETUP

Tasks for setting up materials are: layer separating, placing materials on the work table, manipulating towards the sewing needle and tension control during sewing.
After placing the fabric on the sewing table, there are various tasks to be done before beginning sewing.

- Fabric shape recognition. The camera records a flat peace of material on the work table, in order to identify the fabric shape and position.
- Sewing edges. There are two main groups of seams: seams that put the garment parts together and decorative seams. But on some garment parts both of these seams are needed, for example on pockets. Information on these seams is obtained from CAD software used to design and draw the garment.
- Sewing process planning. The best sewing sequence is determined before starting sewing, in order to lower the sewing cycle time. Optimal sequence is found by using genetic algorithms and this is the next step after determining the seam lines.
- Placing of seam lines. Sewing will be conducted based on seam lines that are inside of edges of fabric parts. Since fabric edges are generated from the camera image, seam lines are placed a couple of millimeters inside of the outer edge of fabric. In case of straight lines, sewing line is found by offsetting the outer lines inwards. This way the seam line is parallel to the outer fabric edge, and this offset distance is determined and differs for different garment parts. The process for curved lines is similar to this one because curves are determined by polygons.
- Start position of the effector. Material is placed randomly on the table, and the effector has to move in order to grip it and guide it towards the sewing machine. The problem has been studied on determining the critical gather length between the front edge and effector location, in order to avoid the gathering of the material.



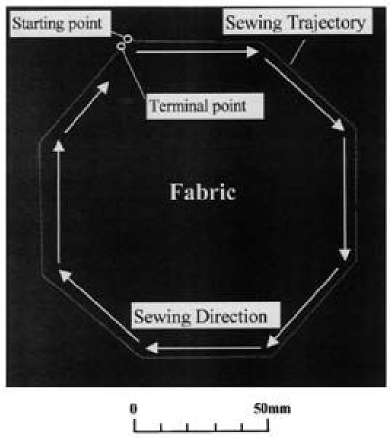


Figure 6. Rotating around the needle in synchronized sewing

After conducting these tasks, the sewing process can begin. In the process of sewing, two tasks are analyzed and adequate algorithms are developed for robot control in order to manipulate materials and regulate the tension force.

5. FABRIC MANIPULATION

The proposed system is a combination of the control system based on images and positions. Analysis based on images is used for determining the fabric shape. After recording an image of the fabric, main characteristics (key points of curves and straight lines), needle position and sewing line orientation are derived from it. The needle position is also set up in the robot's coordinate system. The effector position on the material is random but limited by specific parameters. This position is unknown in the image coordinate system but the robotic system gives the information on the current position of the robot in the coordinate system, and the effector is directed to the main robot system.

For manipulating the material towards the needle, estimations based on image is used, because both distance and movement orientation are known in the image coordinate system. For rotation of fabric around the needle, the rotating angle is calculated in the image coordinate system, but for effector rotation around the needle, the position of the needle in relation to the robot basis is used.

5.1. Sewing of straight lines

Robotic sewing is not a simple task, due to creasing, wrinkling, bending and unpredictable behavior of fabrics - the gravity can completely change the shape of fabrics. Therefor the fabric has to be placed on sewing table in order to maintain its shape , but even this way it is still possible to wrinkle it during robotic handling.

The sewing process consists of three tasks:

- Manipulation towards the sewing needle. Manipulation is done by translating and orienting the effector that guides the fabric. Sewing line is determined. On figure 3. The robot will guide the sleeve towards the machine. The distance (r) between current position of seam line beginning and needle is calculated as well as the angle (θ) between sewing line direction and current direction of the first seam line. Data on linear and angular speed of the effector is obtained from the data on mistakes in positioning and orienting of fabric.
  The new position and orientation of the effector are calculated through linear and angular speed, time step and angle φ which is calculated based on image. Material is transfered to a new position as a consequence of effector movement, which is attached to the fabric so it doesn't slip.
- Sewing process. The edge of seam line on the fabric that matches the sewing line is ready to be sewn through. During sewing, the material moves on the sewing line with a speed that should match the speed of the sewing machine, in order to obtain a good quality seam. The errors are monitored with a visual system and imported to the robot controller in order to correct the fabric orientation.
- Rotation around the sewing needle. After sewing one edge, the material rotates around the needle until the next seam line coincides with the sewing line. Orientation errors are calculated and transfered to the fuzzy system which controls rotations of fabric around the needle, and this determines the effector angular speed.

5.2. Sewing of curves

There is a great need of creating a way of sewing materials of various shapes, because so far, the industrial robots have only managed to make circular or straight line movements. This problem can be surpassed by translating curves to multiple straight lines.

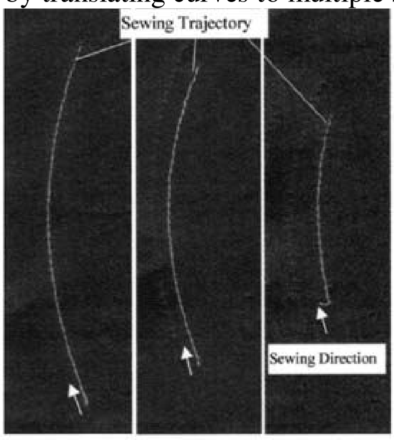


Figure 7. Sewing of curves

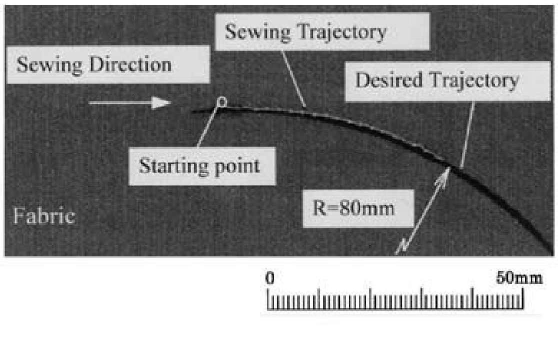


Figure 8. Sewing on the curved line drawn on the fabr with the help of visual servo

In one of the methods, the camera records an image of the fabric with curved edge. After this, the key points of the curve are determined using certain algorithms, with two criteria. First is referring to curve length and second is reffering to relation of perpendicular distance between the point and curve section, and the length of curve section. After this the key points are connected with straight line.

Condition for using this method is that the deviation between the real and desired seam line should be less than maximal tollerated deviation.
Since the outer curve edge is determined by the polyghon parts, the problem of robotized sewing of the curved edges is reduced to a problem of sewing straight fabric edges.

5.3 Control system for manipulating fabrics based on fuzzy logic

This system has been developed in order to surpass the inabilities of robots handling the fabrics in real time and to make a more flexible system of guiding the fabric towards the needle. The fuzzy controller is also very robust and fast. This controller outputs the data on linear and angular speed of the robot effector. After the camera records an image, the fabric axes are determined. After this, the current position r of the chosen axes is calculated and also the orientation θ of the fabric edge, and the needle postion rd and sewing line orientation θd are known from the beginning. Controllor inputs the data on errors, and the fuzzy controller outputs the linear and angular speed, and the effectors moves to the new position.

The advantage of this kind of controller is that the analytical robot and fabric models, or special calculations for every fabric shape are not necessary. Additionaly, the knowledge on system behavior is imported to the controller, so the system reacts on any position, orientation or errors, regardless of fabric properties. Finally , this controller can manipulate the fabric regardless of its shape or type and independent from the position and orientation of the effector on the fabric. Because of this , this controller is considered to be very flexible and robust.

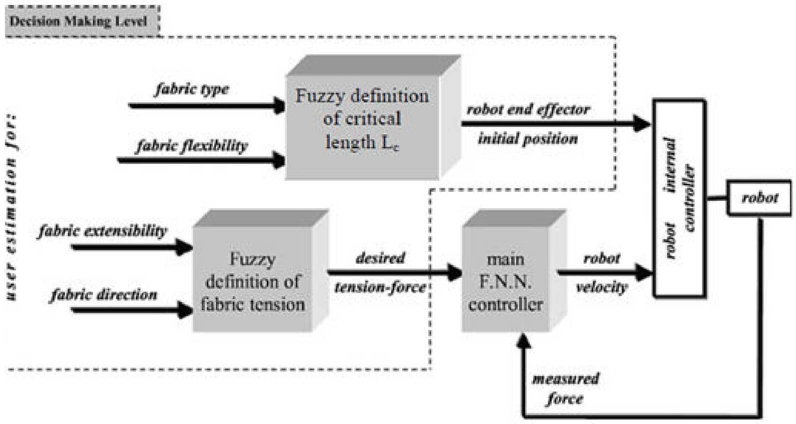


Figure 8. Decision making mechanism based on fuzzy logic

6. TENSION CONTROL

Figure 5 shows hierarchical structure of intelligent control scheme for tension forces regulation. The system communicates with the controller of the commercial robot by sending commands that set the speed of robot effector. On the higher level called “Decision making level” , decisions are being made about the system initiation. Two decision mechanisms are built into this level, based on fuzzy logic, where the knowledge of fabric properties is being processed. First part of this level called the “Fuzzy definition of the length L” is responsible for determining the starting position of the effector on the fabric.

Second part called the “Fuzzy definition of fabric tension” determines desired tension force that should be applied to fabric. On the lower level the main controller outputs the data on effector speed in the sewing process, regulating the fabric tension.

6.1. Determining desired tension force

Desired tension of the fabric in order to obtain a high quality seam is imported into the main controller as input data. So, specific force values must be determined for each fabric type being sewn. Since the goal is to create a flexible system, the intelligent estimator of tension has been developed.
When an engineer collects the knowledge from sewing experts, language descriptions for fabric types, tension force and hand position while sewing are used. For the fabrics the descriptions such as soft, rigid or stretchy are used. For describing applied tension forces, terms such as low force or very low force are used.
This language form is followed in determining the desired tension force whilst inputting data into the main controller. A large number of experienced seamstresses/sewers has been interviewed and their ways of working have been examined. The aim was to collect data on the ways of handling the fabric during sewing.
According to the sewers experience, the fabric is pulled during sewing in order to stay stretched, which means that stretching force has to be applied on fabrics and it depends on :

- Fabric stretch ability. Experts describe fabric stretch with language terms such as: very stretchy, very little stretch, stable, etc.
- The direction of seam line on the fabric

For fabric stretch, different stretch force applied on different materials is described with this rule:
" The more the fabric stretches, the higher the tension force"
According to experts this force is described in following language terms: high force, very high, low force, very low force, etc.
Since fabrics stretch more in one of the directions, in this direction higher tension force must be applied. Highest tension force is used when sewing under 45 degrees angle towards the yarn direction.
The experts are not able to give correct data on tension forces that are used for each fabric, but despite of this, they manage to produce high quality seams by using language terms for describing tension forces, and those same terms are used in educating young sewers.
The conclusion is that the decision on determining the tension force applied to the material is based on fuzzy logic. That is why fuzzy logic is being used. According to the collected knowledge, two input parameters are being determined - "stretch" and "direction", and one output parameter - "tension force".

7. CONCLUSION

In this essay , the robotic system of fabric handling in sewing process is described. In order to produce a high quality seam and to guide the fabric towards the sewing machine needle, a visual servo manipulator based on the fuzzy logic system has been designed. Various experiments prove that this approach is both productive and effective method of guiding the fabric towards the sewing needle, as well as sewing and rotating of fabric around the needle. This controller doesn't demand mathematical calculations, but it's very efficient and strong. It seems that it is possible for robot to sew autonomously , for most fabric types, without human intervention.
But, there are still many problems in robotic garment sewing, because a robot can not find solutions to unpredicted problems of fabric gathering, puckering, stretching and bending as a human expert can. In future experiments, fabric distortion in robotic handling should be implemented as a new element in current algorithms. The final goal is to create a single robotic working unit, by integrating all of developed systems.

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EFFECTS OF DIFFERENT FABRIC STRUCTURES ON THEIR THERMAL PERFORMANCE

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Abstract*: The type and structure of the fabric has a direct impact on the thermal isolation of clothing. Thermal resistance, steam resistance and air permeability are considered key material properties associated with comfort and are heavily dependent on the construction of fabric, the longitudinal yarn weight that is used for making fabric. The aim of this paper is to analyze the relationship between the thermal isolation properties of fabrics and fabric structures. Analyzed are fabrics made of linen, rips, twill and hopsack weaves. The linear mass of all made fabric is a constant 50tex while the weft yarn count ranges from 30-100tex.*

Key words: *heat resistance, fabrics, interlacement, resistance to steam, permeability of air.*

1. INTRODUCTION

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 [2].

The type and structure of the fabric has a direct impact on the thermal insulation of clothing. Thermal resistance, steam and air permeability are considered key material properties associated with comfort. There are other properties that affect the thermal comfort of clothing users, for example. thermal conductivity, diffusivity and absorption. There are also different instruments for measuring the thermal insulation properties of textile materials, such as skin model, Alambeta, Thermo Labo II and Parmetest that is relatively new, and its application has not been hyped [4]. The aim of this paper is to analyze the relationship between the thermal insulation properties of fabrics and fabric structures.

2.CONFORT EVALUATION PARAMETERS

Comfort a person feels when wearing clothes 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 - air conditioning - 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 permitability is better than air permitability, 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.

3. WEAVE FABRIC USED FOR TESTING THERMAL INSULATION PROPERTIES

Plain interlacement represents the tightest intersection of two thread systems. In it, wefts that are odd are raised above one warp. The third weft is the same as the first yawn, the fourth as the second and so on. The interlacement weave report includes two warp and two weft threads. [10].

Twill interlacement is the one in which the binding point of createside rows from left to right - right or Z direction from left to right (left) direction twill S. In a twill bind report, each and every weft and warp thread is bind only once, otherwise it lies above or below the other system. By the system, which is predominantly on the upper side of the fabric, we destinguish the warp and weef. [10].
Hopsack interlacement is characterized by porous fabric with a square appearance, in which there are more warp and weft threads tied together. Fabrics made from weaves are used mainly for men's shirts, women's dresses and blouses. [10]
Rips interlacement is characterized by conspicuous longitudinal or transverse stripes. According to the difference in bindings, there are three types of weaves: smooth rips that has equal width ribs, mixed rep who has a wide variety of ribs, and a reinforsed rips on the upper side, whilst the back side is more or less smoth [10].

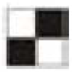
Description of interlacement	Type of interlacement on fabric			
	plain	twill	hopsack	rips
Grafical appearance				
Simbolic appearance	1/1	1/2	2/2	3/3

Image 1.*Schematic representation of the plain, twill, Hopsack and rep weave[11]*

This paper presents the results of measuring fabric with changed structure ranging from their basic structural parameters and thermal isolational properties. Displayed are the 19 varieties of cotton fabrics with different weave and fineness of the weft. The fabrics are produced from the base: the longitudinal mass - 50tex, number of turns 320/dm. All variants of fabrics are dyed and have gone through the same finish. The parameters tested fabrics are shown in Table 1 [4].

Table 1 *Characteristics of fabrics that are used for testing thermal isolation properties*

Br.	Prepletaj tkanina	Podužna masa		Nominalna gustina	
		Osnove, tex	Potke, tex	Osnove, dm^{-1}	Potke, dm^{-1}
1	plain		100		110
2	plain		60		110
3	plain		100		90
4	plain		100		70
5	twill 3/1 S		100		70
6	twill 3/1 S		100		90
7	twill 3/1 S		100		
8	twill 3/1 S		60		
9	twill 3/1 S		50		
10	twill 3/1 S	50	40	320	
11	twill 3/1 S		30		
12	twill 2/2 S		100		
13	twill 2/2 S		60		110
14	rips 1/1 (0,1,0)		100		
15	rips 1/1 (0,1,0)		60		
16	rips 2/2 (2)		100		
17	rips 2/2 (2)		60		
18	hopsack 2/2 (0,2,0)		100		
19	hopsack 2/2 (0,2,0)		60		

4. THE TEST RESULTS OF DIFFERENT WOVEN FABRIC DESIGN

Measurements of thermal isolation properties of the material were obtained using ALAMBETA devices. A statistical analysis was given by using software STATISTICA version 7. The analysis is based on individual measurements of individual samples. Obtained results of the structure of materials are presented in Table 2.

***Tebela 2**. Obtained results of the fabric structure*

number of fabric	actual density of weave dm^{-1}	actual density of weft dm^{-1}	contribution of weave	contribution of weft	surface mass, gm^2	thickness offabric, mm
1	312	115	14,2	2,9	292	0,67
2	316	117	8,8	3,7	240	0,61
3	314	94	9,6	2,7	269	0,69
4	314	73	7,0	2,4	242	0,71
5	315	74	4,7	2,8	241	0,80
6	318	94	6,2	2,9	266	0,79
7	317	116	7,9	3,3	292	0,78
8	317	117	5,5	3,8	238	0,70
9	317	116	5,0	3,6	225	0,67
10	320	118	4,5	3,2	215	0,65
11	318	118	4,1	4,3	198	0,61
12	319	116	7,0	2,7	287	0,79
13	319	118	5,9	3,9	238	0,73
14	311	115	7,3	1,2	284	0,83
15	317	118	6,1	2,4	237	0,74
16	317	119	9,8	3,9	293	0,65
17	320	118	6,8	5,4	242	0,58
18	316	117	6,4	2,3	287	0,79
19	316	117	5,3	3,2	234	0,72

The results of measurements of the thermal isolation properties of the investigated materials are given in Table 3 [4].

***Tabela 3.** Rezultati merenja osobina toplotne izolacije tkanina*

number of fabric	Averageheat		
	conductivity $\lambda, Wm^{-1}K^{-1}10^{-3}$	absorption b, $Wm^{-2}s^{1/2}K^{-1}$	resistance R, $W^{-1}Km^2 10^{-3}$
1	72,9	287	9,4
2	69,6	268	8,5
3	71,5	264	9,8
4	65,9	227	11,4
5	60,6	210	13,9
6	65,2	228	12,7
7	68,5	241	12,1
8	68,0	243	10,9
9	64,3	227	11,0
10	61,7	213	11,1
11	59,7	220	10,5
12	68,9	236	12,2
13	65,4	222	11,7
14	65,9	224	13,6
15	62,6	223	12,5
16	69,8	279	9,6
17	66,6	273	8,9
18	66,3	243	12,9
19	60,4	215	12,7

5. THE INFLUENCE OF STRUCTURAL FABRIC AND WEFT YARN COUNT ON THE PROPERTIES OF THERMAL ISOLATION MATERIALS

Influence of fabric weave and weft yarn longitudinal mass on the properties of thermal isolation materials were evaluated based on the results of 12 varieties of fabric with weft density of 110 dm-1, made of yarn 60 tex, and tex-100 and produced in 6 variants with different weave fabric. Material variants analyzed in this section are presented in Table 4 [4].
Tables 5,7 and 8 are the results of ANOVA generated in STATISTICA software. In the tables, the symbol df represents degrees of freedom. [4].

Table 4. *Group material variants analyzed from the point of construction on the thermal isolation properties of fabrics*

number of fabric	construction offabric	finness ofweave, tex	Prosečna toplotna		
			conductivity λ, W $m^{-1} K^{-1} 10^{-3}$	absorption b, $Wm^{-2} s^{1/2} K^{-1}$	resistance R, $W^{-1} Km^2 10^{-3}$
1	plain	100	72,9	287	9,4
2		60	69,6	268	8,5
7	twill 3/1 S	100	68,5	241	12,1
8		60	68,0	243	10,9
12	twill 2/2 S	100	68,9	236	12,2
13		60	65,4	222	11,7
14	rips 1/1 (0,1,0)	100	65,9	224	13,6
15		60	32,6	223	12,5
16	rips 2/2 (2)	100	69,8	279	9,6
17		60	66,6	273	8,9
18	hopsack 2/2 (0,2,0)	100	66,3	243	12,9
19		60	60,4	215	12,7

Table 5 presents the results of the ANOVA tool for thermal conductivity.

Table 5 *ANOVA results for the thermal conductivity of the material*

	SS	df	MS	F	p
constant	***0.161990***	***1***	***0.161990***	***153481.0***	***0.000000***
weave	***0.000254***	***5***	***0.000051***	***48.1***	***0.000000***
weft	***0.000099***	***1***	***0.000099***	***93.4***	***0.000000***
weave×weft	***0.000023***	***5***	***0.000005***	***4.3***	***0.006257***
error	0.000025	24	0.000001		

Based on these results it was concluded that both factors: fabric structures and masses per unit length of the weft yarns significantly affect the thermal conductivity of the fabric. The largest thermal conductivity was observed in the flat fabric. The second highest thermal conductivity was observed in rep 2/2 (2) and twill 3/1 with fabric structures (Figure 1). [4]

Straight and rips fabric 2/2 (2) are characterized by the highest specific mass (Figure 2), which means that the unit volume containe the largest amount of fibrous material, which takes place thermal conductivity. This proves that rips and the flat fabric have the highest thermal conductivity. Twill 3/1 S materials are characterized by a loose structure, with large amounts of air in them. Results of thermal conductivity were checked using another device - Thermo Labo II. Measurements by Thermo Labo II confirm high thermal conductivity twill 3/1 S, which is comparable to the rep 2/2 (2) fabric structures. It is very possible that the reason for such a high thermal conductivity twill 3/1 with fabric construction is the interaction between various structural factors of the same [4].

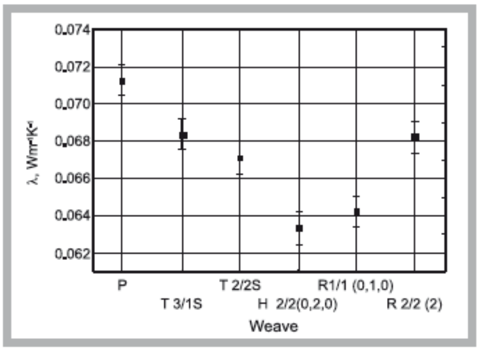


Figure 1. Influence of weave on the thermal conductivity of woven fabrics.

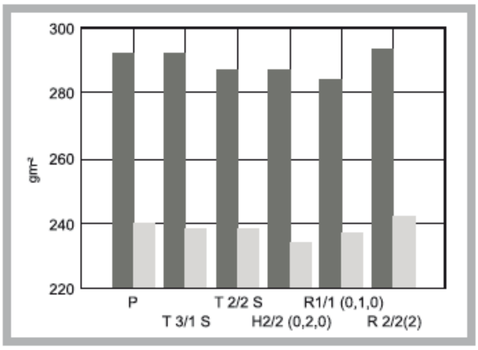


Figure 2. Specific mass of the fabrics investigated in the function of the weave: ■ - weft yarn 100 tex, ■ - weft yarn 60 tex.

The minimum thermal conductivity occurs near Hopsack 2/2 (0,2,0) and rep 1/1 (0,1,0). As can be seen in Figure 3, hopsack 2/2 (0,2,0) and rips 1/1 (0,1,0) fabrics have the lowest specific mass. The presented results show that the thermal conductivity of fabric made from the same material (fiber) depend on the specific weight of the fabric [4].

A direct mass weft yarn also affects the thermal conductivity of the fabric. Fabrics made from yarn for weft fineness 100tex are characterized by higher thermal conductivity than those that are made of weft yarn fineness 60tex. Changes in the thermal conductivity of materials due to changes in the longitudinal mass of the weft yarn depend on weave fabric. Disparities in the percentage of thermal conductivity materials with different weaves due to changes in the longitudinal mass of the weft yarns are presented in Table 6

The smallest changes in thermal conductivity of the material due to the change in the longitudinal mass of the weft yarns are observed in twill 3/1 S, which can be considered as a lack of change. For other fabric structures, changes in the thermal conductivity due to the change of the longitudinal mass weft are in the range of 4.74% to 9.77% [4].

***Table 6** Percentage change in the properties of thermal insulation materials due to changes in the longitudinal mass of the weft yarn*

Fabric weave	Δλ, %	Δb, %	ΔR, %
Plain	4.74	7.09	10.59
Twill 3/1S	0.74	-0.82	11.01
Twill 2/2 S	5.35	6.31	4.27
Rep 1/1 (0,1,0)	5.27	0.45	8.80
Rep 2/2 (2)	4.80	2.20	7.87
Hopsack 2/2 (0,2,0)	9.77	13.02	1.57

The results confirme that there was a statistically significant interaction between the main factors: the structure and fabric of the longitudinal mass weft. Fabric structures change the ratio between the thermal conductivity of materials and the longitudinal mass weft yarns [4].

Heat absorption is a feature that characterizes the fabric from the point of hot - cold feeling at the moment of contact with human skin. The greater the capacity to absorb heat the colder feeling is. The statistical analysis (Table 7) is to be proved that heat absorption is caused by construction materials and fabric weft yarn longitudinal mass, in addition to the impact of structural factors on both heat absorbing material statistically significant at the 0.05 level of probability [4].

***Table 7** Anova results of heat absorption fabric*

	SS	df	MS	F	p
constant	***2182169***	***1***	***2182169***	***15946.25***	***0.000000***
weave	***17654***	***5***	***3531***	***25.80***	***0.000000***
weft	***1023***	***1***	***1023***	***7.48***	***0.011565***
weave*weft	1010	5	202	1.48	0.234204
error	3284	24	137		

The largest thermal absorption and, at the same time, the coolest feeling in the moment of contact of human skin and the fabric was found in flat and rips 2/2 (2) fabric structures. The warmest feeling gave rep 1/1 (0,1,0), hopsack 2/2 (0,2,0) and twill 2/2 weave fabric that is difficult to explain. It is interesting that the lowest absorption and the warmest feeling occurs in the same material that is characterized by an even number (2) of warp and weft overlapping during repetitions [4].
The largest percentage difference in heat absorption caused by the difference in construction material was recorded between flat and rips 1/1 (0,1,0) material. Plain fabrics made of weft yarns fineness 100tex's (option 1) are 28% higher heat absorption from rep 1/1 (0,1,0) made of the same weft yarns (version 14) [4].

The heat absorption material also depends on the mass of the longitudinal weft. Fabrics made from yarn fineness of 100 tex weft is characterized by higher thermal absorption than those that are made of weft yarn fineness 60texa. The largest percentage change in heat absorption caused by changes in the longitudinal mass of the weft yarn is detected in hopsack 2/2 (0,2,0) Material - 13:02% (Table 6) [4].
According to the above results, screen and rips 2/2 (2) are better for summer clothes made of other materials that have been analyzed because they give cold feeling. Rips 1/1 (0,1,0), twill 2/2 S and hopsack 2/2 (0,2,0) fabrics are better for winter clothes because they give a warmer feeling than linen, rips 2/2 (2) and twill 3/1 with the fabric [4].

Based on the results of thermal absorption, studied materials cannot be assessed from the point of view of their better or worse quality. Fabrics can be ranked according to their hot or cold feeling in the moment of contact with the skin.

Fabric structures and masses per unit length of the weft yarns significantly affect the thermal resistance of the material. Moreover, there is a statistically significant interaction between the two independent factors (Table 8).

***Table 8** Anova results of thermal resistance of fabrics*

	SS	Df	MS	F	p
constant	***0.004560***	***1***	***0.004560***	***112341.3***	***0.000000***
weave	***0.000093***	***5***	***0.000019***	***456.2***	***0.000000***
weft	***0.000005***	***1***	***0.000005***	***128.8***	***0.000000***
weave*weft	***0.000001***	***5***	***0.000000***	***4.7***	***0.004104***
error	0.000001	24	0.000000		

The largest thermal resistance is observed with rips 1/1 (0,1,0) and hopsack 2/2 (0,2,0) structural fabric, and is available in flat and rips 2/2 (2) fabric (figure). In the case of fabrics that are made from the same material (fiber) thermal resistance depends not only on the material thickness but also on direct proportional thickness. Tested fabrics are characterized by different thicknesses depending on the fabric and construction of longitudinal weight weft yarn (Figure 6). The results confirm, the above connection between thermal resistance and thickness of material [4].

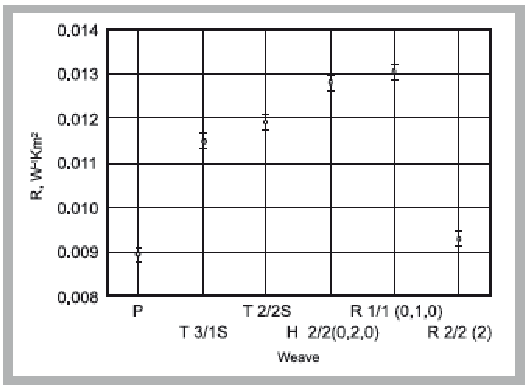


Figure 5. *Influence of weave on the thermal resistance of woven fabrics.*

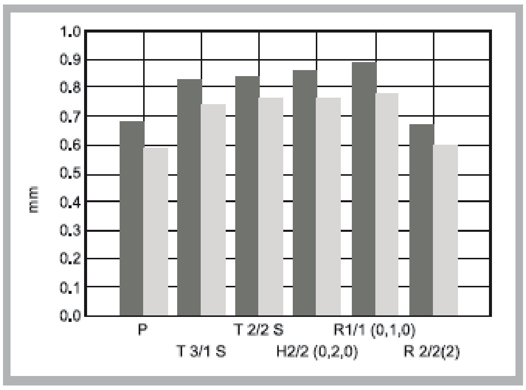


Figure 6. *Fabric thickness in the function of the weave: ■ - weft yarn 100 tex, ■ - weft yarn 60 tex.*

The largest percentage difference in thermal resistance caused by change of weave fabric was observed between plain and hopsack 2/2 (0,2,0) weave. Hopsack 2/2 (0,2,0) materials made of yarn fineness of 100 tex for weft (version 18) has a 49.41% increase in thermal resistance of the fabric weave made of the same weft yarn (version 1) [4].

Fabrics made from yarn fineness of 100 tex warp have a higher heat resistance than those with weft yarn 60 tex, which arises from the difference in the thickness of the fabric caused by varying the longitudinal mass of weft yarns (Figure 7). [4]

In contrast to the change in thermal conductivity and absorption, the percentage change in thermal resistance due to changes in the longitudinal mass weft of hopsack 2/2 (0,2,0) fabric is the smallest compared with other materials. The largest percentage difference in thermal resistance caused by the change of the longitudinal mass of the weft yarn occurs in twill 3/1 S with linen weave, 11:01% and 10:59%, respectively [4].

The results show that it is possible to shape the thermal isolation properties of woven fabric density by changing their structure, longitudinal mass density of fibers or yarns. By changing the fabric construction and leaving the other parameters (such as the type of yarn or yarn density) also allows a significant change in the thermal insulation properties of woven materials - up to 50% (the above-mentioned difference in thermal resistance between versions 18 and 1).

6. CONCLUSION

Based on our research, we may draw the conclusion that the impacts of weaves woven materials affect their thermal isolation properties. The influence of the thermal insulation properties of fabric material is observed to be significant from the practical and statistical point of view. It may be noted that the plain weave fabric with higher thermal conductivity and heat capacity of absorption of twill 3/1 S, twill 2/2 S, rep 2/2 (2), rep 1/1 (0,1,0) and Hopsack 2/2 (0,2,0) weave material with identical lateral masses of weft and warp yarns and with identical nominal masses [4].

Woven fabric weave is characterized by low thermal resistance than twill 3/1 S, twill 2/2 S, rips 2/2 (2), rep 1/1 (0,1,0) and hopsack 2/2 (0.2, 0) interlacement with the same lateral masses of warp and weft yarns and the same nominal mass of warp and weft. Direct mass weft yarn affects the thermal insulation properties of fabrics. The influence of the longitudinal mass weft yarn to the thermal conductivity, absorption and resistance is statistically significant at the 0.05 level of probability.

The effects of the longitudinal mass of the weft yarn modify the influence of fabric structure on the thermal insulation properties of fabric. Strong and statistically significant correlation was found between the thickness of the fabric and its heat resistance, as well as between weight per square meter of fabric and its thermal conductivity. Also, a strong and significant correlation exists between the thermal insulation properties of fabrics and its stukturalnih parameters [4].

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LACE - DEVELOPMENT FROM THE RENAISSANCE TO THE PRESENT DAY

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Abstract:*Lace historically occurs as a fashion accessory and clothing, as well as objects of daily use. Lace is airy mesh fabric made from cotton, linen, silk, sisal, gold or silver threads. It is made by hand techniques of knitting, crochet, tying, stitching or weaving, as well as the machine made. At the same time it is luxurious and sensual, conservative and elegant, a unique blend of craft and art. Lace, since its beginning to the present day, had a great impact on fashion. The author of this article examines the history of lace from its beginning to the present day, and special attention will turn to the analysis of lace from the time of it's flourishing, and the impact that lace has on today's fashion and decoration.*

Keywords*: lace, historical development, Renaissance, Baroque, fashion.*

1. INTRODUCTION

Lace was created in ancient civilizations, mainly in ancient Egypt, but it spread throughout the world since the Renaissance to the present time and reached its rebirth again as an ultra elegant detail. Lace is the name for a breathable, cavitated fabric that is hand or machine made, made from cotton, silk, linen or wool. Lace is made by knitting, crocheting, binding, sewing or weaving, with the use of needles (needles or crochet picks). Technique of making lace evolved from the old technique of making fishing nets. Although the lace-like artifacts can still be found in ancient Egyptian tombs, the beginning of lace or lacing traditionally is said to have started in the 15th century, in Flanders and Italy during the Renaissance. Since then it began to spread across Europe as part of the upper class clothing, ie. as an elite or a luxury garment.

Lace has become particularly popular during the Baroque and Rococo, with time, many countries have developed their own traditions and patterns of lace. Baroque and Rococo derived in part from the Moorish art [18]and Ottoman art[19], where the art of fitting geometric motifs was highly developed.

The appearance of lace coincided with the emergence of fashion as a modern phenomenon, that is, from 14 century and the advent of the Renaissance, which marked a break with the Middle Ages, a time determined by 14 century Italy to 16th century in Europe [20] and the rest of humanity, who announced the emergence and dominance of individuality and insistence on personal style. Thanks to the splendid art of the European courts and of Rome citizen art was born, facing the realities of everyday life, which in Venice and Flanders won the first center of its development. Later, Baroque [21]moved on individuality and made innovations in fashion. Baroque lasted between 1600s. and 1750th

[18] Spanish and Portuguese conquest of the sea kingdom in Iberia, when the Catholic culture came into contact with Islamic art.
[19] The Ottoman conquest of Europe adopted the Islamic Arts near Vienna and Venice, centers of art and culture of the time.

[20] Italy is a country where the art of the Renaissance found its highest expression, since it first came to the city development and accumulation of wealth in certain civil families. The second reason is that Italy was the successor of Rome and the Roman spirit, and therefore most receptive to the splendor and joy of life and in some way the Italians "could not wait" to get rid of the rigidity of the early Christianity, which has given rise to the Middle East, averse ornamentation. ()

[21] In Catholic countries at that time the developing of the Catholic Renewal Movement is established (Counter-Reformation). The point was to counter to the conservativeness of the Protestant Church with the Catholic

year, it is a period of spiritual and secular music, literature and art that continues after the Renaissance, later develops to Rococo and Classicism which appear in the second half of the 17th century. From Europe it spread among its colonies, mostly in Latin America.

Thus, as noted above, the lace is created during the Renaissance, developed during the Baroque period, and the author will hereafter present tatting through history to the present day. Baroque was forced as a visual luxury and this is fertile ground for the development of luxurious lace as forms of art and craft.

2. HISTORY OF LACE AND TYPES OF LACE

Lace is an airy honeycombed mesh fabric made from cotton, wool, silk, agave, gold or silver threads. It is made by hand techniques, knitting, crochet, tying, stitching or weaving , and can also be machine made. No tissue can serve as a basis for this fabric. It was created as the end of the fabric, to prevent erosion of the basics. The edges of the fabric are gradually developed in the related fringe or untangle that reinforce edge. The beginning of lace occurs in the age of the Egyptian state formation as an independent creation of independent fabric and is delivered by the end of the fifteenth or early sixteenth century.

The development of the Renaissance lace can be traced through documents or portraits, but has not yet determined whether the primacy of lacework is Italy or Flanders, but, because of the strong interconnections, exchange experiences was made possible. Renaissance bobbin and sewn lace of the sixteenth century, have strict geometric motifs, and they made rigid collars or cuffs on the sleeves.

During the Baroque, the lace abandon the strict symmetry stop being just a finish for other fabric, they become independent and their main motive prevails flower branches. The highest range in Italian lace was reached in the seventeenth century which resulted in the well-being and desire for luxury in the Baroque costumes.

2.1. Bobbin lace

Bobbin lace was made on roller or Portuguese pillows, of which the largest Portuguese pillows were from Viana and Castelo, and they were popularly called almofadas and they have hundreds of bobbins. The pillow has attached on one end of the thread, while on its other end its wound onto a bobbin. On the pillow there a paper draft attached, and the pattern could be repeated indefinitely. The first kind of lace was made in France and it was made of linen, wool, gold and silver threads. In most Slavic nations, the Slavic or Russian is made and that lace consisted of one color or multicolored bobbin. The samples are often stylized, and in our region lace came from the Czech Republic and Slovakia, and Russia is mentioned because there was a school in Moscow.

The basic procedure was to pull threads from fabrics and textile trimming lifted by the resulting cavities. The people of the Far East have been working light tissue that served as scarves and veils quite like lace. In ancient Rome people wore a lace robe similar to a toga which had edges of fabric similar to mesh. In Burano near Venice nets are made similar to alencone lace with festons. This is the name applied for pašku lace. ( ) Earlier form of sewn lace is made in Spain from which this type spread threw out Europe and South America.

2.3. Crocheted lace

Crocheted lace is made with picks, different threads, and previously created bobbin lace and sewn

luxuries, and that style was easily transmittable from art form to the clothing style, the holy buildings and everyday objects. *Picture Lace in the Baroque* from. The character depends on the thickness of crochet needles (picks) and threads. It spread from Ireland through France to the European continent. In our country it is present for 70-80 years. They are floral designs, and are merged or applied to the netting.

2.4. Lace on shuttle

This kind of lace is made up of small circles and semicircles, braided knots, working with one or two weaver's shuttle. The only center of the production is Limerick, Ireland. Also, these laces are very popular in Bulgaria and Serbia. In Sozopol, for example, are sold as souvenirs to tourists. ()

2.5. Mechanical lace

It evolved from the early nineteenth century when the tulle fabric and machine embroidery patterns were perfected, in 1863. and by the end of the nineteenth century the machine embroidery could mimic every technic of lace embroidery. It is a common phenomenon in recent years that a variety of applications of lace are made on various fabric bases, particularly in large scale.

3. TYPICAL AND FAMOUS LACE FROM ARROUND THE WORLD

In the former Yugoslavia, the most famous lace is of Pag Croatia, Slavonia and Bosnia and oje in Macedonia.

There are typical and famous laces from around the world: Pag lace, bobbin lace, Idrija lace, Duchesse lace, Venetian Bobbin Lace, lace and mesh Milanese Point d'Angleterre.

3.1. Pag lace

Pag lace that is made in the Croatian town of Pag (Island Pag), which is characterized by exceptional beauty, samples quality and method of making tradition and craftsmanship. The specificity of lace is that it is considered to be the root of Mycenae and was kept in the town of Pag, from ancient times because the first mention of lace are from 15 century convent Benedikinki. It was the first lace officially presented at the exhibition in 1880. Empress Maria Theresa in Vienna Court held a lace maker that sewed lace for the court. The striking feature of lace is that previously there were no existing templates or blueprints for development but a way of making that was passed on from generation to generation, from mother to daughter through word of mouth and practical work.

There are many types and forms of lace and one way of making is: with a needle on a rigid surface when on the base of a pattern is a sample continued from the center outwards, like a spider web that is characterized by exceptional compressive strength, and at this lacing threads are used that are of the exceptional thinness and strength of lace that give specific transparent and rugged good looks, and this is the way of the original lacing. Pag lace is different from other types of lace in a way that it uses a thin thread and because it is very firm. Smaller lace can be very nice detail on elegant clothes.

3.2. Bobbin Lace

Unlike needle lace that was created using a technique with an embroidery thread, lace bobbin or spool is designed with different threads of weaving techniques. More coil interfere and intertwine with the development of a motive. Braids called "passementeries", have traditionally been made of gold, silver and colored silk. The manufacture of lace developed in the early 16th century, and was produced for inserts and borders. Unlike needle lace that was created using a technique that uses an embroidery thread, lace bobbin or spool is designed with multiple or weaving technique. More coil interfere and intertwined with the development of a motive. Braids called "passementeries", have traditionally been made of gold, silver and colored silk. The manufacture of lace developed in the early 16th century, and was produced for inserts and borders. Many believe that the first spool of lace was made in Venice, but has spread to Milan, Genoa, Flanders and other parts of Europe. (Palliser, B. 1984) Bobbin lace are softer and easier and as such were more suitable for the European fashion of the 18th century of rigid needlepoint lace, and reached its peak in Flanders and France. Bobbin lace can be divided into two groups on the basis of methods: a non-continuous and continuous.

3.3. Venetian Bobbin Lace

The lace was made in Venice in the 16th and 17th century (Palliser, B, 1984) by inserting a "bridge" between the two cords that are lined lace, and are a repeated motif in continuity. (Jenkins, D., 2003) Unlike the Genoese bobbin lace that contains within itself the characteristics and Abbreviations, Venetian lace is pure graft technique.

3.4. Milanese lace mesh

One of the earliest non-continuous lace was developed in Milan. Tape-like strips of fabric, stitch both sides needed to construct the design. After that, the small loop pulls through small openings with a needle that has a hook. The earliest non-continuous lace, Milan and Flanders, are equally great, with tight braids and motives of exotic fruits, and make magnificent pieces of art on fabric.

3.5. Idrija lace

This elegant medallion is made with small spools of braid and a half stitch, more open weaves, while the base is filled with a coil network. A similar approach in larger or simpler scales is used by lacers throughout Eastern Europe. Similar work is also called Idrija lace, suggesting that it originated in Slovenia. Many residents of the region are Czech or German origin so the question about the origin of this type of lace remains unanswered. Hungarian and Russian manufacturers have also produced several styles of knitted lace.

3.6. Duchess lace

Duchess lace was created in Belgium (Earnshaw, P., 1999) and developed in 1850's. Parts of the lace is especially constructed by a technique of half a stitch and then assembled. Although it is generally related to Belgium, lace of this style was manufactured in several places, including France. It's English counterpart is Honiton, which is made with a little heavier threads and different loops.

3.7. Point d'Angleterre

The origin of this lace is the subject of controversial statements, but it is likely that it originated in Flanders and was prepared in for export to England (Palliser, B. 1984), and thus that name that it carries- a geographical determinant of England, England being in French, and it wore an identical mark to avoid import ban. The hard technique and it's complexity serves many experts as a reason to claim that this lace product was made by more people, or that more of them have participated in the making of the piece. (Kronja-Nikolic, S. 2008) These laces are created and made in Flanders (Belgium) in the 17th century, but they were also copied along with other classic lace in Burano in the 19th century in Italy.

4. MODERN DAY LACE

Today, lace is considered as an elegant and expensive wardrobe and an addition that shows high style and high taste of the wearer. It is recommended for those who want to follow the latest trends and fashion designers also recommend that it is necessary to have a good piece of lace clothing and accessory. Feminine creations of lace largely ruled the catwalks and glamorous premieres, and recently one such creation brought the British princess Kate Middleton, as the best example that lace is still as ongoing.

Fig. Kejt Midlton in Alice Temperly creation

With lace one has to be careful, because it itself is luxuriant, so the creators never advocate wearing more than one article of clothing with lace. For example if the stockings are of lace, you need to be without lace on the rest of your garment. Thus, the lace is an addition to the clothing or, clothing should be made of homogeneous lace to avoid exaggerating the ornamentation and the destruction of visual harmony. Lace today remains current because it is both attractive and sensual, but also conservative and elegant. Today it is worn by fashion icons like Sarah Jessica Parker, pop stars like Jennifer Lopez or Kate Middleton, ie. Princess Catherine of Wales.

Lace is both sensual, romantic and Victorian. Once reserved for the privacy of bedrooms and revealed only to those who we wish to bestow upon her tenderness, now switched to an all over lace - of translucent blouses to shoes and perfume bottles.

Therefore, it does not seem to lace will ever stop being used in fashion, although occasionally it can lay down. Its elegance is eternal, and timeliness. For the future we do not have to worry about lace, although it can be frowned upon at times, it has a value that cannot be only described by its past glory.

Fig. 1. Lace in colection

Today, lace is as expensive as it was before, many pieces can be bought as souvenirs for hundreds and even thousands of euros, and the value of vintage objects only increases nowadays.

4. CONCLUSION

Lace was created in ancient civilizations, as in ancient Egypt, but it spread throughout the world since the Renaissance to the present time where it reached its rebirth as an ultra elegant detail. In our region, the Balkans, it is very popular and traditional crochet lace was popular from Slovenia, Croatia and Serbia to Bulgaria.

Lace is a honeycombed mesh fabric that's made from cotton, wool, silk, agave, gold or silver thread. It is made by hand techniques, knitting, crochet, tying, stitching or, and also machine made. It was created as the ending of the fabric, to prevent erosion of the basics. The edges of the fabric are gradually developed in the related fringe or untangle that reinforced the edge.

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In the former Yugoslavia, the most famous lace was of Pag Croatia, kerice in Slavonia and Bosnia and oje in Macedonia. There are different kinds of typical and famous lace: Lace from the bobbin lace, Idrija lace, Duchesse lace, Venetian Bobbin Lace, lace and mesh Milanese Point d'Angleterre.

Till this day a lace dress looks sophisticated and glamorous, the other lace pieces can, very well fit into an everyday style. When you wear lace, care must be taken for the rest of the outfit, that must fit in with lace. Due to its transparency, it remains as a provocative and sensual fabric, but due to its vintage look also very conservative. Lace has remained popular because it is attractive and sensual, but at the same time conservative and elegant. It is such an inspiration and a fashion accessory for many modern designers, and again through their creation and stylization becomes trendy. Therefore, the future of lace is bright, because even though from time to time it may fall out of fashion, it is once again emerging as an inspiration, and we can say that it can not only be attributed to the past and tradition.

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