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TECHNICAL FACULTY „MIHAJLO PUPIN“
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FOREWORD

Technical faculty "Mihajlo Pupin" University of Novi Sad organizes the eleventh international conference "XI Textile science and economy " TNP2020.

Guided by the fact that we are good people who make good products, on our conference we gather experts from science and economy. From year to year we have followed development of science and economy in this sector. From the very beginning we have cooperated with scientists from all over the world, from America to China. A lot of businessmen from the field of production also participated in our conferences. Experts from the French company Lectra have undoubtedly made a significant contribution to the improvement of quality. They have given us information about modern economic trends and worldwide trends in textile and materials. They haven't only allowed us to access the developing information in this field, they have also equipped us with their own equipment which values about a million euros. We have also had the CAM machine from generation of 4.0 Industrial Revolution or several years now. It represents the best equipment in this part of the Europe. The equipment was mostly obtained from the IPA project of our cooperation with Faculty of Arts and Design, West University of Timisoara.

Meetings of experts from science and economy at our conferences have constantly raised the level of our international cooperation. That provided the exchange of our professors and our students in middle European program CEEPUS, in which about 50 of our students have taken a part. Seventeen of our students and 10 of our professors have taken a part in Erasmus program. For the first time in our faculty, we have one foreign student on exchange. About 40 students from textile were in practice in German companies and about 15 students and two professors were in two programs at Donghua University in Shanghai. Working under the name of „Innovative approach in the education of textile engineers for the Serbian textile industry", we succeeded to include the University of Novi Sad into the Belt and Road World Textile University Alliance, with the company of 33 prestigious universities from all around the world, at the conference on Donghua University in Shanghai in 2018. It is also a great success that we have been elected to be part of the board of this Alliance.

Our vision is to train students, who will, with their knowledge, easily get the jobs that are required by domestic and international companies. Our goal is for our students to be the driving force in enterprises of the Serbian textile industry which will have employed 30 engineers each, and few sewers of samples who will do the sewing jobs in countries with cheap labor. We are going to increase the level of the Conference to a greater extent so that it will be the meeting point for our and foreign scientists and businessmen to open new cooperation activities. We want to involve our students in these jobs.

This Conference can be the initiator of strategic state project of Renaissance production of industrial hemp. More than 6000 products wanted on the market are made from hemp. Yugoslavia produced a quarter of European production in total, and Odzaci was European stock market which determined price of the cannabis. Our department has already begun with project activities in that direction with two institutes from Novi Sad.

We are going towards direction to inn greater extent raise the level of Conference so that could be place of encounters of ours and foreign scientists and businessmen making new businesses we want to include our students as well.

At this tenth conference, we will promote the signed Contract in Shanghai with the regional association Jiangsu Haimen Industrial Zone which employs 500,000 workers, and which will involve our students in the design of home textile for Chinese companies. This is a great step in achieving our initial idea of organizing conferences, which is to create quality students who will

produce quality products. We consider it a great success that our students were recognized by the world's strongest Haimen group in home textile

In the end, I would like to thank all previous participants of our conferences and all those who contributed to the success we have achieved.

The Chairman of the Organizing Committee:

Vasilije Petrovic, PhD, Professor

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CONTENTS

Table of Contents

PAPERS

MARKET REVIEW ON TRIEBOELECTRIC NANOGENERATOR

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Institute for Advanced Textile Materials and Technology (ATMT), Amirkabir University of Technology, Tehran, Iran

ABSTRACT

Smart textiles will have a great market in future. Nowadays researches perform many researches to overcome the challenges and find more application for these fibrous materials. Here, we discussed about the potential market of smart textile in general for different sector including triboelectric nanogenerators. The triboelectric nanogenerators in energy-harvesting mode and their recent challenges and their future prospects were scrutinized.

Keywords: triboelectric, smart textile, energy-harvesting, market, future

INTRODUCTION

Smart textiles are gaining popularity at a rapid pace and the major drivers identified for this growth smartwatches and wristbands, sophisticated gadgets with advanced functions, miniaturization of electronic components,and rapid growth of low-cost smart wireless sensor networks. The overall market for smart textiles is expected to reach USD 4.72 Billion by 2020 [1]. Smart watches and wristbands, sophisticated gadgets with advanced functions, and miniaturization of electronic components are the main drivers for the smart textile market.

The demand for sports and fitness applications are expected to see a rise, which will further drive the demand for smart fabrics as they increase the comfort level for the user and eliminate the use of heavy equipment. In the field of Medical applications, smart fabrics can analysis physiological parameters such as temperature, heart rate and blood pressure. The problems concerning power supply are expected to drive the need for energy harvesting. The major restraining factors for the growth of the smart textiles market are the slow rate of adoption and the lack of extensive standards and regulations. Compatibility issues and high-cost of production of these textiles are also some of the factors affecting the growth of this market. Smart textiles are highly complex and require high-end materials. Hence, the perfect cost-price balance has been difficult to achieve. Incompatibility issues among different types of smart textiles and electronic systems are also common, further making it difficult for the global smart textiles market to achieve a steady growth.

CHALLENGES

The advances in nanotechnology are expected to boost the overall smart textile market.

Incorporating nanotechnology into fabrics helps to change or enhance the properties like fire resistance, electronic capability and monitoring. This textile has many applications in the different field such as health and military sectors to have lightweight uniforms that can detect the blood flow in the body, lightweight battle suits, uniforms that can change the color to match the surrounding, etc [2]. Triboelectric nanogenerators (TENG), based on the triboelectrification and electrostatic induction effects, have been demonstrated as a novel harvesting technique to collect and transform ambient mechanical energy into electric power. Here, some researches in the field of trieboelectric nano generator and energy harvesting fabrics are mentioned. Combining triboelectric nanogenerator (TENG) and textile materials, wearable electronic devices show great application prospects in biomotion energy harvesting and multifunctional self-power sensors in this coming intelligent era. Textile triboelectric nanogenerator which combines advantages of textiles for its breathability, washability, flexibility, lightweight and TENG for its energy harvesting and versatile sensing ability shows great application prospects in the coming intelligent era. So far, great progress has been made in this area. However, textile-based TENG, there still remains challenges to face both for energy harvesting textile-TENG and TENG sensors. First, most fabric-based TENGs have several layers which are complicate to obtain and uncomfortable enough to be used in wearable devices. Second, a majority of fabrics cannot generate electricity without contacting other fabrics or other materials. Two fabrics or more are necessary to do contact separation and contact sliding motion which limits the application of fabric-based TENG. Third, the

fabrication of fabric-based TENG, including coating, woven structure and composite mode, decrease the flexibility, breathability and stretchability of the fabric. Forth, the uneven surface of the fabric or spun fibers may lead to the uneven surface of the coating, which cannot enable the stability of the fabric-based TENG [3].

Related research topics such as sensors, energy harvesting, piezoelectric nanogenerators (PENGs) and triboelectric nanogenerators (TENGs) have received significant attention because a large amount of available energy is generated by the human movement and clothing friction. To overcome the obstacles, researches have represented different solutions which we mentioned some of them here.

RESEARCHES ABOUT TENG AND ENERGY-HARVESTING

Chaoyu Chen et al [4] introduced a 3D double-faced interlock fabric tribo- electric nanogenerator (3DFIF-TENG), as shown in Fig. 1a. which demonstrates the 3DFIF-TENG can be used as multifunctional wearable devices such as pressure sensor and bending sensor. Finally they take advantage of the 3D structure and improve the special structure with warp inserting and weft inserting in the middle layer, which makes the 3DFIF-TENG be multifunctional as a 3D tactile sensor.

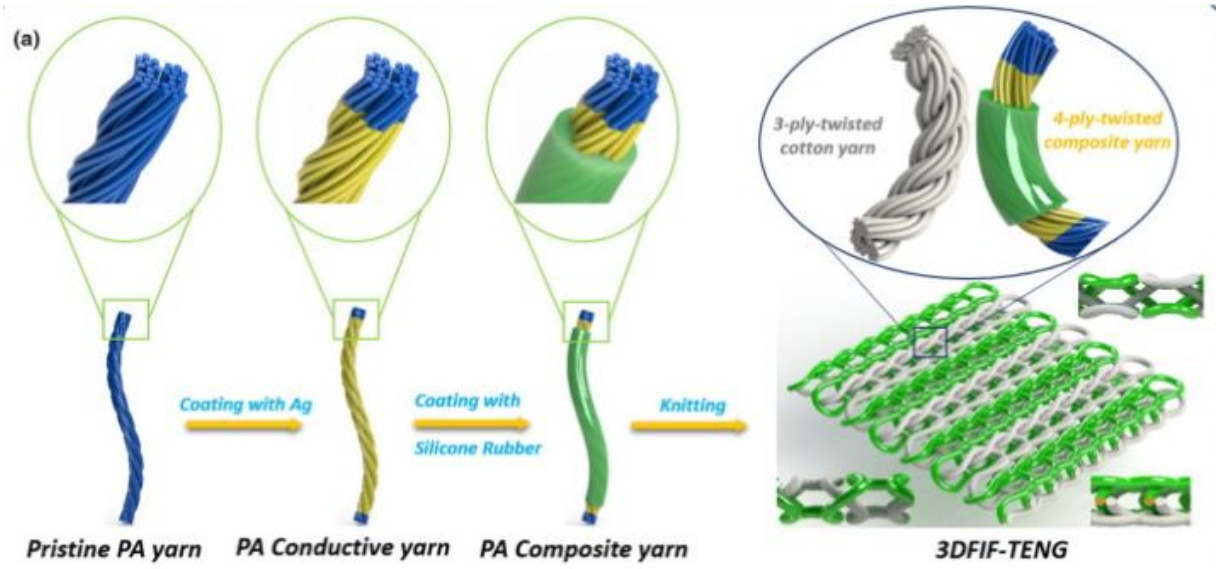

Figure 1: *Fabrication process of the core-sheath yarn and 3DFIF-TENG [4].*

Fiber-based electronic devices are attracting extraordinary attention due to their flexibility, lightness, comfortableness, and applicability to a variety of industries and products, including physical or chemical sensors [4], biomedical monitoring soft robotics , and wearable devices. Furthermore, various portable smart devices are playing major roles in daily life, and these devices require lighter, smaller, or larger capacity power sources. An all-nanofiber-based stretchable TENG (S-TENG) with polyvinylidene fluoride (PVDF) and thermoplastic polyurethane (TPU) nanofiber membranes was reported by Zhao et al. for energy harvesting. This S-TENG, which according to the analysis had a full separation of surface-to-surface, had an excellent triboelectric output performance.

Zhu et al. introduced the microfiber-based TENG in 2018. This TENG consisted of ZnO coated polypropylene (PP) microfibers with a spacer, and it exhibited high transfer charge and output voltage. The properties of a TENG depend on various elements, such as the surface morphology, dielectric constant, spacer, and triboelectric potential difference between the triboelectric. The TENG using nanofibers has been widely investigated because of its advantages, such as ease of production by electrospinning and high surface roughness. Owing to the porous structure of nanofibers, which can contain a large volume of air with high dielectric constant, they have a large contact area, which can enhance the triboelectric effects and produce a high-output generator. Jong Hyuk Bae developed a nano- and micro-fiber-based TENG (NMF-TENG) that was fabricated using a nylon 6 nanofiber mat and melt blown nonwoven polypropylene (PP) as triboelectric

layers. The morphology, porosity, pore size distribution, and fiber diameters of the triboelectric layers were characterized. Moreover, the electrical output performances of NMF-TENGs were investigated [5]. In another study TENG textiles with face loops and higher stich densities proved to be the optimum structural design in terms of output power performance. One simple approach is the application of conductive and dielectric coatings to existing fabrics to assemble fabric-based TENGs as shown in fig2. More generally, the electrodes for these TENGs are composed of metal wires, conductive yarns or fibre-shaped elastomers that have been coated with carbonaceous materials. Additionally, dielectric polymer films (e.g., polydimethylsiloxane (PDMS)) have commonly been coated on these fibre electrodes to act as the triboelectrification layers. These modified yarns or wires have then been hand-woven into TENG textiles [6].

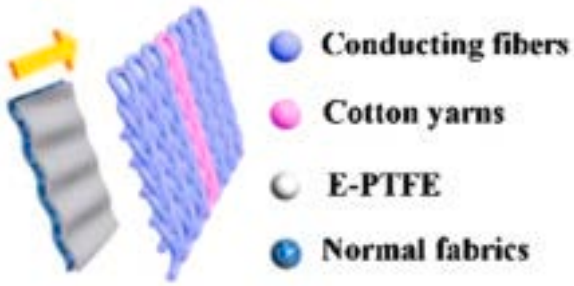

Figure 2: *Schematic diagram showing the structure of the laminate fabric and the TENG textiles.*

In another work Sung Soo Kwak et al represented fully stretchable triboelectric nanogenerator (S-TENG) that has been fabricated with knitted fabrics and has been integrated with the directly available materials and techniques of the textile industry they investigated plain-, double-, and rib-fabric structures and analyzed their potentials for textile-based energy harvesting. The superior stretchable property of the rib-knitted fabric contributed to a dramatic enhancement of the triboelectric power-generation performance owing to the increased contact surface [7]. Except for the judicious use of tribo-materials or the tribo-layer architecture optimization, the rest of the methods for enhancing the TENG output are reliant on expensive equipment and complicated processing, that undermine the advantages of TENGs and may not provide the required stability and reliability. This PhD study aims to establish novel strategies to enhance output performance of TENG by developing new tribo-materials and phenomena such as coupling of tribo-piezoelectric effects to showcase potential applications of the TENG devices [3].

CONCLUSION

In summary, there is a long way to have mass productions in the field of smart textiles based on TENG. However, due to the potential of TENG and its application clothing like smart and wearable device power systems and self-generated electronic systems, many investigation e done by scientists.

REFERENCES

1. *https://www.marketsandmarkets.com/Market-Reports/smart-textiles-market-13764132.html*.
2. *https://www.mordorintelligence.com/industry-reports/analysis-of-global-smart-textiles-market*.
3. Zhao, P., Design of high-performance Triboelectric Nanogenerators (TENGs) for energy harvesting applications. 2020, University of Bolton.
4. Chen, C., et al., 3D double-faced interlock fabric triboelectric nanogenerator for bio-motion energy harvesting and as self-powered stretching and 3D tactile sensors. Materials Today, 2020. **32**: p. 84-93.
5. Bae, J.H.O., H.J.; Song, J.; Kim, D.K.; Yeang, B.J.; Ko, J.H.; Kim, S.H.; Lee, W.; Lim, S.J. Nano- And Microfiber-Based Fully Fabric Triboelectric Nanogenerator For Wearable Devices. Polymers 2020, 12, 658.
6. Huang, T., et al., Fabric texture design for boosting the performance of a knitted washable textile triboelectric nanogenerator as wearable power. Nano Energy, 2019. **58**: p. 375-383.
7. Kwak, S.S., et al., Fully Stretchable Textile Triboelectric Nanogenerator with Knitted Fabric Structures. ACS Nano, 2017. **11**(11): p. 10733-10741.

ADVANCED TEXTILE AND APPAREL FIRMS TO DEVELOP OVERSEAS INDUSTRIAL PARKS POST THE COVID-19 PANDEMIC

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ABSTRACT
This paper first has reviewed the situation of fighting COVID-19 pandemic, which is under a framework of four phase, turning point, 0 increasement record, extremely suffered region return to normal and prevention foreign imported cases and domestical sporadically cases are all explained with real date as China case. Second this paper analyzed impact of the pandemic to Chinese economy, predicted that China's economy 2020 could be increased about 2.2%. Based on review of China textile and Apparel industries historical development and a sample analyses and other information, estimated that China Textile and Apparel industries this year could be increased about 3-4%. Third this paper analyzed accumulation of COVID-19 cases globally, use 10 million cases counted days analyses, point out the turning point period, and make a discussion about quasi 0 increasement situation happening possibility, optimistically predicted such situation happening period. Fourth, this paper discussed reason for advanced CTA firms to develop overseas industrial parks and the enlightenment of casual wear brand R&D for function fibers. Finally this paper discussed possibility and advantage for choose East European region as overseas industrial park destination for Advanced Textile and Apparel firms' globalization development.

Key Words: CTA (Chinese Textile and Apparel), COVID-19 Pandemic, Oversea Industrial Parks, Prediction of Economic Increasement, Turning point of the Pandemic, R&D in Function Fiber

INTRODUCTION

The Covid-19 pandemic has greatly impacted global economy, in which textile and apparel industries are also suffered. As China has successfully controlled the pandemic, though its textile and apparel industries has got big impact in first quarter of this year (2020) and the industries had got recovery in second and third quarters. This paper first, analyzes the case of China's circumstance to control the Covid-19 dissemination and explore the ways to understand time spans of both turning point and mainly end of the Covid-19 the dissemination in China. Second, this paper analyzes its textile and apparel industries historically and the enlightenment of casual wear bands to make R&D in function fiber to win competitiveness. Third, this paper suggests the strategies for advanced textile and apparel firms to make investment in overseas industrial parks in the coming era of post the pandemic.

Brief review of fighting COVID-19 in China

Review of the original of COVID-19 is a hot topic and a scientific research issue, according to screen out result, we have got the information from the media that on December 26 2019 , Dr. Jixia respiratory department of Hubei Integrated Traditional Chinese and Western Medicine Hospital (Wuhan) reported 4 cases of unnormal symptom, which could be regarded as reasonable first case of such novel coronavirus.
On December 31, 2019 National Health Commission of the P.R. China sent working team to Wuhan. On January 1 2020, the National Health Commission of China set up epidemic leading group. On January 2, Wuhan Institute of Virus Research of Chinese Academy of Science has got complete genome sequence of novel coronavirus 2019. On January 3, China reported new coronavirus epidemic to WHO, U.S.A and neighboring countries of China.
On January 10 2020, Dr.Yunhua Li of Wuhan Province Xinhua Hospital reported 30 cases of unnormal CT results. On the same day, the National Health Commission of the P.R. China shared information of the complete genome sequence of novel coronavirus 2019 to WHO and all the countries in the world.

On January 20 2020, Dr.Nanshan Zhong, the member of high level expert group of the National Health Commission, announced on public media that such novel coronavirus can be contaminated person-to-person.

Then, started from January 23 2020, Wuhan as well as Hubei Province have been locked down and lasted for 76 days (re-opened on April 8). During the locked down period more than 42,000 medical staffs (Doctors, nurses and CDC researchers) had been sent to Wuhan and other parts of Hubei Province, tremendous medical equipment and various living goods had been sent to Hubei Province.

After medical teams consistently long time to cure patients with 29 medical staff death and all Chinese people's coordinated efforts (to wear masks, to stay home and to keep social distancing, and follow the instructions of the Health Departments, the coronavirus transmission has been stopped in mainland China. Related information and analyses are listed as following.

February 12 2020, confirmed 15,152 COVID-19 positive cases, which is also the turning point (Inflection Point) of the COVID-19 event in China, the definition an inflection point, also known as turning point normally, in mathematical subject refers to the point that changes the direction of the curve upward or downward. Intuitively, an inflection point is the point that makes the tangent cross the curve. If the function of the curve graph has the second derivative at the inflection point, the second derivative at the inflection point is different sign or does not exist. So time span from December 26, 2019 to the daily highest record date (turning point date) totally is **48 days**, and we may call this as **first phase** victory to see dawn.

March 11 2020, Dr. Tedros Adhanom Ghebreyesus of the WHO Director-General: COVID-19 can be characterized as a pandemic. Whereas in mainland China, on March 12 2020, it is the first date to record 0 increasement of confirmed new case, which could be regarded as **second phase** victory point, so the time span from December 26, 2019 to this 0 increasement record is **77 days.**

On April 2 the last medical team withdrew from Wuhan, it means that the most suffered area in mainland China has been returned to normal (the victory of the battle of Wuhan), so the Covid-19 pandemic in China has been mainly ended. Based on such facts above, we can count the date that this Covid-19 event from first case report from Dr. Jixian Zhang (December 26 2019) to the end of the event (April 2 2020) is totally **98 days** (5 days in December 2019, 31, 29 and 31 days respectively in January, February and March, and 2 days in April 2020). This stage could be called as **third phase** victory.

After that we have seen mainly foreign imported case via air and some domestical sporadically cases related with border and cold chain reason, this stage we may call it as **fourth phase.** As global situation is still tough, this stage or phase is long lasting, some experts call it as new normal. All those explanations of above four phases are roughly the situation happened as fighting Covid-19 in China.

The impact of COVID-19 on China's economy

As COVID-19 came suddenly, China's spring festival changed its normal situation, Wuhan and Hubei Province locked down, factory stopped to operation and people to stay home for separation, national wide travel control, schools stooped (primary school to university), China's economy got big impact. IMF estimated that China will be increased about 1.2 % of GDP in its April prediction. World Bank's prediction is 2.3% of China's GDP increasement in April.

According to the National Bureau of Statistics of P.R. China, first quarter China's GDP was -6.8% (6.1% of 2019 as comparison), second quarter GDP was 3.2% increasement, third quarter GDP was 4.9% increasement. Some Chinese experts predicted that fourth quarter's China GDP will be like 5.9% increasement.

Based on above data, if we suppose that China's last year four quarters economy is equal, so roughly China's whole year GDP increasement in 2020 could be like [0.25X(-6.8%)+0.25X3.2%+0.25X4.9%+0.25X5.9%]/1 =1.8%, which seems not match with international experts'prediction. As we know that actually China's economy is in the increasement of yearly data as 6.1%, so each quarter should be differently allocated, if we proportionally suppose all four quarters' weight as 22, 24, 26 and 28 percent respectively, China's GDP increasement in 2020 could be as 2.2%, which is quite match with the prediction of World Bank's prediction

as 2.3% increasement of GDP of China. The formula to calculation of China GDP increasement is seen in following.

[0.22X(-6.8%)+0.24X3.2%+0.26X4.9%+0.28X5.9%]/1 =2.198% (China GDP in 2020)

Understanding of CTA (China Textile and Apparel) Industries nothing to do with the Pandemic (to the 2019)

As one of the key words of this conference is Textile and Apparel and for the intention to increase mutual understanding , I would like briefly to review China's Textile and Apparel (CTA) Industries from 1949 to 2019 in following.

(1) China's CTA industries was poor before liberation (1949), there were only few electricity energy machines related CTA, such as cotton spinning, weaving and knitting in Shang-Qing-Tian (Shanghai, Qingdao and Tianjin) coast region.

(2) As China has big population (600-800 million) that time in 1950s-1970s, textile and apparel goods were extremely shortage of supply under central planning economic system, even to use textile coupon to get fabric and garment in shop, before the reform and opening policy in 1978.

(3) Thanks to the new reform policy, CTA industries had got great development in all aspects in the period of 1978-1994, China's textile and apparel export took up numerous Number Ones in the world (Cotton Spinning and weaving, Knitting fabrics, Chemical fibers, and apparels and so on).

(4) For long term historical review respect, CTA industries had passed a way that firstly got main development in quantity, secondly turn to quality and high tech development, till the year 2000, China's fiber treatment reached to 24.7% of the world total, textile and apparel export reached to 14.8 of world total.

(5) In the period of Year 2014-2015, CTA industries reached up to the export peak (Year 2015 China's export was 38% of world total).

(6) To 2016-2017, the quantity of CTA export slightly fell, but during the year 2017 CTA industries has produced 28.78 billion pieces of garments, equivalent for providing 3.83 pieces of ones to each person in the world that time.

(7) China has developed a whole matured supporting upstream and downstream industrial clusters and pressure-resistant industrial supply chains, which is quite competitive power.

(8) From January to November 2018, China's textile and apparel exports reached US $ 253.9 billion, with a year-on-year growth of 4.4%. Among them, textile exports reached US $109.3 billion, up 9.5% year on year. Clothing exports reached 144.7 billion US $, up 0.8%.

(9) According to customs statistics, China's exports of textile yarns, fabrics and accessories totaled RMB 1.87 trillion in 2019, up 2.5 percent from the previous year. Of this amount, RMB 1.04 trillion was exported for clothing and accessories, a slight increase of 0.3%; Textile yarns, fabrics and products totaled RMB 828.32 billion, up 5.5%.

Based on above explanation, we summarize that quantitative development of CTA is enough big with a whole matured supporting upstream and downstream industrial clusters and pressure-resistant industrial supply chains, whereas technology development, design and management (branding and globe marketing and development) in high level are expected for the CTA Industries to transition.

Impact of CTA Industries with the Covid-19 Pandemic

Concerning the impact of COVID-19 pandemic to CTA industries, following three points could be analyzed.

(1) 2019/2020 first quarter some CTA Listed Firms

In order to know the situation of CTA firms suffering form the pandemic, we try to find the listed CTA firms data in the Table 1.

Table 1. Revenue and Net Profit Comparison Table of Listed CTA Firms

Firm Name	Revenue		+-	Net profit		+ -	Industry
Stock Number	2019 (F)	2020(F)		2019(F)	2020(F)		
LONGSHENG 600352	47.71	42	-	12.62	11.76	-	DYEING
LUTHAI TEX 000726	15.45	12.52	-	1.95	1.04	-	Cotton Spinning
SUNVIM 002083	12.43	11.65	-	1.35	0.96	-	Cotton Spinning
RUNTU 002440	18.02	11.43	-	2.6	2.3	-	DYEING
XINYE TEX 002087	14.79	10.59	-	0.78	0.63	-	Cotton Spinning
HUAFANG 600448	6.89	6.9	+	0.02	0.09	+	DYEING
JIAXIN SILK 002404	9.13	6.18	-	0.4	0.28	-	Silk Garment
XINAO TEX 603889	7.17	4.88	-	0.49	0.65	+	Wool Spinning
FYNEX TEX 600493	2.56	1.93	-	0.07	0.02	-	Cotton Spinning
Total	134.15	108.08	-19.43%	20.28	17.73	-12.57%	

Source: www.chyxx.com

We can see that most of listed CTA firms are suffered with revenue decrease about 20% and net profit about 12.5%.

(2) Quick shifting of CTA firms to produce masks and protective garments

Before spring festival 2020, the price of disposable mask is RMB 0.6 Yuan, when Wuhan is locked down, the price of the mask increased greatly, and a lot of firms entered mask industry (8950 firms since January 25, according to the research). Some of already involved firm, such as, Kingfa (listed stock market number 600143), had got profit RMB 2.4 billion in first half this year, and increased 373%.

Meanwhile, the price of materials to make mask such as melt-blown polypropylene nonwoven fabrics has been greatly increased, market price from RMB 20,000 to sky price RMB 500,000+ per ton, administration department has paid efforts to sue behaviors of price speculation.

Production of Masks has been increased tremendously from 14.8 million pieces on February 5 to 116 million pieces on February 29, increased 684%, protective garment is also increased greatly. From March 1 to May 31, China imported mask 70.6 billion pieces and protective garment 0.34 billion suits to 200 countries in the world. So mask and protective garment industries in China, which is a miniature of CTA industries, have already set up in China. Even this process is accompanied with speculation and impulsive investment, a powerful manufacturing supply system not only in CTA industries but also in other industries have been quality soundly existed in China is no doubt.

(3) Turnover Prediction of CTA industries in 2020

As global economy suffered greatly, according to IMF, world economy could be decreased about 3 percent, advanced countries could be reduced about 6.1 percent. World demand for Textile and Apparel goods could be also reduced greatly, home textile goods in China declined about 25 percent in first quarter. But from second quarter, situation changed as COVID-19 pandemic surged in some countries, such as India, Vietnam, and Bangladesh, some orders that previously produced in China late owing to labor costs turned to those nations have returned back to China, so CTA industries have got the chance to almost full production, according our telephone survey to some clustering of CTA by authors.

Here we would like to make a comparison to CTA industries with 2019 and 2020. We got firstly the data of eight months of this year 2020, the export value of China's textile and apparel products has reached US $187.41 billion. Furtherly we took 2019 whole year textile export data as RMB 1.87 trillion, which equals to eight months as US$181.5 billion < US$187.41 (2020 Data), and the calculation result is 3.3% increasement, so optimistically whole year's data could be up 3-4 percent, slightly bigger than whole economy increasement as 2.2% in above calculation.

Global Turning Point of the Covid-19 Pandemic and 0 level increasement prediction

According to above analyses of China's fighting COVID-19 process (there are three important date, turning point, 0 increasement point, and turning to normal), we may naively and optimistically to make an analyze about COVID-19 pandemic globally.

According to WHO data (also some of which is come from Johns Hopkins University), we could list data as following Table 2.

Table 2. Some date of 10 million confirmed cases and days passed counted globally

Numbers of 10 M	Date	Confirmed cases	Days Counted
1	June 28, 2020	10 million approx.	157
2	August 11, 2020	20 million approx.	55
3	September 17, 2020	30 million approx.	37
4	October 20, 2020	40 million approx.	33
5	November 9, 2020	50 million approx.	20
6	November 26, 2020	60 million approx.	17
7	December 14, 2020	70,461,926	18

So according to above table, We have seen that days to get 10 million cases firstly have been tremendous reduced, but from 5th to 7th 10 million cases (since November 9 to December 14) the pandemic now seems in a high platform, and accumulation of 10 million confirmed case globally need average 18.3 days [(20+17+18) /3 =18.3]. That is to say, the days to get 10 million cases stopped in a high platform, optimistically we hope this November and December could be the worst situation for the pandemic. The reason to make such analyses is we would like to believe the philosophy that everything will go to its opposite when it comes to the extreme (Chinese saying 物极必反!).

Based on above analyses, I would like to make analyses optimistically that global turning point of COVID-19 could be already in the above platform period. But next 0 increasement is really hard to predict, we may need to avoid to use 0 concept for global victory of such pandemic, daily confirmed case less than 10 in a country and world have such problem countries less than 10 (here we called it as quasi 0 stage) could be instead China's 0 record stage in this paper, such situation happening time, hopefully will be in first half of 2021. Also there are some positive signs related with fighting the pandemic to support above analyses qualitatively in following.

(1) UK approved Pfizer/BioNtech vaccine on December 2. 2020, and started its first public use on December 8,2020.

(2) Bahrain and U.A.E. approved Sinopharmaceuticals China biocoVID-19 inactivated vaccine on December 4 and 9, 2020 respectively.

(3) US also started public use on December 14, 2020.

(4) Before that Russia vaccine had been already started to use and further to public service on December 5, 2020.

(5) Chinese President Xi Jinping stressed that China actively supports and participates in international cooperation on COVID-19 vaccines. China has joined the COVID-19 Vaccine Implementation Plan and is ready to strengthen cooperation with other countries in vaccine research and development, production and distribution. We will honor our commitments, provide assistance and support to other developing countries, and strive to make vaccines an accessible and affordable public product for all peoples.

(6) WHO plans to launch distribution of COVID-19 vaccines in the first quarter of 2021.

By the way, we need to pay more attention to avoid politic influence with fighting COVID-19, that less political bias, more cooperation globally with learning each other is the right way.

Of cause there are also negative information comes like UK announced that there a virus variation that has 70%+ powerful possibility to dissemination, this kind of event could make the situation worse. Anyway, we may hope human society's learning ability to fight this negative factor to win the battle, not to let the turning point come too later!

But concerning the impact to Textile and Apparel industries worldwide, if above quasi 0 record really come in the first half of next year, post the pandemic V-type economic rebound could be expected, which is good opportunity for advanced Textile and Apparel firms to catch up.

Overseas Industrial Park: One of Development Directions of Advanced Firms of the CTA Industries

Industries

As we pointed above that CTA industries have reached into world number one since 1994, and its volume of exporting to the world take about 37-39 % of whole world share, globalization is one of the key directions for CTA industries' development. We suggest that advanced CTA firms to think about overseas industrial park development, which is based on following reasons.

(1) Industrial Park is effective means to develop Economy, China did get benefit from it.
Singapore government and firms firstly developed China-Singapore Suzhou Industrial Park in 1994, which has 278 square kilometers and yields GDP RMB 207 billion in 2015. China has totally developed 219 state level economic and technique zones. Concurrently, China still develop "State Level New Areas", such as Pudong New Area in Shanghai,Tianjin Binhai New Area, Sichuan Tianfu New Area, and Chongqing Liangjiang New Area, etc., totally 20 ones.

In all those zones and areas, economic development is fast than other areas, so it is clearly that Parks-Zones-Areas is effective means to develop economy, which is one of the sound experiences of China reform.
(2) Some TA firms (not only Chinese ones but also foreign ones, such as PVH in US) has got good experience in Overseas Industrial Park development in past two decades.
Here we put some of their overseas park's pictures as explanation for this development direction strategy in Fig.1 to Fig.4.

Figure.1 Jiangsu Hodo Group, Cambodian Sihanoukville Special Economic Zone

Figure.2 Jiangsu Qiyuan Group, Eastern Industry Zone in Ethiopia

Figure.3 Guangdong Huajian Group, Jimma Industrial Park in Ethiopia

Figure.4 HAWASSA Industrial Park in Ethiopia USA firm PVH deeply involved

(3) An Enlightenment from the Casual Wear Brand's Development in China Market

When we think about the directions for Advanced CTA firms to develop post the pandemic, we would like to mention an insight about casual wear brand's operation case in China market. JeansWest was one of famous casual wear brand in China market, led by Hong Kong Entrepreneurs, Yang brother's team, this brand firstly developed casual wear chain shop in Shanghai in 1993. After that JeansWest successfully developed more than 2,800 shops in China, also some shops out of China. But in recent years, the JeansWest faced big challenges for further development in China markets.

To use similar development model as JeansWest, we have seen quite much casual wear chain store brands in China, such as Meters/bonwe, Semir, Baleno, Giordano, and Ton Lion, have all had some degree of development and seem to all have got bottleneck for further development. What is the key issue for solving such bottleneck? Some experts blamed that E-commerce is killer, but is it really such case?

In China market, we could also see an international brand (UNIQLO) has opened many chain stores in China's first and second-tier cities, also this brand took up 1,500 square meters in CIIE (China International Import Expo in Shanghai this November 2020), to see in Fig.5

Figure.5 UNIQLO in CIIE (China International Import Expo in Shanghai)

We can see that Such big garments displayed in Fig.5 by UNIQLO only weight about 235 grams, and this brand also showed their high-tech fabrics in the CIIE. Obviously to pay more R&D investment in function fibers is one of main gaps for such two kinds of categories in casual wear brands.

Actually there are more SMEs' addicts in China that have developed their special filed products with advanced technologies, recently with Donghua University's background (our former name as China Textile University) we contacted a firm director Mr.He Shuhui, of Zhejiang Shanmen Hongyuan Plastics Co., Ltd. Mr.He is one of such science and technology addicts. His products showed in Fig.6 This firm focus on functional material development, continuous make investment for 5 years, solved numerous failures and difficulties, finally getting breakthrough in new type of function fibers, which has the features to anti-Covid-19 virus, anti-frequently seen bacteria in foot and in pants crotches, and anti-mites, so this firm cooperated other firms to develop their functional products like: Socks, Inner Pants, Inner Sweaters, Pillow and pillowcases, and Glasses frameworks and so on.

We know that concerning product development, technique breakthrough is only first step, continuously market development operation is further task. Why do I introduce such case here? The intention is to hope Advanced firms which could be CTA firms, or East European firms, to cooperate together to develop this opportunity. Also when CTA firms go abroad for developing overseas industrial parks, pay more attention in R&D to function fiber to let customers to have sound feeling, is also an important way.

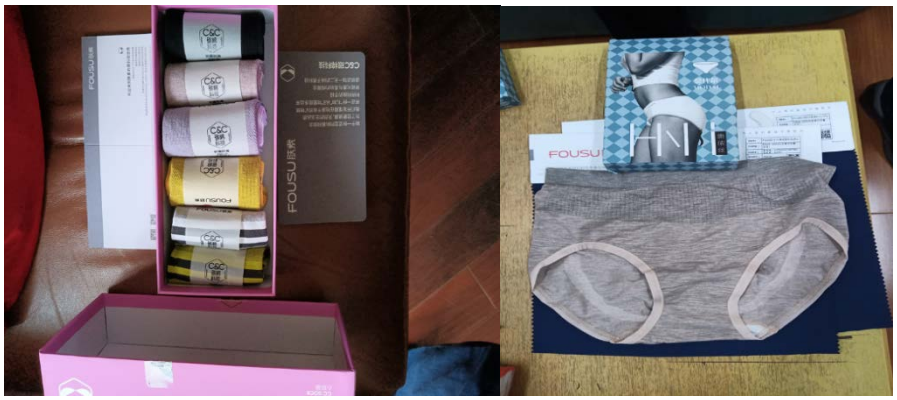

Figure 6 . Socks and Inner pants with the function fiber to anti-frequently seen bacteria in foot and in pants crotches.

(4) RCEP is a new signal for promoting Industrial Parks.
Very recently, the Regional Comprehensive Economic Partnership (RCEP) has been signed on November 15 2020, a proposed agreement between the member states of the Association of Southeast Asian Nations (Asean) and China, Japan, Korea, Australia, New Zealand.

The RCEP is expected to eliminate a range of tariffs on imports within 20 years. It also includes provisions on intellectual property, telecommunications, financial services, e-commerce and professional services. Obviously industrial parks are included and this region will also the capability to seek oversea opportunities.

East European Region Could be the Potential Destination for the Cooperation

How is about the possibility for East European countries to develop Industrial Parks with China and other country's Textile and Apparel firms?

As China had developed more than 200 overseas industrial parks and other types of economic development zones in the world till the end of year 2019, and there are a few such kind of economic parks in France, Belgium, Serbia, and Russia, we think that to develop textile and apparel industrial parks in East European Region could be also possible. In this paper we may only make a comparison of some country's labor yearly salary as an initial analyze, Serbia as a potential destination, related data with Chinese and Vietnam ones are listed in Table 3.

Table 3. Comparison of some country's labor yearly salary (USD)

Country	2010	2011	2012	2013	2014	2019
China (mainland)	4,300	5,000	5,870	6,740	7,380	13,309*
Viet Nam	1,270	1,390	1,560	1,740	1,890	2,165**
Laos	980	1,090	1,270	1,450	1,600	
Bangladesh	780	870	950	1,010	1,080	
Nigeria	1,460	1,710	2,460	2,690	2,950	
Thailand	4,320	4,620	5,210	5,360	5,410	
Serbia	5,850	5,910	5,700	6,050	5,820	6312-8724***
Bulgaria	6,630	6,870	7,070	7,280	7,420	

Source: China Security Research Institute, * from China State Statistics Bureau Report, ** from Viet Nam China Chamber of Commerce, *** from China Embassy in Serbia (after and before tax)

As we know that East Europe Region has more good human resources than Asean Region, and Scientific and technological powers are more vivid, to cooperate with RCEP region including Advanced China Textile and Apparel firms is quite expected!

CONCLUSIONS

(1) China has successfully controlled contamination of COVID-19, February 12, 2020 could be regarded as turning point (first phase), the time span from first reported case on December 26 2019 to turning point is 48 days. The date of all mainland China with 0 increasement record is March 12, 2020, the time span of which are 77 days, that is regarded as second phase. To the victory day of Wuhan medical team withdrew on April 2, we regarded it as third phase, and time span of this is 98 days. After that. we have seen mainly foreign imported cases via air and some domestical sporadically cases related with border, hospital and cold chain reason, we call it as fourth phase, so it is roughly the situation of fighting Covid-19 happened in China.

(2) According to the National Bureau of Statistics of P.R. China, first quarter China's GDP was -6.8% (6.1% of 2019 as comparison), second quarter GDP was 3.2% increasement, third quarter GDP was 4.9% increasement. This paper predicted that China's economy 2020 could be increased about 2.2%. As Chinese economy quick recovery form the pandemic, China Textile and Apparel industries this year could be increased about 3-4%.

(3) Also this paper based on review of CTA industries, point out that quantitative development of CTA is enough big with a whole matured supporting upstream and downstream industrial clusters and pressure-resistant industrial supply chains, whereas technology development, design and management (branding and

globe marketing and development) in high level are expected for the CTA Industries to transition. Meanwhile, China's Textile and Apparel export have been 38% around of world total, so globalization for CTA industries is sure for the post pandemic.

(4) World turning point of the pandemic could be optimistically recognized already in this November and December time as above point 5th to 7th 10 million cases period. Time to Next quasi 0 record is extremely hard to predict, according to the philosophy that everything will go to its opposite when it comes to the extreme, we would like to predict such quasi 0 record globally will fall in the first half of next year 2021. After that Textile and Apparel industries globally will get V-shape rebound.

(5) For globalization, advanced China Textile and Apparel firms may pay more investment for overseas industrial parks development, meanwhile CTA firms need to learn international advanced firm like UNIQLO to more focus on scientific and technological development, pay more attention to R&D in function fiber research. China's existing SMEs' innovative results could be also used in the overseas industrial park development.

(6) As East European region has good human resource and sound base of R&D power, advanced CTA firms could choose the region as the park destination, and more cooperation between East European region and RCEP region including China could be expected.

REFERENCES

(1) Yi-Magazine, the Timetable of Big Events of Wuhan Epidemic, 2020 07 13 https://www.0713666.com/news/show-2386.html
(2) The State Council Information Office of the P.R. China, Fighting Covid-19 China in Action, Foreign Languages Press, Beijing, China 2020, P13.
(3) IMF Prediction of China's GDP increasement in 2020, https://www.chinairn.com/news/20200426/172150343.shtml
(4) World Bank prediction of China's GDP increasement in 2020, fhttps://www.sohu.com/a/385047132_166880
(5) Liao Qun, Chief Economist of China CITIC Bank, Fourth quarter China's GDP increasement, https://www.sohu.com/a/429229757_120911203
(6) Industry prospect investment trend portal http://www.chyxx.com/industry/201905/738022.html
(7) What is China's textile and garment export situation in 2019? http://guoqing.china.com.cn/zhuanti/2020-04/15/content_75934789.htm
(8) China Business Information Network News, Analysis of the overall situation of world economy and trade in 2020 https://s.askci.com/news/hongguan/20200702/1711371162968.shtml
(9) The epidemic has led to a decline in domestic and international market demand. In 2020, the business income and export volume of China's home textile industry will decline http://free.chinabaogao.com/fangzhi/202006/0622500S32020.html
(10) State Council Information Office of the P.R. China https://new.qq.com/omn/20201107/20201107A0CCRS00.html
(11) China's textile and apparel exports fell 1.85 percent in 2019, China Custom Office, http://www.cblfta.org.cn/cblftaorg/vip_doc/16204871.html
(12) Xi Jinping, China will honor its commitment to make vaccines a public good that is accessible and affordable to all peoples
(13) https://baijiahao.baidu.com/s?id=1683978492857578081&wfr=spider&for=pc

SUSTAINABILITY IN FASHION INDUSTRY

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ABSTRACT:

China's textile and garment industry has the largest production volume in the world and has become an important driving force for China's rapid economic development. The traditional textile and garment industry consumes a lot of water resources in the production process, and in the production and processing of textile, printing and dyeing, production, etc. The resulting printing and dyeing wastewater and air pollution have caused serious damage to the environment and ecology; at the same time, a large amount of garbage will be formed after the clothing is discarded, especially the pollution caused by chemical fiber clothing. In view of the increasingly serious environmental problems faced by the traditional textile and clothing industry, green sustainable has become the only way for the industry to transform and upgrade, and thus has become the future development trend of the industry. In recent years, with the promotion of the national and industrial sectors, apparel and related textile companies have begun to realize the importance of sustainable development and increase investment in sustainable development through hardware upgrades. In addition, with the maturity of the consumer market and consumers, the public's attention to green sustainable development has significantly increased. As a result, the sustainable development of the apparel industry is imperative. The sustainability of the apparel industry can be achieved through design, product innovation, and technological innovation, from design to product, through the entire production process. Through the use of literature research, case studies, and summarization methods, this paper combines case analysis to the green sustainable development of the apparel industry from the perspectives of clothing design, material selection, dyeing and finishing related to production, and cycle reconstruction. Caring, summarizing and summarizing. In summary, the paper found that the zero-waste design method of paper-like fabrics can minimize the disposal rate at the design stage, and the detachable design method extends the service life of the garment. Following the 3R1D principle in the selection of clothing materials can effectively reduce the environmental cost of materials. In the production of clothing, the use of 3D knitting technology, DPOL technology and other new environmentally friendly technologies to improve traditional technology, can achieve zero or low emissions of waste. Provide reference and reference for the green sustainable development of the garment industry.

Keywords: *Sustainability, fashion design, production, dyeing and finishing*

INTRODUCTION

Based on the overall situation of the apparel industry and the new development requirements for building a resource-saving and environment-friendly society, China’s twelfth five-year plan puts the emphasis on the energy-saving and environmental protection industry in the development of high-efficiency energy-saving, advanced environmental protection, and resource recycling Technical equipment, products and services.[1] The energy conservation and environmental protection industry has attracted extensive attention from people from all walks of life at home and abroad. At the same time, the currently deteriorating environmental and ecological problems have seriously affected human life and the development of the textile and apparel industry and related companies. The clothing industry covers a wide range, so the green and sustainable development of the clothing industry needs to be considered from the aspects of design, materials, production, and technology. The development of China's clothing green environmental protection industry has problems of insufficient system and insufficient technological innovation capability. This article analyzes from the three aspects of design method, raw material selection method, and production method, and analyzes, summarizes and summarizes the relevant green sustainable development cases in the clothing industry, and proposes zero-waste design, detachable design techniques, 3D weaving technology, and green dye The reference suggestions of the whole technology and DPOL technology to solve the problem provide reference and reference for the green sustainable development of the apparel enterprises.

Sustainable Design

Zero waste design
A large number of designers are exploring on the road of one piece and zero waste. Among them, Japanese designer Issey Miyake released his own design brand “132.5” in October 2010. In “132.5”, the fabric is still

folded once in origami form. The concept of molding is unique among contemporary designers. All of the brand's designs are cut and sewn from a piece of cloth. The fabric used is also a polyester fiber material made from recyclable PET plastic bottles. It not only adheres to zero waste, but also fully upholds the concept of sustainable development.[2] As shown in Fig. 1, the "132.5" clothing meets the basic needs of human dressing. More importantly, the folding design allows the clothing to be flexibly changed in structure by changing the fixed point, increasing the possibility of wearing and reducing unnecessary waste. , Which enhances the sense of design and facilitates storage and maintenance.

Figure 1. Design "132.5"

Pattern zero waste design

Pattern zero waste design is a design concept that incorporates the reduction of fabric waste into the design and production links. As early as in traditional Japanese clothing, such a concept already exists, as shown in Fig. 2, a kimono is carried out[3]. After the split, you will find that the kimono is composed of multiple rectangles of different sizes and lengths, and these rectangles are a complete fabric after recombination. Therefore, the traditional Japanese kimono has minimized the discard rate during the pattern design stage.

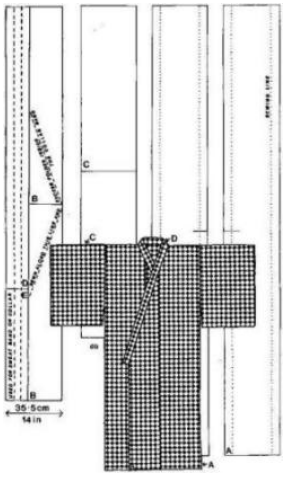

Figure 2. *Traditional Japanese kimono*

In addition, since the last century, many designers had insisted on the study of "paper pattern zero-waste design", such as the "One-Seam coat" designed by Balenciaga in 1961and the "one piece skirt" designed by Yeohlee Teng in 2009 and so on.They had attracted extensive attention.[4] In today's society, the environmental impact of waste and over-manufacturing in the production process of garments is becoming more and more serious, and the concept of sustainable development of clothing is becoming more and more popular. Therefore, such "paper pattern zero waste design" has gradually become popular and valued.

Removable design

Removable design is a common functional design in the contemporary era. Under the concept of green environmental protection, the interchangeability of detachable design allows clothing to change its style to achieve the purpose of wearing the same clothing on different occasions and in different seasons , thus extending the service life of clothing.

Figure 3. *Template changes*

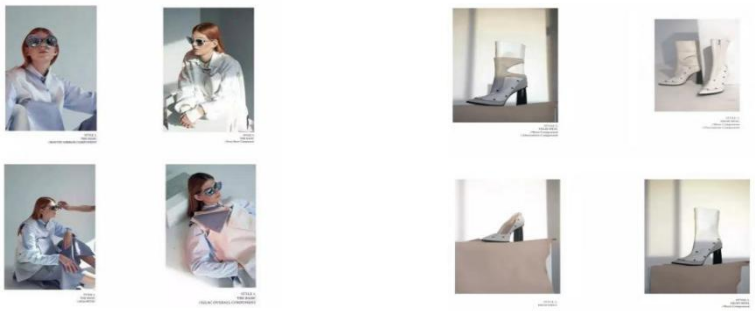

Figure 4. *Accessories*

Parsons graduate Wei Hung Chen, designed to overcome the waste problemin his graduation design work.[5] He designed seven clothing modules that can achieve more than 30 styles through different transformations, expanding in the style of dress. At the same time, it suppresses the waste caused by fast fashion. As shown in Fig. 3, a skirt can be disassembled as part of a jacket, or two layers can be disassembled and reassembled into a new state, increasing the choices of clothing. In addition, for more matching methods, as shown in Fig. 4, the designer also made accessories to enrich his clothing modules, to inspire the wearer's inspiration. He randomly combined the various modules, to participate in the creation of his own daily clothing. Interchangeability will extend the use of a piece of clothing to achieve sustainable development.

Recycling design

In the modern industrialization, the mass production of clothing has caused a lot of waste in the replacement of clothing. Therefore, the design of clothing recycling has great environmental protection value. The cutting-edge designer Faustine Steinmetz is dedicated to the exploration of denim. She collected the old denim clothing for reconstruction. She splited the denim clothing into multiple strips, stitched it into a brand new denim suit, and did the raw edge treatment. She perfectly interprets the sustainable development concept of fashion personality.[6]

Figure 5. *Design for Dior*

Figure 6*. Design for LV*

In addition to this patchwork design, in the sustainable design for the major brands made by Saint Martin students, different discarded technologies are used to create a new look and maintain the originality of the brand. Fig. 5 is the design made by the student for Dior. The old clothes are cut into rectangles for sewing into pants, and then the remaining fabric is made into skirts, sleeves, hoodies. At the same time, the pleats are used to reduce the loose volume and create unintentional clothing styling. The students who designed for Louis Vuitton integrated the brand's sense of travel, based on comfort and flexibility. As shown in Figure 6, all body fabrics are cut into squares to recreate, and the remaining sleeves become the collar. They create a deconstructed beauty, while adhering to the environmental concept of sustainable development.[7]

Sustainable Material Selection

The green concept requires the selection of clothing materials to comply with the "3R1D" principles, namely "Reduce", "Reuse", "Recycle", and "Degradable". Therefore, clothing that conforms to the green concept is the proper use of fabrics and accessories, materials can be recycled, and easy Degraded. This requires that the raw materials of clothing are environmentally friendly and human friendly from the beginning of production, to the processing of the clothing production chain, to the use of consumers, and finally to the end of use and recycling. The use of energy and pollution to the environment must be controlled within prescribed standards.

In China, the apparel industry's requirements for ecological textile fabrics are still generally low. The currently implemented standard is the GB/T1885-2010 ecological textile technical requirements, which has been implemented since August 2012. It is not much different from the 2010 version of the international ecological textile technical requirements, and is far from the latest 2019 version of the international standard requirements. For example, the requirements for the samples of heavy metals, polycyclic aromatic hydrocarbons, surfactants, etc. are still temporarily lacking.[8]

Among the natural fabric cotton, linen, silk and wool commonly used in clothing, organic cotton and colored cotton are common green ecological materials. Organic cotton is different from ordinary cotton in that it does not involve pesticides and other chemicals that pollute the environment and are harmful to humans. Because colored cotton is naturally colored and antibacterial, it eliminates the bleaching and dyeing steps of the processing process, and does not contain dyes and other harmful chemicals. It is more suitable to be close to the skin, and is a high-quality material for making underwear, pajamas, sportswear, and clothing for pregnant women, infants and children. In addition, there are some newly developed green natural fabrics, for example, aloe fiber is suitable for making health care functional socks, sportswear, underwear and other knitted products. The product has the functions of moisture absorption, breathability, deodorization, anti-mold and antibacterial, which is beneficial to human health. With the increasing demand for fabrics and the continuous improvement of technology, more green ecological fabrics have appeared. For example, bamboo fiber, soybean fiber, milk fiber and so on.[9] Recycled fibers made from waste plastics and clothing as raw materials, combined with spinning and processing through modern scientific and technological means, are energy-saving, emission-reducing and high-value-added products. They are also common green ecological materials.[10]

In addition, in September 2017, Color Solutions International (CSI) launched "Sustainable Colors and Trends". The dyeing technology used for fabrics is also a key reference element for fabric selection. Traditional dyeing technology generates a large amount of waste water, harmful substances and energy consumption. At present, the dyeing technology of fabrics is also constantly being upgraded. For example, the “Reactive Dye Salt-Free Dyeing Key Technology” project of Qingdao University has realized the industrialization of salt-free dyeing for the first time and has been put into use. Compared with two-phase dyeing, it saves energy by 27% and reduces pollutant emissions by 74.2%. Compared with conventional loose fiber dyeing, it saves 67% of chemicals and reduces waste water discharge by 46%.[11]

In the selection of clothing materials, pure natural fibers are used, and the materials with low environmental consumption cost are used. The use of environmentally friendly process technologies such as natural dyes and environmentally friendly dyeing aids in the production of apparel products will guide and encourage consumers to purchase green and environmentally friendly products, and promote the development of

environmentally friendly products and the application of environmentally friendly processes by enterprises, which will become the future apparel New direction of enterprise development.

In today's enterprises, more and more enterprises realize the importance of sustainable green design to the development of enterprises. klee klee is a sub-brand of Suran. In 2017, the brand launched a cultural development and protection cooperation project with the Chinese ethnic minority Dulong ethnic group, completed a series of Dulong ethnic pattern surveys, product upgrades and transformations, and reorganized the unique design with modern design The patterns, materials and yarn weave structure of the dragon family. In addition to the cloaks, bags, carpets and other products with visual design, its products have been warmly loved by consumers, and are sold out. The klee klee brand uses environmentally friendly cotton, organic linen, organic ramie, and no genetically modified wool in the raw materials of the product, which not only increases the skin-friendly comfort of the product, but also reduces the consumption of raw materials to the environment. In addition, the klee klee brand did not ignore the importance of environmental protection in the process of product production organization. The physical decolorization and dyeing process is omitted from the product design process, and the original production is retained. The "sign language and blue" series of products developed by it also adopt a zero-waste design method, retaining the actual width of the original fabric and reducing the amount of scrap Waste, improve the utilization of fabric. In the decoration design of its brand's physical stores, the original clay bricks are also used for decoration. The klee klee brand goes deep into every link of the life cycle to reduce the damage and consumption of products to the environment and form a complete environmentally friendly manufacturing chain.[12]

Sustainable Production of Clothing

D technology and knitting cross-border cooperation

Uniqlo held a global exhibition in Paris during the 2018 Fashion Week, with knitwear as the protagonist. All the knitwear is made by 3D wholegarment technology. The biggest advantage of this technology is the whole garment. Three-dimensional weaving, avoiding sutures and thread ends, and can accurately achieve the layout required by the designer. As shown in Fig. 7, Uniqlo has also applied this technology to the Uniqlo U series in a small range. In the production process, traditional production of knitted sweaters requires many processes such as cutting and manufacturing of fabrics, which will not only produce waste of fabrics but also reduce efficiency 3D wholegarment technology can completely avoid unnecessary waste and reduce labor costs, saving Uniqlo's expenses as a whole. Therefore, after this series, Uniqlo slowly put the technology to the public and directly for consumers Produce the garments they want and achieve a zero-waste, green and sustainable production method.

Figure 7. *Uniqlo U series*

3.2 Green dyeing and finishing of knitted fabrics

In China, the dyeing and finishing industry consumes more than 10 billion tons of wastewater each year, and the wastewater discharge accounts for about 35% of the total industrial discharge.[13] Therefore, the resource-saving and sustainable development of the dyeing and finishing industry must not be delayed. With the development of science and technology, the dyeing and finishing industry gradually uses emerging technologies to save water and save energy in all aspects.

In the pretreatment process, bio-enzyme technology and cold dyeing technology can improve the quality of the pre-treated fabric, and save energy, water, and additives, reduce the cost of pretreatment and the difficulty of sewage treatment. Compared with the traditional alkali treatment process,bio-enzyme technology and cold dyeing technology are more efficient and sustainable. In the dyeing process, there are currently great achievements in aerosol dyeing, cold roll dyeing, small bath ratio dyeing, supercritical carbon dioxide dyeing, etc. Aerosol dyeing is based on the combination of equipment and technology, and cold roll dyeing is reducing consumption. At the same time as the effect of energy consumption and chemical consumption is significant, the product quality has also been significantly improved. Small bath ratio dyeing can not only save dyes and reduce the amount of alkali-fixing salts in dyeing alkali baths, but also reduce waste and wastewater discharge. The Dutch DyeCoo was first developed and is currently being put into practical use. The advantages of this technology are that it does not require water, chemical additives, dye utilization, high efficiency, and low energy consumption. The most important thing is that carbon dioxide can be recycled and will not produce sewage. As well as harmful gases, to achieve environmentally friendly development.

On the basis of pretreatment and dyeing, the printing process is also developing rapidly. Energy-saving and emission-reducing printing technologies include: urea-free reactive dye printing technology, full solid color printing technology, and single-channel rapid digital printing technology. The urea-free reactive dye printing technology can solve the problem of sewage nitrogen and ammonia exceeding the standard, but the performance needs to be improved. The full fixing printing technology is effective in improving the problem of reactive dye fixing rate. The single-channel fast digital printing technology is a new technology in recent years, which completely solves the problem of the speed of the scanning machine. It not only has a high output, but also saves the time of plate making and network making, and most directly contains the pollution caused by electroplating and the pollution of chemical waste left over from the network.It is of great significance to the digital printing market and the sustainable development of the dyeing and finishing industry.

With the development of global garment industry, finishing technology is becoming more intelligent and multifunctional.At the same time, the application of ion treatment technology and foam finishing has also been developed. Plasma treatment technology can have a significant effect in reducing sewage discharge and saving steam consumption, and greatly reduce the amount of chemicals, which not only effectively saves costs, but also is a major Breakthrough.[14] Foam finishing is a typical low-feed solution and energy-saving process for ecological requirements. It can ensure that chemical agents are evenly distributed under the minimum moisture supply condition, which is fully in line with the development of green dyeing and finishing.

DPOL technology

The DPOL (Direct Panel on Loom) technology invented by Indian designer Sid-dhartha Upadhyaya completely subverts the traditional garment production process. As shown in Fig. 8, this technology connects the loom to the computer, and the set pieces are directly produced by the loom. The road and the seam allowance are produced together, which is convenient for direct stitching.[15] This technology saves the traditional link from cutting to sewing, and the production time is greatly shortened. More importantly, it saves waste scraps. Like 3D weaving technology, it avoids waste from the source of production and has great market potential.

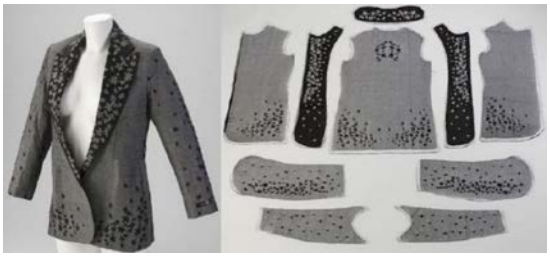

***Figure 8**. Garments and cuts produced by DPOL technology*

Recycling upgrade

The green concept in clothing, or ecological concept, means that throughout the entire life cycle of a clothing product. It must not only protect the natural ecological environment to the maximum, but also achieve the high quality level of the clothing product and realize the function of the clothing product to people. Therefore, starting from the source, the green design of clothing should pay special attention to the selection of clothing materials, which should not only be friendly and comfortable to human body, care for health, but also take into account the treatment of materials in production and the recycling of materials at the end of service life, so as to reduce the generation of waste, reduce environmental pollution and energy consumption, and achieve the ultimate goal of mutual benefit and symbiosis between human and nature.

In January 2013, the State Council issued the Circular Economy Development Strategy and Immediate Action Plan, which included the textile and apparel industry in the national circular economy development strategy.[16] The circular economy is different from the traditional economy. It is not a linear economy with one-way flow of materials, but a network economy of material energy circulation supported by ecosystem theory. It implements the guidelines of low exploitation and high utilization of resources to prevent the generation of environmental pollution. Mainly, the green accounting system is adopted as the evaluation standard, and the whole process is controlled to try to achieve zero or low emissions of waste. For example, the "Eco Circle" system adopted by Zhejiang Jiaren New Materials Co., Ltd.'s "High-quality Waste Textile Chemical Recycling" project is the world's first recycling system with polyester chemical recycling technology as the core. The clothing recycling system reuses used clothes in the form of fibers in the manufacturing of clothes, reducing environmental pollution in the treatment of used clothes, and at the same time reducing the resource consumption of clothing production.[17]

CONCLUSION

At present, the textile and apparel industry as a whole is faced with difficulties such as rising prices of dyeing and finishing processes and increased labor costs. Therefore, green and sustainable development of the apparel industry is the only way to accelerate the transformation and upgrading of the industry. Green sustainable development has become a driving force for building an environmentally friendly enterprise. From the clothing design method, the zero-waste design method of fabric and paper pattern can be adopted, so as to achieve the minimum waste rate of fabric in the design stage. The detachable design can create a brand new appearance of the garment, maximize the use times and lifespan of the garment, and reduce the consumption cost of the environment. The selection of garment raw materials follows the 3R1D principle, and is reduced, repeated, recycled, and degradable. Through the combination of modern technology and new green environmental protection materials such as cellulose fiber, soybean fiber, organic cotton, colored cotton and other new environmentally friendly materials, energy saving, emission reduction and high value-added products are manufactured. On the sustainability of apparel production methods, the cross-boundary technology of 3D technology and knitting realizes a seamless process, reduces waste of scraps, improves the efficiency of apparel production and reduces energy consumption, thereby achieving true zero loss. Green. The use of aerosol dyeing technology in knitting dyeing and finishing and pretreatment, the use of innovative technologies such as ion treatment in post-processing and foam finishing technology, provide new ways for green sustainable development of clothing. In addition, the design must not only meet the requirements of environmental protection, but also ensure the function, service life and quality of the product. Supervising products through environmental certification in the apparel market and guiding consumers to purchase green and environmentally friendly products will become the main trend of green and sustainable textile development in the textile and apparel industry.

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REFERENCES

[1] Development and Reform Commission: Energy-saving and environmental protection industry planning is being stepped up and formulated. Ferroalloy, 2009.
[2] Wei Linna. "132 5." Design by Issey Miyake. Beijing Institute of Clothing Technology, 2015.
[3] Zhang Mengxuan. Experimental application of "one-piece" structured clothing. Shenzhen University, 2017.
[4] Yuan Zhen. Research on zero-waste clothing structure design based on fabric width. Zhejiang University of Technology, 2017.
[5] 一 衿 × YIJIN. Freely modular modular clothing | Parsons graduate Wei Hung Chen. http://www.sohu.com/a/198318558_540061
[6] Doudou. Vision-Fashion - The feelings of denim in the old days. Sohu.com.
http://www.sohu.com/a/123204997_526372
[7] Fashion designer. Redesigning big-name waste clothing such as LV, Dior and Givenchi. Redefining brand clothing with waste clothing | Saint Martin students provide sustainable design for major brands http://www.sohu.com/a/138698921_758194.
[8] Li Xueyang. Research on the detection of harmful substances in ecological textiles and the analysis of the composition of coated fabrics. Tianjin University, 2017.
[9] Cong Honglian, Fan Siqi, Dong Zhijia. Development status and development trend of functional warp knitted sports fabric products. Textile Herald, 2017 (05): 83-86.
[10] Liu Xiao. Recycling the recycled resources of polyester fiber. Dyeing and finishing technology, 2018, 40 (04): 7-9, 36.
[11] Song Fujia, Liu Kailin. Inventory of environmental protection dyeing and finishing technology. Textile Herald, 2018 (11): 64-67.
[12] Zhang Jianwei. The Yunnan Dulong Ethnic Culture Development and Protection Project was launched. People China Youth Network. Http://wenhua.youth.cn/xwjj/xw/20160 4 / t20160423_7901611.htm
[13] Wang Jiyong. Sustainable development of dyeing and finishing technology for cotton fabrics. Textile Herald,
2009 (10): 52 + 54-56 + 58-60 + 62-63.
[14] Zhao Hong, Cai Shenghua. Intelligent innovation and green production technology of knitting dyeing and finishing equipment. Textile Herald,
2018 (07): 32-35.
[15] Chang Zhuo. Zero-waste design of clothing in the context of sustainable development. Journal of Henan Institute of Technology (Natural Science Edition), 2016, 28 (02): 16-20.
[16] The 10 most influential news events in China's renewable resource industry in 2013. Renewable Resources and Circular Economy, 2014, 7 (04): 1-2.
[17] "Environmental management" is becoming more and more important Fibers contribute to environmental protection through technological innovation. Textile and Garment Weekly, 2016 (04): 53.

E-LEARNING FOR CREATING SAFE AND EFFICIENT ENVIRONMENT FOR TEXTILE STUDIES – A SKILLS4SMARTEX PROJECT CASE STUDY

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ABSTRACT

At a time when the world literally came to a standstill due to the pandemic of the new corona virus, the question of education at various levels seemed to be an insoluble task. However, as much as education and study were affected, the situation in these areas was not as critical as in some other areas, such as the production of goods. This was thanks to the fact that distance and e-learning techniques/environments have already been highly developed. Industrial production, as well as majority of services, were stopped in order to slow the spread of the pandemic. In Europe, these measures have generally come into force two to three months after the outbreak declaration. This paper presents some experiences related to distance and e-learning for creating safe and efficient environment for textile studies by using the e-learning materials, developed through a number of projects by consortia of partners from different European countries.

Key words: e-learning, textile studies, Erasmus+, Skills4Smartex project, pandemic

INTRODUCTION

The World Health Organization was informed by China on 31 of December 2019 about a pneumonia of unknown cause detected in Wuhan. The outbreak was declared a Public Health Emergency of International Concern on 30 January 2020 (WHO, 2020). Already on 13 of January the first case of novel coronavirus outside of China was confirmed in Thailand. As expected, the virus continued to spread fast in Asia, but also on other continents. A number of actions has been taken by countries and national governments in order to assure all needed measures for assuring health and care of people, above of those, infected by a new Corona virus COVID-19. By the end of February 2020, it was clear, that special measures will be needed to protect the lives and health of practically the whole world population.

Starting from 16 March 2020, the universities in Slovenia, among them the University of Maribor, switched from the conventional study process to distance education. The lectures and other forms of the study process were mainly carried out according to the regular, previously defined official timetables. Open-source learning platform Moodle is used as the e-learning environment, file storage and therefore the central part of e-learning process. It is a robust, secure and integrated system to create personalised learning environments. Moodle provides the most flexible toolset to support both blended learning and 100% online courses. It can be configures by enabling or disabling core features, and easily integrating everything needed for a course using its complete range of built-in features, including external collaborative tools such as forums, wikis, chats and blogs (Moodle, 2020).

Because of the pandemic outbreak the videoconferencing has become one of the most important parts of our daily life and work. Mostly used videoconferencing systems today include MS Teams, Skype and Zoom. At the University of Maribor MS Teams is the official videoconferencing systems for distance learning. MS Teams, Moodle and e-learning materials, created within the Erasmus+ projects Advan2Tex, TexMatrix and Skills4Smartex, assure the safe and efficient environment also for textile studies. Distance and e-learning can therefore help creating safe and efficient environment for textile studies by using the suitable e-learning materials, developed through a number of projects by consortia of partners from different European countries.

STRENGTHS OF E-LEARNING

In their book “The Learning Revolution”, the authors (Dryden G., Vos J., 2001) assessed that then for the first time in the history we knew the way how to store the most important information and how to make them

available – almost momentarily, in any desired form and literally to everybody. Computers and communication technology enable the networking of people into the world-wide network, destined for learning. The development changes in education are the most significant in transition of the conventional to the information society. E-learning presents the use of modern educational forms, greatly supported by computers and information technology. It can be stated as an important part of the emerging information society.

Numerous positive characteristics and effects of e-learning, above all place and time independency of teachers and students, can be effectively applied also to textile studies. From the literature it can be seen that e-learning originated from distance learning, which had in certain regions already a long tradition. However, one should keep in mind that modern concepts of distance learning and e-learning include more than simple mediation of study materials. E-learning covers a wide set of applications and processes, such as Web-based learning, computer-based learning, virtual classrooms, and digital collaboration. It includes the delivery of content via internet, intranet/extranet, audio- and video-streams, satellite broadcast, interactive TV, data carriers and more. Advantages, which are seen here are in asynchronous and just-in-time learning. Moreover, courses can be tailored to specific needs. Today, in modern learning environments, the information and skill-acquisition paradigm has evolved to incorporate technology, and a plethora of knowledge sources can leave learners feeling overwhelmed. The increase in flexible working hours and working from home means that not everyone will be on the same schedule or in the same location (Penfold S., 2020). These facts only confirm the need for suitable, well-structured and up-to-date e-learning materials, also for supporting textile education, in “pandemic” but also in “normal” times.

E-LEARNING PROJECTS IN TEXTILE FIELDS

In their work Designing e-learning materials with learning objects (Stracenski M. et al., 2004) the authors stated that e-learning materials were inevitable part of a modern educational environment. They have found applications in classical distance learning communities as well as in university and generally higher education courses. Advanced technology possibilities were the driving force behind the e-learning disseminations. The authors described in their paper Innovation, multimedia e-learning for textile industry – ETEX, presented at the 44. Congress IFKT in the year 2008, a multimedia-supported learning system, designed and developed by a project consortium of project partners from six European countries (Lenfeldová I. et al., 2008). The following topics were incorporated into the e-learning system: warp knitting (flat – single and double needle bar), weft knitting (circular – small, seamless; flat and straight bar frame) and knitted structures and patterns.

One can find in the literature and on the web numerous other attempts and realized e-learning projects designated to different areas, also those, related to textile and garment technology. Without any doubt, we can estimate that the number of e-learning products, designed especially for textile and apparel topics, will rise in the future.

The eLiTA project

E-learning is also an important part of a Lifelong Learning Programme, which aim is to enable individuals at all stages of their lives to pursue stimulating learning opportunities across the Europe. A consortium of seven academic and training organisations and companies from the United Kingdom, Greece, Latvia, Portugal, Romania and Slovenia started their activities within the eLiTA (e-Learning in Textiles and Apparel) project in October 2008 (Stjepanović Z. et al., 2010). The project was successfully concluded at the end of September 2010. The first computer-based learning modules were developed in 1995 at the Department of Textile Industries, University of Leeds, UK for undergraduate and postgraduate students to study the fundamental principles of textile technology. This “Introduction to Textiles” suite of modules provided an estimated 80 hours of learning material covering: Yarn Manufacture, Knitting Technology, Weaving Technology, Woven Structures, Non-Woven Fabric Manufacture, Dyeing, Printing and Finishing Technology, Clothing Technology and Textile Testing and Quality Assurance. Three additional modules followed in 1996 and another two in 2004. In 2004, the e-learning system was produced in Czech, French, Lithuanian and English language. Important technical breakthrough happened in 2006, when previously CD-ROM-based system became a web-based e-learning system. In this year, two additional partners from Turkey entered the project. Within the eLiTA project, the following four modules: Apparel Technology, Carpet Technology, Dyeing,

Printing and Finishing and Hosiery Technology were updated, converted for internet delivery and translated into Greek, Latvian, Portuguese, Romanian and Slovenian to provide the modern interactive e-learning tools.

The Erasmus+ Projects

Erasmus+ programme was created for equipping the European citizens with the education, skills and creativity that they need in a modern knowledge society. Education and training principles have to adapt to new circumstances and assure the youth the knowledge needed to improve the competitiveness of the EU. Erasmus+ provides €14.7 billion over seven years to strengthen education, training, youth and sport in Europe (Erasmus+, 2020).

Project Advan2Tex

The first from the series of Erasmus+ projects carried out by the consortia of European project partners was entitled E-learning course for innovative textile fields – Advan2Tex (Stjepanović Z., Radulescu I.R., 2015). It was accepted for financing under the Strategic Partnerships Vocational Education and Training in August 2014. The project duration was from September 2014 to August 2016. The project partners were INCDTP – The National R&D Institute for Textiles and Leather, Bucharest, Romania (Coordinator), University of Minho, Department of Textile Engineering, Minho, Portugal, Textile Testing Institute, Brno, Czech Republic, University of Maribor, Department of Textile Materials and Design, Maribor, Slovenia, and Technical University "Gh. Asachi", Faculty of Textiles, Leather and Industrial Management, Iasi, Romania. The Advan2Tex project envisaged the development of new tools for improving key competences of young textile specialists: professionals in the textile industry, young entrepreneurs and students in higher textile education. The project also aimed at improving the level and the assessment of textile competences, including entrepreneurship, languages and digital skills. Promoting the take-up of innovative practices by use of Information and Communication Technologies (ICT), open and flexible learning and promoting the structured inter-regional cooperation were the next two objectives. Last, but not least, the project aimed at promoting entrepreneurship education, employability and new business creation, supporting the personal and professional development of the target group. The following modules, related to seven selected innovative textile fields, were developed: (1) Advanced knitting technology; (2) Virtual prototyping of garments, 3D scanning, clothing for people with special needs; (3) New methods for testing textile materials; (4) Standardization of textile testing; (5) Sustainability of textile technologies; (6) Entrepreneurship, and (7) Innovation management.

Project TexMatrix

The title of the second project was Matrix of knowledge for innovation and competitiveness in textile enterprises – TexMatrix (Radulescu I. R. et al., 2019). It was a strategic partnership project for Vocational Education and Training. Its duration was from September 2016 to August 2018. The consortium of project partners was almost the same as for the Advan2Tex project with the difference that instead of the Textile Testing Institute, Brno, there was a new partner from Italy, the Centrocot institute and TecMinho instead of UMinho. The Knowledge matrix for innovation can be understood as a powerful instrument to quantify the intangible assets of a textile enterprise. Examples of intangible assets are: innovation strategy/culture, informational resources, training methodology, relationships portfolio, IP rights etc. Their identification for selected European textile enterprises was used as a basis for benchmarking study. The SWOT and GAP analysis of this study helped the research providers of the project's partnership to offer innovation management, research and training methodology solutions for the textile enterprises. These solutions were comprised within a comprehensive Guide, to serve as support for the training courses. The Guide was implemented as e-learning content on existing e-learning platform. An important part of the project's outcomes was the e-learning course, which was prepared in five European languages (English, Italian, Portuguese, Romanian and Slovenian) and included multiple choice tests in each module, YouTube videos with interviews and various communication instruments between tutors and trainees. The impact of the project's outcomes was especially high within the organized multiplier events and blended courses. Various target groups of textile professionals and trainees were successfully addressed (Radulescu I. R. et al., 2019).

Project Skills4Smartex

Smart textiles for STEM training – Skills4Smartex is the third in the series of Erasmus+ projects. It is an ongoing project with the duration of two years (October 2018 to September 2020). The project consortium is:

INCDTP – Bucharest (coordinator), TecMinho as interface of the University of Minho, Portugal, Gent University, Belgium, University of Maribor, Faculty of Mechanical Engineering, Slovenia, Technical University "Gh. Asachi"- Iasi and TZU, the textile testing institute from Brno, Czech Republic.

The main aim of the project is to improve the knowledge, skills and employability of VET students in the fields related to STEM by providing appropriate training tools to understand multidisciplinary work through smart textiles. The main objectives of the project are: (1) Creating a Guide on smart practices meant for supporting innovation in textile enterprises; (2) Creating a Course in smart textiles, meant for multidisciplinary thinking; (3) Creating a Dedicated e-learning instrument, meant for channelling the interest of VET students for "serious games"; (4) Improving the skills of VET students by means of practical work in constructing smart textile prototypes. The three main outputs of the project are: O1 – Guide for smart practices; O2 – Course in smart textiles; O3 – Dedicated e-learning instrument.

The Guide for smart practices started with the survey aimed at a state-of-the-art report related to Technical and Smart Textiles with the goal to identify existing opportunities for producing smart textiles in European companies by using a questionnaire and forecasting expected occupations and work profiles for young trainees. The elaboration of the questionnaire and performing the survey by involving altogether 63 textile companies followed. In addition, the analysis related to technical/smart textiles was performed by including some representative companies from each of the involved countries, which had more experiences/products in the relevant area. The results were published in a Guide for smart practices meant for transferring smart practices from enterprises to Vocational Education and Training (VET) schools and young students (Rudolf A., Stjepanović Z., 2020). Providing real life prototypes and multi-disciplinary working activities on smart textiles will make textile occupations more attractive to young students, and will improve knowledge, skills and employability of VET students in STEM related fields. The Guide for smart practices is implemented on-line using the Moodle e-learning platform (Radulescu I. R. et al., 2019).

The Course in smart textiles comprehends the chapters for the smart textile course with multiple choice tests for each of the following seven chapters: (1) Novel fibers and yarns; (2) Plane material structures; (3) Virtual prototyping of sensors on garments; (4) Smart textile prototype design; (5) Smart textile prototype manufacturing; (6) Data processing; (7) Testing of smart textiles. Each chapter has four educational modules, consisting of the basic disciplines needed to develop smart textiles: Mathematics, Physics, Materials Science and Chemistry and Electro-Technics. Each chapter was prepared by one of the project's partners. Altogether, seven chapters result in a total number of 28 educational modules on smart textiles. These educational modules were prepared from the theory to practice and are called STEM to SMART approach. In addition, special attention was given to the elaboration of smart prototypes and preparation of four modules for each of the chapters by each partner from the smart prototype to the theory, called SMART to STEM approach. These modules will help the participants of the blended courses to understand the basic principles of design/production/functions of smart textile materials/products. A total of 56 modules have been prepared for both approaches within the Skills4Smartex project.

In order to enable quick and free access to the 56 educational modules an e-learning instrument was programmed in PHP. This instrument includes a filter, which enables selection of the desired educational module, Figure 1. Three criteria underline the concept of the modules:

- The approach from theory to practice (STEM to SMART) or vice-versa (SMART to STEM).
- The chapter of technological process step of smart textiles.
- The STEM discipline.

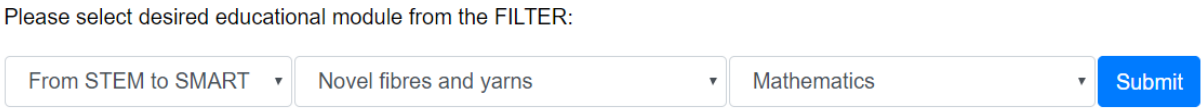

Figure. 1 – Print screen of the PHP filter

As such, the PHP filter acts as "serious games" e-learning instrument. By permitting quick and free access to the educational resources, the instrument complies with the provisions of the Erasmus+ program and enables a synthetic overview for the learners. This structural concept supports the idea of distance learning.

The Chapter entitled Virtual prototyping of sensors on garments was prepared by the Slovenian partner University of Maribor, Faculty of Mechanical Engineering, Institute of Engineering materials and Design. It was based on the creation of a virtual and real prototype of the garment used for both approaches, STEM to SMART and SMART to STEM. Figure 2 presents the virtual and real prototype of the blouse with two types of switches determining the level of a smart textile product.

Level 1 - Switch ON/OFF *Level 2 - Switch 'push button'*

Figure 2: Virtual and real prototype of the blouse

An example from the e-learning materials related to the STEM to SMART approach for the Chapter Virtual prototyping of sensors on garments is given for the module Mathematics. The use of mathematics has been explained on the example of 3D body scanning. In clothing engineering, the 3D human body model presents an important part for simulation of virtual garments. It is obtained by 3D scanning of the human body whose 3D body model is imported into a virtual 3D CAD/PDS environment. Figure 3 represents the principle of a laser triangulation sensor; shown are two object positions (3D Scanning, 2020). Similarly are explained with text, figures and equations all other natural sciences comprehended in Chapters and Modules, for both STEM to SMART and SMART to STEM approaches.

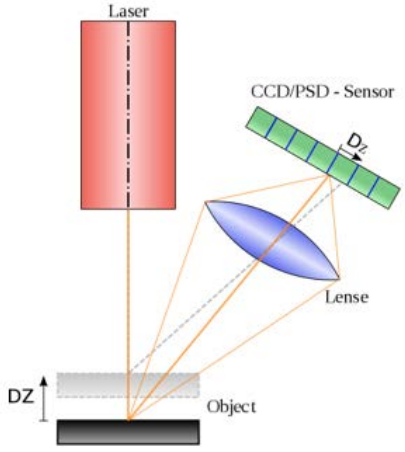

Figure 3: Principle of a laser triangulation sensor

CONCLUSIONS

Due to the pandemic, universities in Slovenia, including the University of Maribor, switched from traditional study methods to distance learning as of 16 of March 2020. Lectures and other forms of the study process were mainly carried out according to the regular, previously established official timetables. It was proved that MS Teams, Moodle and e-learning materials created within the Erasmus+ projects Advan2Tex, TexMatrix and Skills4Smartex can ensure a safe and efficient environment for textile studies. Distance and e-learning

can therefore help to continue the education in textile-related fields by using the appropriate e-learning materials developed in a number of projects by consortia of partners from different European countries. This contribution focused more on the on-going project Skills4Smartex as a case study for modern e-learning in the field of smart textiles.

Acknowledgment
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REFERENCES

WHO (2020). *Rolling updates on coronavirus disease (COVID-19).* Available online at https://www.who.int/emergencies/diseases/novel-coronavirus-2019/. [Accessed 15. 4. 2020].

Moodle (2020). *The Moodle Project*. Available online at https://docs.moodle.org/. [Accessed 16. 4. 2020].

Dryden G., Vos J. (2001). *The Learning Revolution*, Educy, Ljubljana.

Penfold S. (2020). *Modern learning: 6 reasons why learning has changed forever*. Available online at https://elearningindustry.com/ [Accessed 21. 4. 2020].

Stracenski M. et al. (2004). Designing e-learning materials with learning objects, Proceedings of the conference *Mipro 2004 "Computers in education"*, Rijeka, pp. 13-16.

Lenfeldová, I. et al. (2008). Innovation, multimedial e-learning for textile industry – ETEX, Proceedings of the *44 Congress IFKT "Knitting round the clock"*, Saint-Petersburg.

Stjepanović Z. et al. (2010). The eLiTA project: web-based education platform for textile studies. *International Joint Conference on Environmental and Light Industry Technologies*, Budapest, Hungary, pp. 241-249.

ERASMUS+ (2020). *EU programme for education, training, youth and sport*. Available: https://ec.europa.eu/programmes/erasmus-plus. [Accessed 21. 4. 2020].

Stjepanović Z., Radulescu I.R. (2015). ERASMUS+ Project Advan2Tex: Overview and objectives. *Fibres & Textiles in Eastern Europe*, 23 (3), pp. 142-143.

Radulescu I. R. et al. (2019). Texmatrix - The knowledge matrix for innovation applied to textile enterprises. *Industria textilæa*, 70 (2), str. 197-202.

Radulescu I. R. et al. (2020). Dedicated e-learning instrument to support STEM knowledge by means of smart textiles. *The 16th International Scientific Conference eLearning and Software for Education*, Bucharest.

Rudolf A., Stjepanović Z. (2020). STEM education intended for understanding the development of smart textile products. *III Međunarodna konferencija Savremeni trendovi i inovacije u tekstilnoj industriji*, Beograd.

3D Scanning (2020) *Triangulation*. Available from: https://en.wikipedia.org/wiki/3D_scanning#Triangulation. [Accessed 28. 4. 2020].

RESEARCH ON PHYSICAL PROPERTIES AND SUBJECTIVE ASSESSMENT OF PROTECTIVE MASKS

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ABSTRACT
The research about the physical characteristics of disposable protective masks of different types, materials and manufactures, as well as the subjective feeling of wearing masks and the possibility of unimpeded breathing and sweating. Three types of masks made of nonwoven (disposable) materials as well as one type of reusable, washable masks made of cotton were used in this research. In the experimental type, the structural and constructive characteristics of the cotton masks were determined and the physical properties of all four types were examined. Water vapour permeability through absolute and relative permeability and air permeability through materials as well as the sample mass before and after wearing one after a period of one or two hours were also examined.

Key words: *Protective masks, nonwoven textile fabrics, cotton fabric, air permeability, water vapour permeability, subjective assessment of comfort*

INTRODUCTION

The structure of nonwoven material the protective masks are made from is porous. Research shows that pore size is closely connected to tissue permeability function. The larger the average pore size of the same type of fabric, the better permeability. Differences in pore size and permeability of different types of fabrics are obvious. For the same type of fabric, the permeability differs due to differences in material, starting from fibers, yarn density, fabric structure, warp and weft density as well as fabric thickness. Since the permeability of duplicated fabrics is significantly lower than the permeability of single-layer fabrics, duplicated fabrics have an enhanced barrier property of harmful substances. Nonwoven materials usually represent a network structure of one type of fiber, with higher permeability and higher passage of harmful substances through the material, while in combination with other fibers, it has a larger contact surface. Therefore, it has a stronger absorbing function. The permeability function is a characteristic of a surgical mask, which mostly depends on the structure of the fabric and the method of combining the material. At the same time, permeability also affects the comfort, filtration strength and impermeability of surgical masks, thus affecting the quality itself. Therefore, the establishment of standards for testing the permeability of surgical masks is good for improving the system of production of medical masks and thus ensuring the health of surgical masks users.
General protective masks are mostly divided into four categories: 1 – fabric masks, 2 – medical masks, 3 – surgical masks and 4 – N95 masks.

Methods for selecting masks

Mask quality requirements generally include two categories, mask usage requirements and mask performance requirements. There are some basic requirements for its usage: the mask should cover the user's mouth and nose, the mask should have good tightness on the face, the surface of the mask should not be damaged or stained, the mask should meet certain degrees of color fastness, the mask's belt should meet a certain strength not to be torn apart and so on. The thermophysiological comfort of the masks represents a way in which the mask lets in or retains heat and moisture and thus helps the body maintain a balance of heat while resting or during different intensities of activities. According to ISO 7730 standard, thermophysiological comfort is defined as "a state of mind that expresses satisfaction with the warmth of the environment". The most important influences on the thermophysiological comfort of users are: (M. S. Pesic, Leskovac, 2020.)

- influence of clothing-mask (thermal resistance, resistance to water vapour passage…),
- environmental impact (temperature, relative humidity, air speed),
- activity level.

EXPERIMENTAL PART

Materials

Figure 1. shows the appearance of all types of masks used in the research. The masks are selected in accordance with the market and demand. Four types, the most commonly used masks that can be found in all pharmacies and retail shops, are given in Figure 1.

a) *b)* *c)* *d)*

Figure 1. Masks used in the research

Sample a) Reusable cotton mask: (washable) in twill 2:1 weave. The longitudinal mass of the weft is 27.5 tex and the longitudinal mass of the warp is 27.4 tex. The density of the warp is 43 *wire/cm*^{1}, while the density of the weft is 25 *wire/cm*^{1}. Its surface and volume mass are: 208,23 $g \cdot cm^{-2}$ i 0,17 g/cm^{3}.

Sample b) Protective three-layer disposable mask (blue): Raw material composition: nonwoven fabric. The mask contains so called "filter" made of polymer extrusion and it represents the central layer of the mask, which has an antibacterial role as well as a deodorizing role. High quality polypropylene of nonwoven material, three layer, with ultra-thin design. Its surface mass is 83,12 $g \cdot cm^{-2}$. Bulk density is 0,079 g/cm^{3}.

Sample c) Protective three-layer disposable mask (light blue): The third type of mask is a three-layer disposable mask. It consists of a three-layer nonwoven fabric of 25 gram polypropylene. Its surface mass is 79,39$g \cdot cm^{-2}$. Bulk density is 0,045 g/cm^{3}.

Sample d) Protective three-layer disposable mask (white): The type of mask, which can be found at the best price and therefore it is most common on the market. This is a single-layer type of nonwoven fabric mask of 25 gram polypropylene. Its surface mass is 85,53 $g \cdot cm^{-2}$. Bulk density is 0,032 g/cm^{3}.

Standards

In this research, the following standards were used:
- SPRS EN 12751:2008, Textiles - Sampling of fibres, yarns and fabrics for testing,
- SPRS EN ISO 139:2007, Textiles - Standard atmospheres for conditioning and testing (ISO 139:2005),
- SRPS F.C0.011:1981, Textile products of flat surfaces (metric goods), fabric, fabric woven, fabric knitted, nonwoven goods and similar - Technical requirements,
- SRPS F.S2.016:1986, Textiles - Woven fabrics -- Determination of mass per unit length and mass per unit area,
- SRPS EN ISO 5084:2013, Textiles - Determination of textile thickness and textile products.
- SPRS EN ISO 15496:2008, Textiles - Measurement of water vapour permeability of textiles for the purpose of quality control (ISO 15496:2004),
- BS 5636 :1990, Textiles - Method for determination of permeability of fabrics to air.

Methods

Absolute and relative water vapour permeability

Absolute permeability (P_a) of water vapour represents the amount of water vapour in mg that passes through a material of *1 cm* in a period of *1 hour* and it is calculated by the formula:

$$P_a = \frac{60 \cdot m}{S_A \cdot t} (mg \cdot cm^{-2} \cdot h^{-1})$$

where:

m – is the mass of water vapour that passes through the material for a certain amount of time and it is determined by reducing the amount of water in the vessel *(mg)*,

S_A – is the working surface of the test tube – sample and it is equal to the evaporation surface *(cm^2)*,

t - is time *(min)*.

The relative permeability (Pr) of water vapour is the ratio of the mass of water vapour that passed through the material and mass of water vapour that evaporated from the uncovered cup at the same time:

$$P_r = \frac{m}{B} \cdot 100\ (\%)$$

where:
m – is the mass of water vapour that passes through the material for a certain amount of time and it is determined by reducing the amount of water in the vessel *(mg)*,
B – is the amount of water that evaporates at the same time from an uncovered vessel of the same dimensions *(mg)*.
Water vapour permeability test procedure
The absolute and relative water vapour permeability through the material is determined as follows: Two plastic cups of the same diameter were taken, filled with water (40 *ml*) and then their masses were measured. The first cup *(figure 2 a)* is covered with a sample of material which is 78 *mm* in diameter and which surpasses the surface of the cup opening on which the ring is further placed so that the material adheres better to the edge and it does not release water vapour around the rim of the cup. The second cup *(figure 2 b)* remains uncovered. After one and two hours (recommended time for wearing protective mask), the masses of the cups are measured. The differences in the masses of evaporated water will be used for calculating absolute and relative water vapour permeability through the material. All samples of the material on the cups were placed face up in the first case and vice versa in the second case. Measurements are performed both on the face as well as on the back of the material – masks.

a) *b)*

Figure 2. Water vapour permeability measurement: a) sample cup, b) open cup

According to the change in the mass of water in cups and the appropriate formulas, the calculation of the absolute and relative water vapour permeability through the material is carried out. While doing so, the surface of the opening on the ring, which is 14,51 cm^2, was taken as the working surface of the sample.

According to the formula for calculating **the absolute water vapour permeability** and the data from the table, the calculation of the absolute permeability was carried out. In the example below, the calculation for the first sample (CTN 1 R) is carried out for a time period of one and two hours.

$$P_{a1h} = \frac{60 \cdot \mathrm{m}}{\mathrm{S_A} \cdot \mathrm{t}} = \frac{60 \cdot 77.7}{14.51 \cdot 60} = \frac{4662}{870.6} = 5{,}354\ mg/cm^2 \cdot h$$

$$P_{a2h} = \frac{60 \cdot \mathrm{m}}{\mathrm{S_A} \cdot \mathrm{t}} = \frac{60 \cdot 161.7}{14{,}51 \cdot 60} = \frac{9702}{870.6} = 11{,}144\ mg/cm^2 \cdot h$$

The calculation of **the relative water vapour permeability** is carried out in accordance with the formula and the results of the mass of evaporated water. The example of calculation of the relative permeability for the first fabric sample is shown below:

$$P_{r,1h} = \frac{\mathrm{m}}{\mathrm{B}} \cdot 100 = \frac{77{,}7}{112{,}6} = 69{,}005\ \%$$

$$P_{r,1h} = \frac{\mathrm{m}}{\mathrm{B}} \cdot 100 = \frac{161{,}7}{213{,}2} = 75{,}844\ \%$$

Air permeability
Air permeability through textile material *(Pv)* or in other words the porosity of material, represents the amount of air *(cm^3)* that passes through material of 1 *cm^2* surface during 1 *s* at a certain pressure *p (Pa)*. It is calculated in accordance with the following formula:

$$P_v = \frac{\mathrm{V}}{\mathrm{S_A} \cdot \mathrm{t}} (\mathrm{cm^3/cm^2 \cdot s, ili\ cm/s})$$

where:

V – is the amount – volume of air passed (mm^3).
S_A – is the measuring surface of the sample (mm^2),
t – is the test time (s).

Air permeability test procedure

The sample that is being tested is placed in the terminals of the measuring instrument. Above the test head opening, the vacuum pump is automatically started by pressing the clamping arm. The selected test pressures maintained and after a few seconds, the display shows the air permeability of the test sample, in pre-selected measuring units. In this case, the permeability on the face and back of the material/ sample was measured separately. The measurement was performed in accordance with the standard BS5636 $5cm^2/98Pa/cm^3/cm^2/s$, on the measuring device for measuring air permeability (Air permeability tester SDL ATLAS - M021A -) *figure 3.* and the results were shown on the display of the device itself. The pressure was 98 *Pa*, while the measuring surface was $5cm^2$.

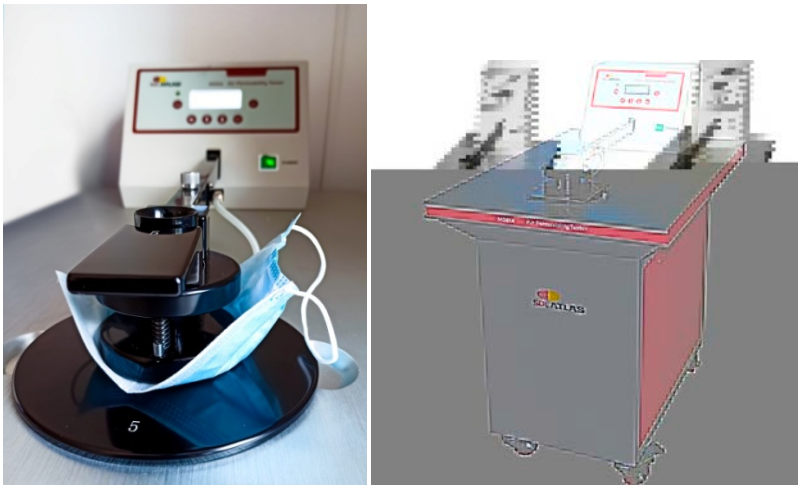


Figure 3. Air permeability tester SDL ATLAS - M021A -

RESULTS AND DISCUSSION

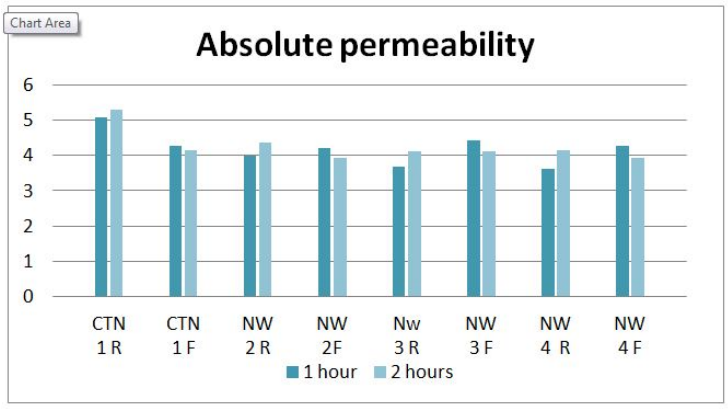


Figure 4. Histogram of absolute permeability depending on the type of material ($\frac{mg}{cm^2 \cdot h}$)
Note: Meaning of the abbreviations CTN - cotton, NW - non woven

Observing the results from the *figure 4* for the first cotton sample (CTN 1R and CTN 1F), it can be seen that the vapour permeability depends on the structure, construction and raw material composition of the material itself. When the results for all four samples are compared, it is clear that the first cotton sample has the highest permeability, while the samples obtained from chemical/artificial fibers have approximately the same level of

permeability. The permeability of all samples is higher from the back to the face *(the back of the material is facing the face of the person who is wearing the sample*) than from the face to the back. The first cotton sample has particularly pronounced value. This order corresponds exactly to the values of the structural parameters of the material as well as the method used for obtaining them. In fabrics obtained by weaving warp and weft, and where horizontal and vertical density, surface mass and porosity have a direct effect on permeability, it is clear that the materials obtained in this way will have better permeability compared to synthetic fibers.

In terms of raw material composition, NW – 2, 3 and 4 nonwoven material samples (polypropylene and polyester) have lower water vapour permeability compared to cotton fabrics due to their denser structure and lower porosity and thus water vapour passes through them more slowly.

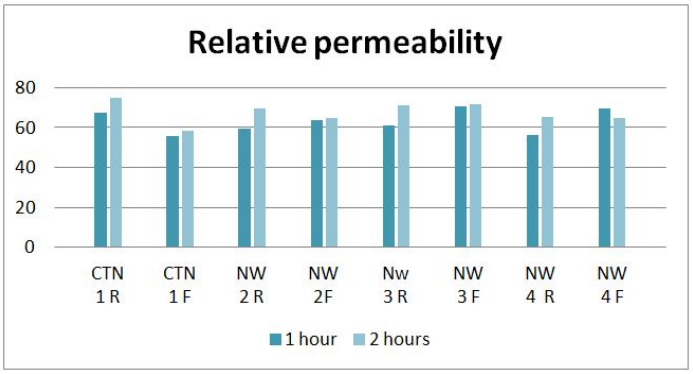


Figure 5. Histogram of relative permeability depending on the type of material (%)

In the case of relative water vapour permeability, the highest value possesses the first group of samples, CTN 1 R on the back of the material - *figure 5*. From the group of samples obtained from nonwoven materials, the highest relative permeability has NW 3 F measured on the face. It is followed by the sample 4 (based on its relative permeability) measured on the face, while the lowest permeability was shown also by the sample 4 on the back. Both absolute and relative water vapour permeability depends on the surface mass, material thickness, porosity and raw material composition.

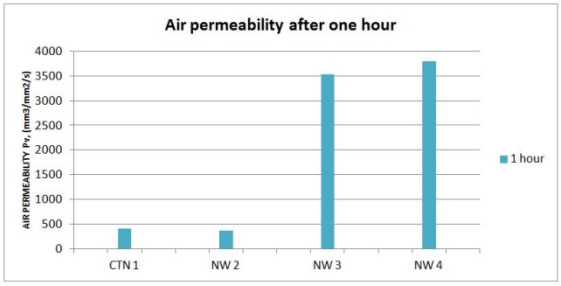


Figure 6. Histogram of air permeability change for each sample after one hour

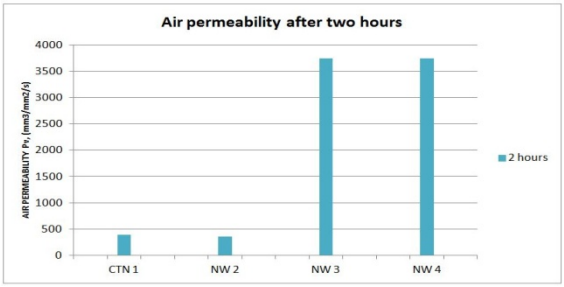
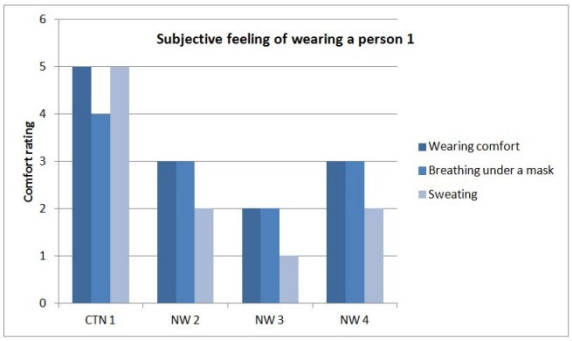
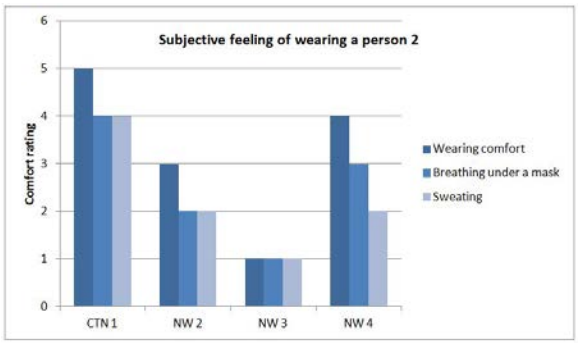


Figure 7. Histogram of air permeability change for each sample after two hours

Figures 6. and 7. show the mean value of permeability on the face and back of the material. It can be seen from the results that the air permeability is a quantity that depends on the raw material composition of the samples, i.e. on the structure of the yarn from which it is made and on other characteristics. Samples of nonwoven materials with polyester yarn have higher air permeability compared to cotton for the reason that PES yarn is made of filamentary fibers, so it is quite "smooth" in structure (compared to cotton yarn). Such yarn in fabrics provides less resistance to air flow. This difference can be especially seen in samples 3 and 4, which have approximate values. It was also found that samples with lower porosity have higher air permeability. When the values of air leakage are observed, especially from the face to the back and vice versa, it appears that these are different values. The reason for that is the different construction, ie. the appearance of the sample on the face and back, which is why the air permeability is different. It was also found that the permeability of the samples is increasing after wearing the sample for two hours in samples 3, 4 and 5, while in the cotton sample, the permeability after wearing the sample for two hours is decreasing.

Figures 8 and 9 clearly show an assessment of the comfort of wearing masks. Sample number 1 (cotton mask) for both persons represents the most comfortable mask to wear and to work smoothly. Other samples were less pleasant during wearing and created a less pleasant feeling for the persons who were wearing them, with occasional removal of the mask from the face. From the samples from the group of nonwoven materials (2, 3 and 4), the sample number 4 showed the best results for both persons, while sample number 3 was rated as the worst sample to wear.





Figures 8 and 9. Subjective feeling of wearing a protective mask

CONCLUSION

The structure of the used samples is conditioned by the properties of the fibers which were reflected in the packing density of the fibers in the material and their characteristics. As a consequence, the used materials are characterized by different pore sizes, i.e. different porosity, that caused differences in behavior of samples in terms of air and water vapour permeability. Water vapour permeability is closely connected to air permeability. In general, material that has higher air permeability also has a higher water as well as water vapour permeability.
Based on the analysis of the obtained results, their comparison and statistical processing, the following conclusions can be made taking into consideration the thermophysiological comfort of the products/masks worn on the user's face:

The comfort of the used product depends on many parameters. Therefore, only a comprehensive approach to measuring and calculating a large number of parameters in the technological range from yarn characteristics, through fabrication and finishing of fabrics to fabrication and verification of material characteristics can obtain reliable indicators for quality characterization of their properties. It is necessary to carefully design and produce an appropriate number of non-commercial samples in industrial conditions and perform their testing, and based on the connection of influential parameters in individual groups of tested characteristics the reliable indicators can be obtained.

According to the obtained results, it can be concluded that, when it comes to the subjective feeling of wearing protective masks, cotton masks are the most reliable and most recommended. It is primarily due to its natural fiber origin and pleasant feeling when they are worn on the face. Masks made of nonwoven materials showed less comfort when compared to cotton ones. Another indicator of the quality of cotton masks is that they can be worn repeatedly. Therefore, they justify the price, which is almost five times higher than the other types of masks.

When it comes to air permeability, polypropylene masks have shown significantly higher permeability, mostly due to the fibers, which are in general smooth, so that the air passes freely between the pores. As for the water vapour permeability, the cotton type of masks showed better water vapour permeability and thus, made it more comfortable to wear.

Observing the overall results, it can be concluded that there is a connection between the feeling of thermophysiological comfort of the assessor and the values of the parameters obtained by objective

measurements. Therefore, we can talk about a new method of assessing the thermophysiological comfort of the material, which includes both objective and subjective testing methods.
The obtained results are a reliable basis that the new method can be used in further research on new target groups of respondents.

REFERENCES:

[1] S. Lukic; A. Milutinovic-Nikolic; D. Martinovic, Netkani materijali na bazi agroceluloznih vlakana u ekologiji i medicini, 2003., XLVII ETRAN Conference, Herceg Novi,
[2] L. Mark and M.L. Marienfeld, "Geotextile trends and developments", Tappi Journal vol. 78 (9) pp. 143-146, 1995.,

[3] David Rigby Associates, Technical textiles and nonwovens: world market forecasts to 2010,
[4] Sunjka, S., Djekić, V., Filip, S., Netkani tekstil, Tehnicki fakultet „Mihajlo Pupin", Zrenjanin, 2009.,
[5] J. Stepanovic, S. Janjic; Mehaničke tekstilne tehnologije, 2015., Univerzitet u Banjoj Luci, Tehnološki fakultet, Banja Luka, 2015.
[6] V. Bijelic, Završni rad, 2015., Sveučilište u Zagrebu, Fakultet kemijskog inženjerstva i tehnologije, Sveučelišni preddiplomski studij, Zagreb, srpanj 2015.
[7] B. Davies, Nonwovens Industrial Textiles, vol. 3, pp. 37-43, 1998.
[8] P. Böttcher, "Medical textile: current status and trends" ITB NonwovensIndustrial Textiles, vol. 4, pp4-15, 1995.
[9] M. S. Pesic, Istraživanje termofiziološke udobnosti odeće od rebrastih pletenina - doktorska disertacija -, Univerzitet u Nišu, Tehnološki fakultet, Leskovac, 2020.
[10] S. Djordjevic, Uticaj strukturnih i tehnoloških parametara pletenina na njihove fiziološke osobine, -diplomski rad-, Univerzitet u Nišu, Tehnološki fakultet, Leskovac, 2013.
[11] https://www.synwinchina.com/how-does-air-permeability-affect-the-quality-of-surgical-masks
[12] https://www.testextextile.com/quality-detection-and-specification-for-use-of-masks/

INVESTIGATION OF AIR AND WATER VAPOUR PERMEABILITY THROUGH COTTON TYPES OF FABRICS OF DIFFERENT STRUCTURAL SOLUTIONS

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ABSTRACT

The air in the body – climate- clothing system determines the condition of the skin, the transfer of the heat, moisture and steam. Air also transmits heat radiation, e.g sunbeams, etc. The movement of that air in the physical and chemical sense determines the time in which a certain system (package) of clothes will be put on. This parameter is determined in accordance with the temperature of the human body and the difference in vapour pressure between human skin and the environment. There is a microclimate that is transmitted through the layers of clothing from the first to the last. This movement of air is called the "fireplace" effect. Rough (uneven) materials are harder to wet with the sweat of the human body than the smooth ones. In this way, the space of the microclimate between leather and textiles increases. In addition to the surface of textiles, the thickness and density of textile materials play an important role in air conductivity.

In this set of properties, the most important for application are moisture exchange properties, i.e.: water vapour permeability, hygroscopicity, air permeability, etc. On one hand, water absorption (or moisture) depends on the geometric characteristics of the material (its type, structure and construction). On the other hand, it depends on the pressure, temperature and humidity of the air.

Key words: water vapour permeability, absolute permeability, relative permeability, air permeability

INTRODUCTION

When designing clothes, it's necessary to know all the physiological-hygienic parameters that it is must ensure that it meets the exploitation requirements. Water vapor travels from humans skin through clothing into the surrounding air because of the differences in water vapor pressures on the skin surface and water vapor pressure in the surrounding air. Evaporated heat flow (wet heat flow orheat of vaporization) depends on the size of the clothing surface and the thermal resistance of the clothing flowwater vapor. Big role in the basic textile materials for the production of products from them, except structural mechanical and aesthetic characteristics, have hygienic properties that are not uncommoncalled physical properties. In this set of properties, the most important for application aremoisture exchange properties, that is water vapor permeability, hygroscopicity, permeability air, etc. The absorption of water (or moisture) depends on one side on the geometric characteristic of the material (of its type, structure and construction) and on the other hand of pressure, temperature and humidity. Cotton fibers have a pronounced absorption of moisture, they paint well and have permanent colors after several hours of washing and wearing. Because of good the strength of the cotton and the existence of bandages, which allow the extraction of individual fibers from yarns, fabrics have very good durability and strength. Cotton fabrics have a pleasant feel, good thermal conductivity and are comfortable to use, especially in warm climates.

EXPERIMENTAL PART

The purpose of this paper is to examine certain physical properties of fabrics intended for the production of clothing items that are worn on the human body. In the examination of these properties, fabrics in linen weave, twill 3:1 and twill 4:1 weave were used. The structural and constructive characteristics of fabrics were determined, as well as the vapour permeability through absolute and relative permeability and air permeability.

TESTING MATERIALS AND METHODS

Table 1 shows the materials used in the test.

Table 1: Materials used for testing

Fabrics	Raw composition of warp (two-wire)	Raw composition of weft (single-wire)	Interweave
A 20/14	polyester/cotton 50/50 %	cotton 100 %	plain
A 20/16	polyester/cotton 50/50 %	cotton 100 %	plain
A 20/18	polyester/cotton 50/50 %	cotton 100 %	plain
A 20/20	polyester/cotton 50/50 %	cotton 100 %	plain
A 20/22	polyester/cotton 50/50 %	cotton 100 %	plain
B 20/14	polyester/cotton 50/50 %	polyester/cotton 35/65 %	twill 3:1
B 20/16	polyester/cotton 50/50 %	polyester/cotton 35/65 %	twill 3:1
B 20/18	polyester/cotton 50/50 %	polyester/cotton 35/65 %	twill 3:1
B 20/20	polyester/cotton 50/50 %	polyester/cotton 35/65 %	twill 3:1
B 20/22	polyester/cotton 50/50 %	polyester/cotton 35/65 %	twill 3:1
C 20/14	polyester/cotton 50/50 %	polyester/cotton 50/50 %	twill 4:1
C 20/16	polyester/cotton 50/50 %	polyester/cotton 50/50 %	twill 4:1
C 20/18	polyester/cotton 50/50 %	polyester/cotton 50/50 %	twill 4:1
C 20/20	polyester/cotton 50/50 %	polyester/cotton 50/50 %	twill 4:1
C 20/22	polyester/cotton 50/50 %	polyester/cotton 50/50 %	twill 4:1

In this research, the following standards were used:
- SPRS EN 12751:2008, Textiles - Sampling of fibres, yarns and fabrics for testing,
- SPRS EN ISO 139:2007, Textiles - Standard atmospheres for conditioning and testing (ISO 139:2005),
- SRPS F.S2.016:1986, Textiles - Woven fabrics -- Determination of mass per unit length and mass per unit area,
- SRPS EN ISO 5084:2013, Textiles - Determination of textile thickness and textile products.
- SPRS EN ISO 15496:2008, Textiles - Measurement of water vapour permeability of textiles for the purpose of quality control (ISO 15496:2004),
- BS 5636 :1990, Textiles - Method for determination of permeability of fabrics to air
- SRPS EN ISO 9237: 2010, Textiles - Determination of air permeability through textile surfaces,
- SRPS F.S2.041: 1985, Textile products - Method of testing the power of water absorption by absorption.

RESULTS AND DISCUSSION

Water permeability testing procedure

The absolute and relative permeability of water vapour through the fabric was determined as follows:
Two cups of the same diameter were taken, which were partially filled with water and their mass was measured. The first glass is covered with a cloth, i.e. a sample of material with a diameter of 78 mm, which exceeds the surface of the cup, its mass is measured and then a ring is placed so that the material adheres to the edge of the cup so that no water vapour is released. The other cup remains uncovered. After certain amount of time (after 1, 2 and 4 hours), the mass of the cup, the mass of the cups with materials and the mass of the materials are measured. The differences in the masses of evaporated water will be used to calculate the

absolute and relative permeability of water vapour through the material. All fabric samples on the cups are placed face up.

Figure 1: Water vapour permeability test procedure

The tables show the differences in the masses of water that evaporated over time. According to the change in the mass of water, the calculation of the absolute and relative permeability of water vapour through the material is performed. The working surface of the sample was taken as the surface of the opening on the ring, which is:

$$SA = \frac{D_o^2 \cdot \pi}{4} = \frac{4{,}3^2 \cdot 3{,}14}{4} = 14.51 \text{ cm}^2$$

where: D_o – is a ring hole diameter (*cm*).

*Table 2: Mass of the water vapour (water) passing through the material at a certain time (*in *mg)*

Sample	After 1 hour (*mg*)	After 2 hours (*mg*)	After 4 hours (*mg*)
A 20/14	81.7	148.3	283.7
A 20/16	130.5	199.8	331.1
A 20/18	67.2	136.7	267
A 20/20	62.1	125.9	248.3
A 20/22	54.6	111.6	228
B 20/14	66.8	128.1	247.4
B 20/16	54.43	111.8	229.3
B 20/18	54.8	112.2	229.3
B 20/20	55.3	113.5	235.9
B 20/22	59.8	121	207.3
C 20/14	53.9	114.5	200.8
C 20/16	53.5	115.9	208.3
C 20/18	49.6	106.1	193
C 20/20	50.5	107.3	200.9
C 20/22	50.6	108.2	190.1

Table 3: Mass of water that evaporated from uncovered cups (in mg)

Sample number (cup)	After 1 hour (mg)	After 2 hours (mg)	After 4 hours (mg)
1	147.3	260.2	455.5
2	138.9	245.6	544.1
3	121.6	223.9	393.5
4	115.8	215.9	387.8
5	105.6	203.3	377.5
6	136	214.2	402.9
7	130.5	237.4	410.9
8	111.9	204.4	343.2
9	106.4	192.4	334.5
10	108.1	196.3	367.1
11	95.8	182.4	325.7
12	95.3	188.1	350.3
13	126.7	223.3	375.7
14	112	200.1	332.2
15	106.2	190.5	319.9

Results of absolute vapour permeability

According to the formula mentioned above and the data from table 4, the calculation of the absolute water vapour permeability is performed. The results of the absolute water vapour permeability for all fabrics during the period of 1, 2 and 4 hours are shown in table 4 and in figures 2, 3 and 4.

Observing the results from table 4, it can be concluded that water vapour permeability depends on the construction and structure of the fabric, i.e. geometry, more precisely, thickness. When comparing all fabrics, it can be noticed that the highest permeability is in plain weave (A 20/14, A 20/16, A 20/18), and when comparing fabrics only in twill weave, it can be noticed that the results are identical, with minimal deviation, which depends on its similarity, i.e. structure.

Table 4: Results of the absolute water vapour permeability through fabrics A, B and C.

Sample	P_{a1h} ($\frac{mg}{cm^2 \cdot 1h}$) for 1h	P_{a2h} ($\frac{mg}{cm^2 \cdot 1h}$) for 2h	P_{a4h} ($\frac{mg}{cm^2 \cdot 1h}$) for 4h
A 20/14	0.242	0.439	0.840
A 20/16	0.386	0.592	0.981
A 20/18	0.199	0.405	0.791
A 20/20	0.184	0.373	0.735
A 20/22	0.162	0.330	0.675
B 20/14	0.198	0.379	0.733
B 20/16	0.161	0.331	0.680
B 20/18	0.162	0.332	0.679
B 20/20	0.164	0.336	0.699
B 20/22	0.177	0.358	0.614
C 20/14	0.159	0.339	0.595
C 20/16	0.158	0.343	0.617
C 20/18	0.147	0.314	0.572
C 20/20	0.149	0.318	0.595
C 20/22	0.150	0.320	0.563

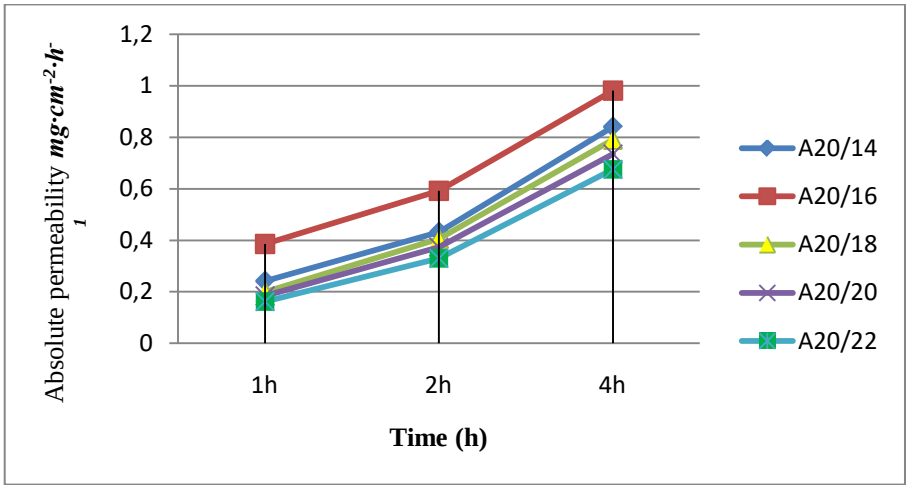


Figure 2: Absolute water vapour permeability for fabric A in plain weave (mg·cm^{-2}·h^{-1})

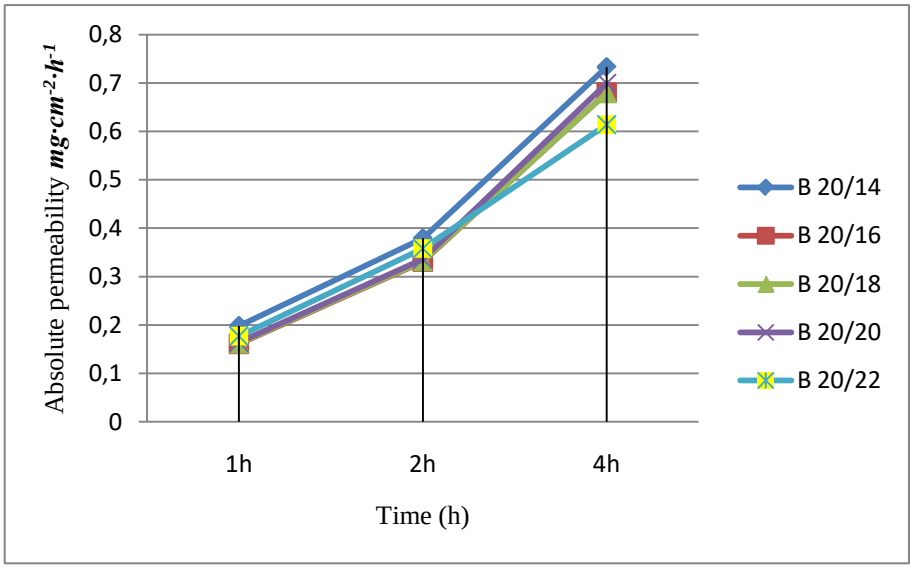


Figure 3: Absolute water vapour permeability for fabric B in twill 3: 1 intertwine (mg·cm^{-2}·h^{-1})

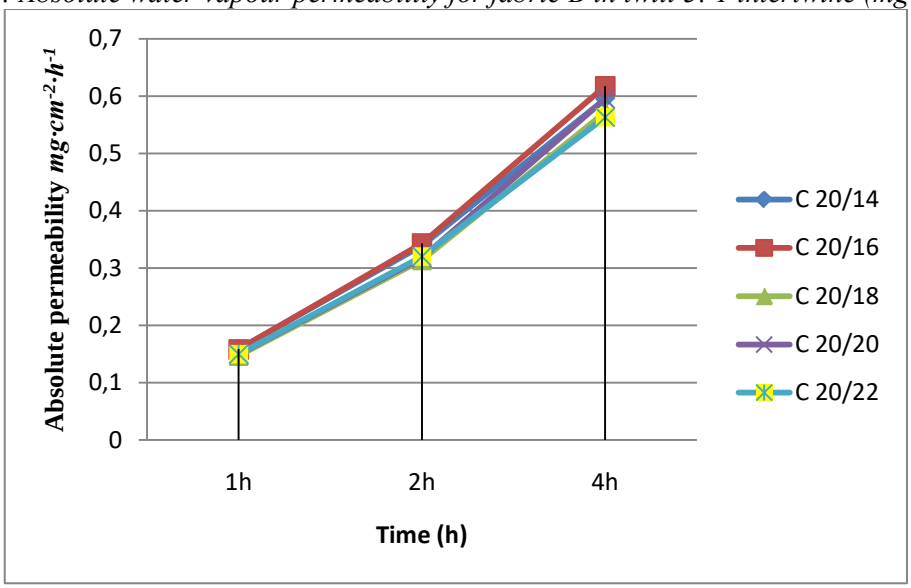


Figure 4: Absolute water vapour permeability for fabric C in twill 4:1 intertwine (mg·cm^{-2}·h^{-1})

Figure 5 shows the absolute water vapor permeability for samples A 20/18, B 20/18 and C 20/18 to more clearly show the difference in results, where it can be seen that the samples in the plain weave have higher absolute permeability than twill.

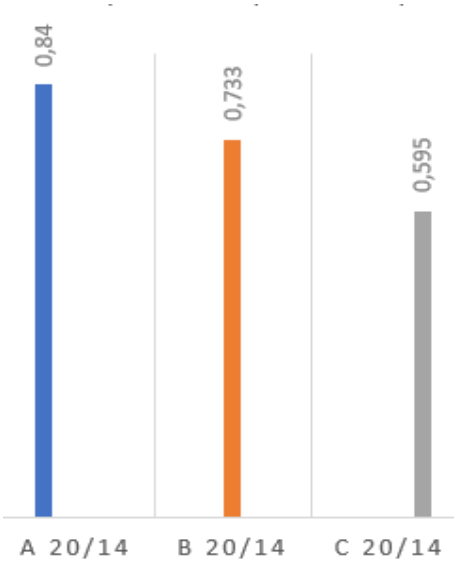


Figure 5: Absolute water vapour permeability for 4 hours ($mg \cdot cm^{-2} \cdot h^{-1}$)

Results of relative vapour permeability

The calculation of relative water vapour permeability is performed in accordance with the known formula as well as in accordance with the results of water masses from tables 2 and 3. The results of relative water vapour permeability for all fabric samples for a certain period of time (1, 2 and 4 hours) are shown in the table 5.

Table 5: Results of relative water vapour permeability through the material

Sample	P_{r1h} (%)	P_{r2h} (%)	P_{r4h} (%)
A 20/14	59.538	56.994	62.283
A 20/16	60.853	81.352	93.952
A 20/18	55.263	61.054	67.852
A 20/20	53.627	58.314	64.028
A 20/22	51.704	63.010	60.397
B 20/14	49.117	59.804	61.405
B 20/16	41.709	47.093	55.997
B 20/18	49.419	54.892	66.812
B 20/20	51.973	58.991	70.523
B 20/22	55.319	61.640	56.469
C 20/14	56.263	62.774	61.652
C 20/16	56.138	61.616	59.463
C 20/18	39.147	47.514	51.371
C 20/20	45.089	53.623	60.475
C 20/22	47.646	56.798	59.425

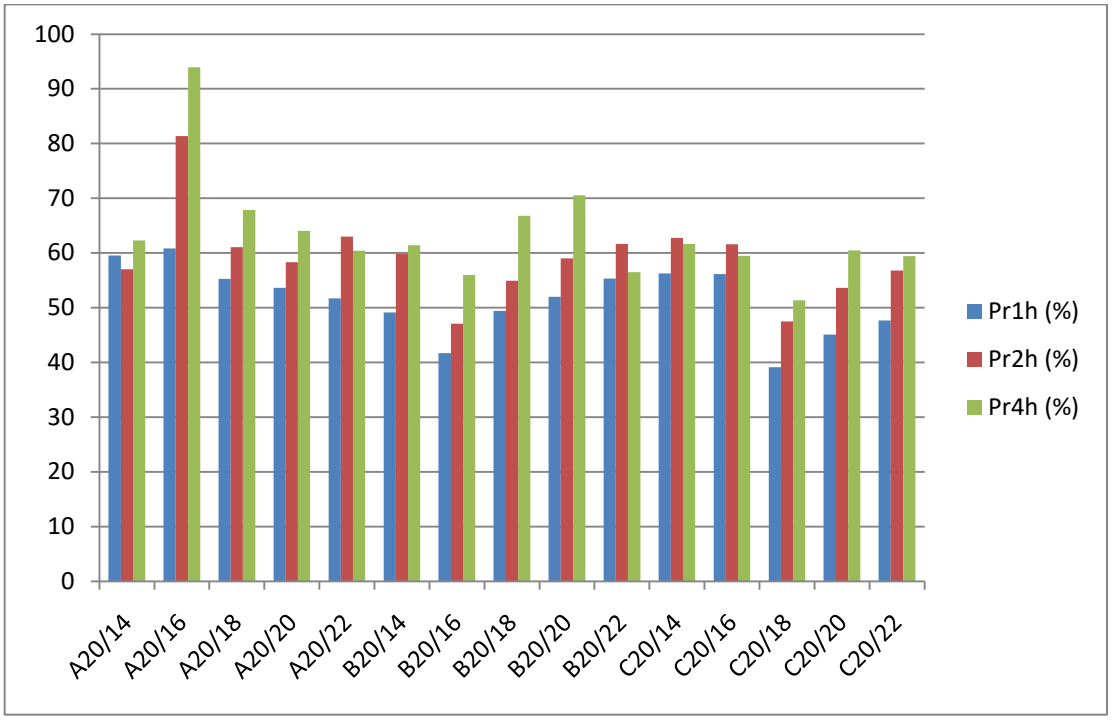
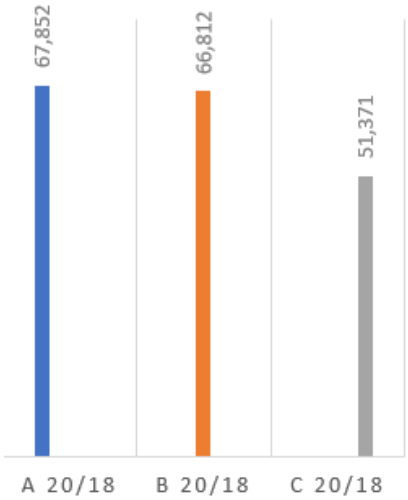


Figure 6: Histogram of the changes in relative permeability depending on the type of intertwine (%)

According to the results expressed in % obtained from the table 5 and figure 6, it can be concluded that the permeability varies depending on the type of intertwine and test time. In the case of relative water vapour permeability, the fabrics in plain weave have the highest value of permeability. The highest relative water vapour permeability was shown by the plain sample A 20/16, with a visible deviation in connection to twill weaves. The lowest relative permeability has the fabric D 20/18 in twill 4:1 weave. Relative water vapour permeability increases proportionally with the test time in all samples, except for samples A 20/14 and A 20/16, where the permeability decreases slightly after two hours and increases with an upward curve after 4 hours.

Figure 7 shows the relative water vapor permeability for samples A 20/18, B 20/18 and C 20/18 in %, considering that in these samples the results are most realistically presented and obtained, where it can be clearly seen that the fabric is C 20/18 had the lowest permeability due to its composition and interweaving, ie. structures.



Fugure 7: Relative water vapour permeability for 4 hours (%)

Air permeability testing procedure

The test sample is placed on the Textest table, a circular holder is pressed in order to prevent air from leaking out of the working surface and the measuring head i placed (lowered) over the knitwear. The test surface is 20 cm^2, and the air pressure is 200 Pa. Test time is 1 minute. The air flow on the face and on the back of the fabric is measured separately.

The air permeability is then calculated on the basis of the obtained values of the air flow in accordance with the formula:

$$Pv = \frac{q_v}{S_A} \cdot 167 \ (mm^3/mm^2/s)$$

where:

qv – is the average value of air flow through knitwear (*dm^3/mm*), which is obtained by reading on the device, S_A – test head area (*cm^2*).

Air permeability test results

According to the results of measuring the air flow on the device and the previous formula, the air permeability through the fabrics was determined. The fabrics were examined both on the face and on the back with 200 Pa and the surface of 20 cm^2, while the results were presented in *$cm^3/cm^2/s$*.

Table 6 shows the results of air permeability of the used materials.

Table 6: Results of the air permeability through fabrics

Samples	Air permeability ($cm^3/cm^2/s$)		
	face	back	main value
A 20/14	980	1050	1015
A 20/16	912	1020	966
A 20/18	478	517	497
A 20/20	233	190	212
A 20/22	90	291	191
B 20/14	3960	4283	4122
B 20/16	3060	3300	3180
B 20/18	2213	2240	2227
B 20/20	1643	1657	1650
B 20/22	1243	1233	1238
C 20/14	6210	6317	6264
C 20/16	4780	4697	4739
C 20/18	3723	3897	3810
C 20/20	2757	2790	2774
C 20/22	2193	2230	2212

From the results, it can be seen that the air permeability depends on the type of the fabric, as well as on the number of weft wires. Samples of C twill 4:1 have the highest air permeability.

When observing the values of air leakage from the face and from the back and vice versa, it can be noticed that different values were obtained. The reason for that is the different construction, i.e. the appearance of the fabric on the face and on the back, which is why the air permeability is different. Unlike plain, twill 3:1 and twill 4:1 have higher air permeability, which depends on the density of the weft, as well as on the type of weave.

Figure 8 shows the results obtained when testing fabrics A 20/18, B 20/18 and C 20/18 ($cm^3/cm^2/s$), where you can see that fabric C has the highest air permeability due to its structure and weft density of $17cm^{-1}$, while in the fabric A and B $19cm^{-1}$.

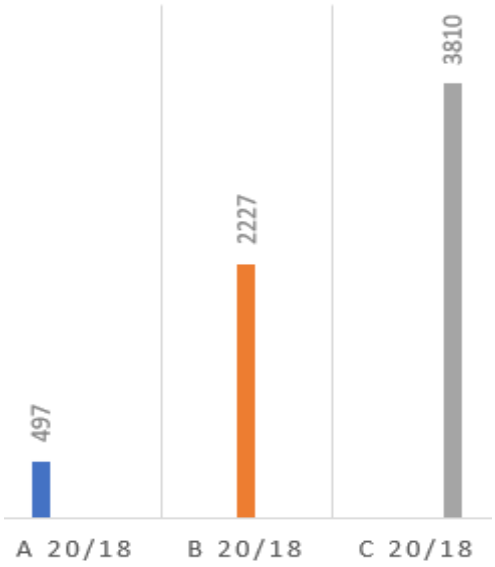


Figure 8: Air permeability ($cm^3/cm^2/s$)

CONCLUSION

Air permeability can affect the comfort of a textile material in several ways. Textile material that is permeable to air is at the same time permeable to water vapor. However, it should be borne in mind that air and water vapor are transmitted through textile material by various mechanisms. All textile fibers, regardless of chemical composition, are impermeable to air. As mentioned earlier, the textile material allows air to pass through the pores between the yarns and possibly through the openings between the fibers. In contrast, the diffusion of water vapor is done through the pores in the material but also by the fibers themselves to a greater or lesser extent depending on their composition and structure.

Water vapor permeability is closely related to air permeability. A material that has a higher air permeability also has a higher water permeability, ie. water vapor.

In the end, it can be concluded that with the increase in thickness and surface mass, as well as with the increase in the number of weft wires, the vapor permeability and air permeability decreased.

REFERENCES

[1] R. Čunko, Ispitivanje tekstila, Sveučilište u Zagrebu, Tehnološki fakultet, Zagreb, 1989.
[2] V. Simonović, Fizičko ispitivanje tekstila, DITT leskovačkog basena i Nagradni fond trekstilaca Vilem Pušman, Leskovac, 1971.
[3] https://tekigvel.rs/keper-tkanina/
[4] M. S. Pešić, Istraživanje termofiziološke udobnosti odeće od rebrastih pletenina - doktorska disertacija -, Univerzitet u Nišu, Ttehnološki fakultet, Leskovac, 2020.
[5] H. N. Yoon, A. Buckley, Textile Res. J. 54 (1984) 289-298
[6] B. Das, A. Das, V. K. Kothari, R. Fanguiero, M. De Araujo, Autex Res. J. 7 (2007) 100-110
[7] V. Čepujnoska., S. Ćortoševa, Metodi za ocenka na pokazatelite na kvalitetot na tekstilnite materijali, Univerzitet Kiril i Metodij, Skopje, 1991.
[8] https://www.ucg.ac.me/skladiste/blog_13220/objava_40891/fajlovi/3P%20EE%20_%20EEZ%202019%20Difuzija%20vodene%20pare%20_rac.primjer
[9] http://www.tf.ni.ac.rs/casopis-arhiva/sveska3vol2/c11.pdf

ANALYSIS OF THE INFLUENCE OF WASHING AND DRY CLEANING ON QUALITATIVE CHANGES OF TWO-LAYER LAMINATED FABRICS

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ABSTRAKT

In this paper are examines and compares the properties of three laminated two - layer fabrics before and after 10 cycles of washing at 40 ° C and before and after 10 cycles of dry cleaning. The purpose of this paper is to show the changes that occur as a result of maintaining laminated fabrics that are most often used to make clothing and ranches. The results showed that with the number of washing cycles, the resistance of laminated fabrics to the influence of water decreases. All three fabrics are made of polyester and all three are made in plain weaving. The fabrics have approximate surface masses and range from 170-192 g/m^2 . Also, among other parameters, the values of water vapor permeability and breaking force were compared. The results of this research are important in order to predict the changes during maintenance that this type of textile material goes through.

***Key words**: laminated fabrics, water repellency, water permeability, polyester*

INTRODUCTION

There are two definitions of a ‘coated fabric’. The first one is, ‘A material composed of two or more layers, at least one of which is a substantially continuous polymeric layer and at least one of which is a textile fabric. The layers are bonded closely together by means of an added adhesive or by the adhesive properties’. The second definition is, ‘A textile fabric on which there has been formed in situ, on one or both surfaces, a layer or layers of adherent coating material’.[1]

The processes of coating and laminating have become much more important and novel techniques for adding performance, durability, appearance retention and aesthetic value to textiles. Custom coating and lamination processes add an additional range of property, usages, functionality, improves the ability to perform as needed, and retains overall inherent properties of textiles, all of which have been consistently proven after receiving proper customer coating and laminating services. [2]

Coated fabric behavior during deformation differs from uncoated fabrics behaviour. It is well known that the fabrics become stiffer after coating, because coating material fills the spaces between the yarns and cements the warp and weft threads together. Coating changes all the fabrics properties. It increases tensile moduls and bending rigidity, especially in the warp direction. [3]

Laminated fabrics used for clothing purposes may have the property of water repellency and watertightness while retaining the property of breathability, ie to allow water vapor (sweat) to pass through. These fabrics protect the user from rain, snow, sleet, cold wind and they allow user's skin to breathe. In this paper, the laminated fabric will be presented, its characteristics, benefits, application for the purpose of clothing, while in the experimental part we will see its practical durability, strength, resistance to washing… In the experimental part of the paper, polyester fabrics with climate membrane will be examined. Polyester is most often used in the production of this type of fabric because it has exceptional dimensional stability and offers excellent resistance to dirt, alkalis, decay, mold and most organic solvents. Polyester also fulfills a very important condition, which is that it is durable and light and has a fine feel on the touch. For these reasons, polyester meets these very important requirements that consumers expect when choosing clothes, of course polyester is also quite cheap and easy to maintain.

Also, excellent heat resistance and thermal stability is another attribute of polyester. Polyester is essentially hydrophobic and does not absorb moisture, however, most of the polyester used for the inner layer of clothing is chemically treated so that they are able to "pull" moisture from the body to the outside of the fabric where it will evaporate.

The most relevant tests for assessing the resistance of laminated fabric to the action or impact of water are resistance to surface wetting and resistance of fabrics to penetration by water.
-Determination of resistance to surface wetting (spray test) ISO 4920

This International Standard defines a “spray test” method for determining the resistance of surfaces, of all types of fabrics, to wetting, which may be treated or untreated with waterproofing or water repellency agents.
ISO photo scale:

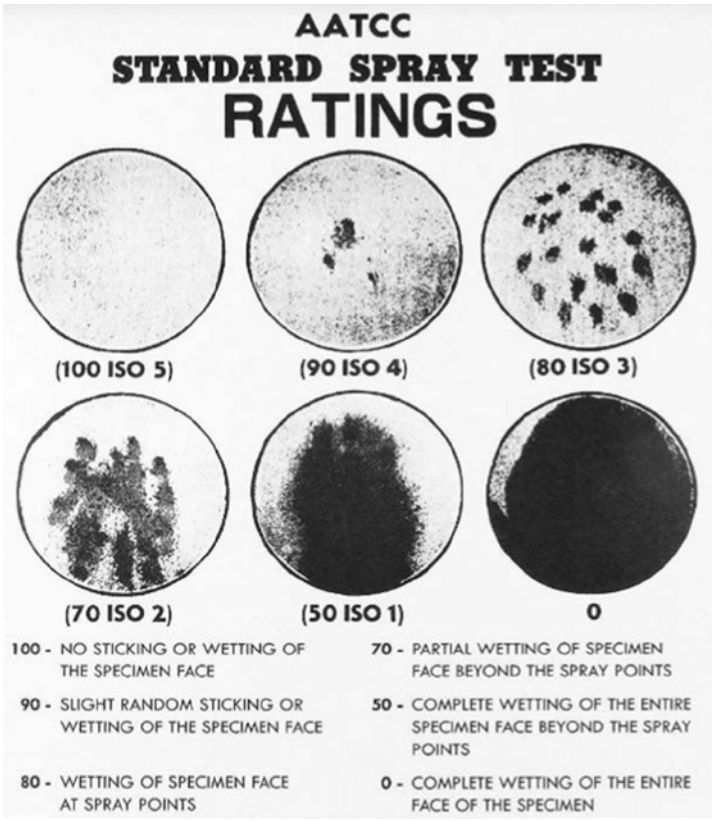


Figure 1. ISO representation of water repellency test based on AATCC photographic scale [4]

Figure 2. Water-repellent fabric [5]

- Water resistance ISO 811

The resistance of the fabric to hydrostatic pressure is a measure of resistance to the passage of water through the fabric. The face of the fabric is exposed to an increase in water pressure, under standard conditions, until water penetrates in the form of clearly formed droplets, in three places. The pressure at which water penetrates the fabric in the third place is recorded. The pressure may be applied above or below the test sample.

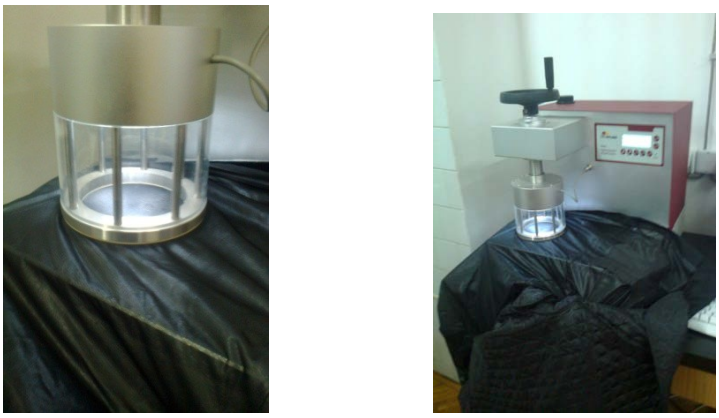


Figure 3. Determination of resistance to water penetration on the hydrostatic pressure tester according to the ISO 811 standard [6]

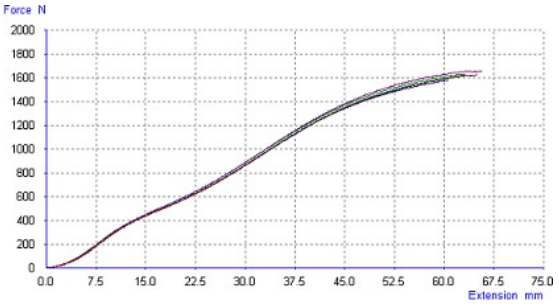
EXPERIMENTAL

In the experimental part of this paper, three polyester laminated fabrics with clima membrane will be examined. The tests that will cover these fabrics are: mass per unit area, determination of number of threads per unit length, determination of material composition, plain, oil resistance, breaking force, breaking elongation, water repellency (basic fabrics, after 10 washes, after 10 dry cleanings), determination of resistance to water penetration (basic fabrics, after 10 washes, after 10 dry cleanings), water vapor permeability (before and after 10 washes) (table 1).
The aim of the test is to determine to what extent and whether there is any weakening of the laminate that is applied and attached to the fabric in order to improve the characteristics of the fabric.

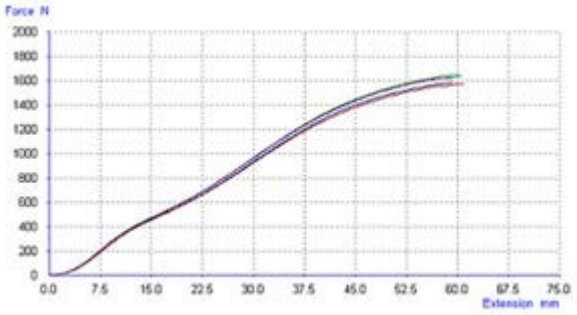
Table 1. Test results of three samples of laminated fabrics before and after washing at 40 ° C and before and after dry cleaning

	Sample 1	Sample 2	Sample 3
Breaking force/elongation warp before washing weft SRPS EN ISO 13934-1:2015	1623 N / 31,6 % 939 N / 38,6 %	1570 N/ 36,9 % 940 N/ 26,3 %	1353 N / 34,4% 1109 N / 46,5%
Breaking force warp after washing weft SRPS EN ISO 13934-1:2015	1614 N / 29,8 % 954 N / 36,3 %	1578 N/ 34,9 % 977 N/ 23,9 %	1457 N / 30,5% 1106 N / 38,3%
Water vapor permeability before washing ASTM E96/E96M:2016	3542,8 $g/m^2/24^h$	5140,8 $g/m^2/24^h$	5246,3 $g/m^2/24^h$
Water vapor permeability after 10 washes (40 ° C) ASTM E96/E96M:2016	3271,4 $g/m^2/24^h$	4854,3 $g/m^2/24^h$	5125,7 $g/m^2/24^h$
Resistance to water penetration before washing SRPS EN ISO 811:2018	720 cmH_2O	1358 cmH_2O	1621 cmH_2O
Resistance to water penetration after 10 dry cleanings SRPS EN ISO 811:2018	690 cmH_2O	1300 cmH_2O	1620 cmH_2O
Resistance to water penetration after 10 washes (40°C) SRPS EN ISO 811:2018	510 cmH_2O	900 cmH_2O	1100 cmH_2O
Water repellency before washing ISO 4920:2012	grade 100	grade 100	grade 100
Water repellency after 10 dry cleanings ISO 4920:2012	grade 100	grade 100	grade 100
Water repellency after 10 washes (40°C) ISO 4920:2012	grade 80	grade 90	grade 90
Mass per unit area ISO 3801:1977	172,8 g/m^2	179,8 g/m^2	191,4 g/m^2
Determination of number of threads per unit length ISO 7211-2:1984 warp weft	 720 t/10cm 550 t/10cm	 350 t/10cm 180 t/10cm	 230 t/10cm 180 t/10cm
Material composition ISO 1833-24:2010	polyester with climate membrane	polyester with climate membrane	polyester with climate membrane
Plain	weave	weave	weave
Oil resistance SRPS F.A1.019:1981 quality grade quality level	 100 very good	 100 very good	 100 very good
Fabric resistance to 50 consecutive washes (40°C) SRPS EN ISO 105-C06:2016	no changes	no changes	no changes

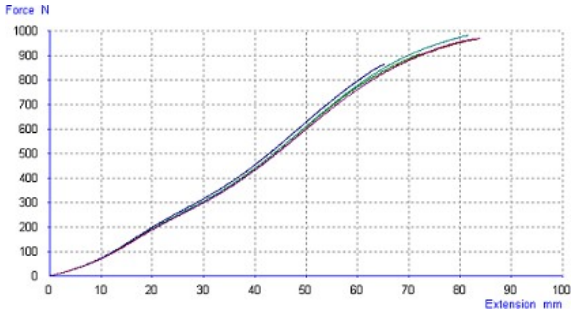
Figure 4 shows the breaking force before and after washing in sample 1 in the direction of the warp and weft.



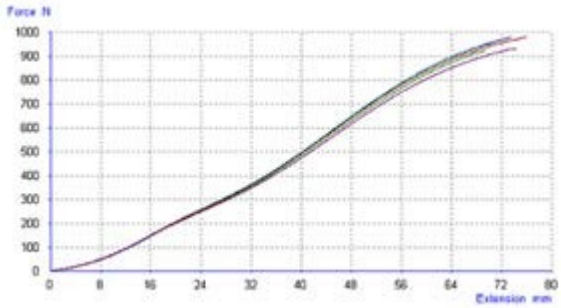
-warp before washing



-warp after 10 washes

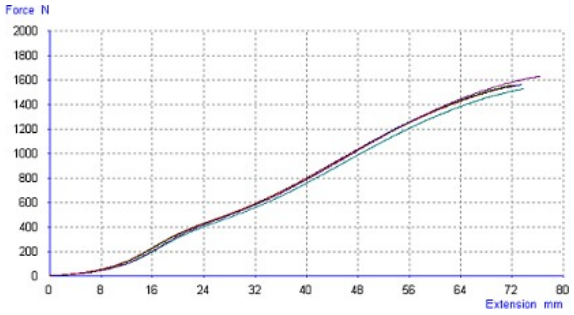


-weft before washing

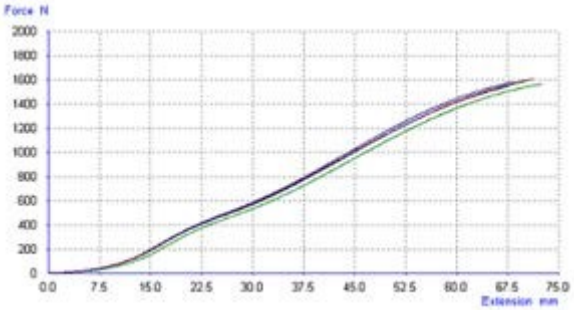


-weft after 10 washes

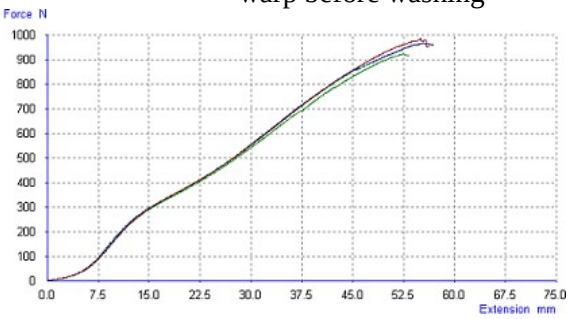
Figure 4. Breaking force before and after washing on sample 1 in the direction of the warp and weft Figure 5 shows the breaking force in the direction of the warp and weft before and after washing in sample 2.



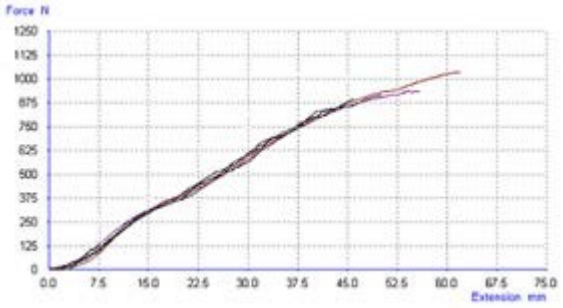
-warp before washing



-warp after 10 washes



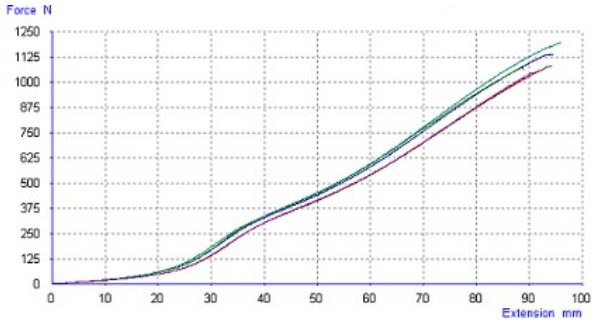
-weft before washing

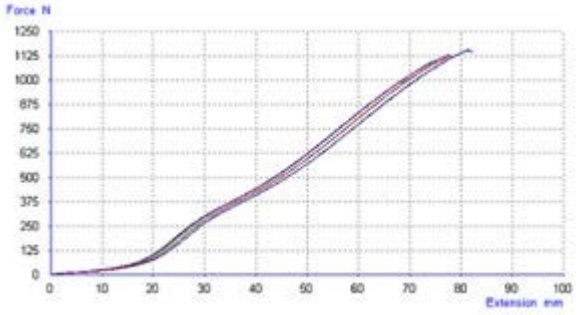


-weft after 10 washes

Figure 5. Breaking force before and after washing on sample 2 in the direction of the warp and weft

Figure 6 shows the breaking force in the direction of the warp and weft before and after washing on sample 3.
-warp before washing -warp after 10 washes





-weft before washing -weft after 10 washes

Figure 6. Comparative overview of the breaking force before and after washing on sample 3 in the direction of the warp and weft

DISCUSSION OF RESULTS

Based on the tests performed, the obtained results indicate that there are almost no deviations in terms of breaking force, ie they enter the allowed tolerance of measurement uncertainty except for sample 3 where the breaking force is higher after ten consecutive washes by 7%. Breaking elongation it is on the samples after 10 washes lower on average by 3% compared to the samples before the wash, which can be explained by a smaller loss of elasticity and hardening of the membrane during the washing process. In diagrams 1, 2 and 3, it can be noticed that the sensor registered an almost identical path to the rupture on test sample at the warp and weft on all three samples. When testing the water vapor permeability in sample 1 after 10 washes, the permeability decreased by -7%, on sample 2 by - 5.6%, in sample 3 by - 2.7%. Which can be explained by less swelling and damage to the membrane during washing, where its function is reduced. Watertightness in sample 1 after 10 washes decreased by 29.2%, in sample 2 by 33.7% and in sample 3 by 32.1%. While after 10 dry cleanings the attenuation is significantly less and on sample 1 it is less by 4.1% in sample 2 by 4.3% and in sample 3 it is unchanged after 10 dry cleanings.
Such large changes after 10 washes can be explained by the fact that during washing and the use of commercial detergent the membrane was etching due to the fact that the detergents used for washing contain oxidizing agents, surfactants, bleach… which caused etching and weakening of the membrane. (Figures 7 and 8). While in dry cleaning there was no weakening of the membrane because the Perchlorethylene used is not aggressive towards the material being treated with it and the membrane has remained almost completely preserved. Water repellency of samples 1, 2 and 3 had the best grade of 100 before washing process and dry cleaning and no change after dry cleaning, while after 10 washes there was a change in sample 1 by two grades lower and in samples 2 and 3 by one. The weakening of the water repellency after washing can be explained by the weakening of the means by which the fabric was treated. Their durability is limited by the number of washes. These fabrics have shown extremely good resistance to the action of oil and have a quality rating of 100 and a quality level of "very good". After 50 washes, there were no significant visual changes.

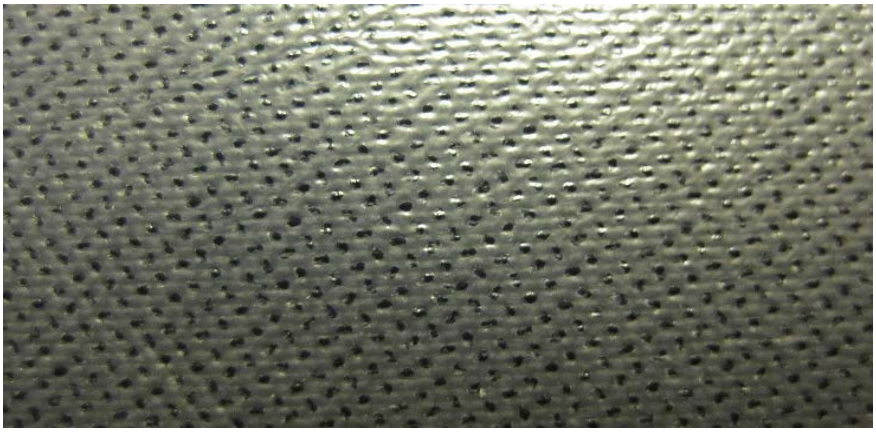


Figure 7. Climate membrane before washing

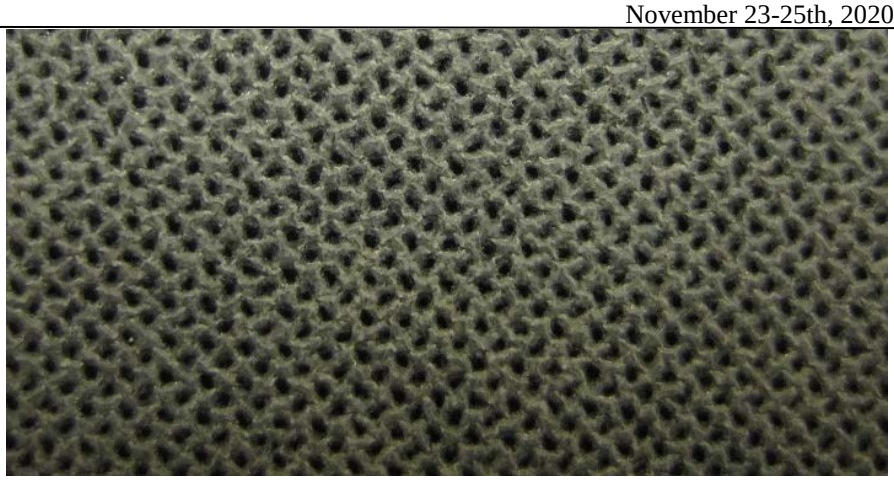


Figure 8. Climate membrane after 10 washes at a temperature of 40 ° C

CONCLUSION

Based on the obtained test results, it can be concluded that the laminated fabric has a number of favorable characteristics, e.g. strong breaking force, high water vapor permeability, high water repellency grade and water impermeability, very good quality assessment of oil repellency… And that it is ideal for use as shell material for jackets and suits for special purposes because it is waterproof and at the same time allows the passage of water vapor (sweat) and is light. The disadvantage of such fabrics is, as can be concluded from the tests and from Figures 7 and 8, in which clearly shows that the membrane was etching after washing and thus the resistance of the climate membrane is weak as well as treatment for water repellency and partially reduces water vapor permeability. Therefore, it would be ideal if this type of fabric was maintained exclusively by dry cleaning, which would extend its service life, while retaining all the positive characteristics for many years.

REFERENCES

[1]. Coated and Laminated Textile Materials and Process, H. Venkatesan, V.N. Gowrishankar.
[2].https://www.textileschool.com/3152/coated-and-laminated-textile-fabrics/
[3]. Study on tensile properties of coated fabrics and laminates, V. Masteikaite, V. Saceviciene, Indian Jurnal of Fibre&Textile Research, Vol. 30,September 2005, pp.267-272
[4]. ISO 4920:2012 Textile fabrics — Determination of resistance to surface wetting (spray test)
[5]. https://www.caimi.net/wp-content/uploads/2019/01/SPRAY-TEST-ENG.pdf
[6].ISO 811:2018Textiles— Determination of resistance towater penetration — Hydrostatic pressure tes

TRADITIONAL TECHNOLOGY AND PATTERN ANALYSIS OF TIANMEN BLUE CALICO

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ABSTRACT:
Tianmen blue calico is a "fairy flower" born in Jingchu. Based on the protection of Jingchu textile intangible cultural heritage, this paper analyzes the development status and technological process of Tianmen blue calico, and analyzes the pattern characteristics of Tianmen blue calico from the aspects of animals, plants, dragon and Phoenix harmony. Extract the essence of traditional patterns, repair and restore the damaged pattern, and apply it to people's daily necessities. Therefore, the paper explores the regional advantages and artistic aesthetic value of Tianmen blue calico, and promotes the application of traditional patterns of blue calico in the field of modern design.

Key words: Tianmen blue calico, Jingchu textile intangible cultural heritage, pattern analysis

INTRODUCTION

Hubei Tianmen blue calico, as a traditional printing and dyeing technique of Jingchu textile intangible cultural heritage, is the crystallization of Chinese artistic creation. As a representative of the traditional blue calico in Central China, it was listed as an exhibit in the World Expo. Tianmen blue calico has a long history of inheritance. It not only contains the traditional printing and dyeing culture and people's ideological connotation in Jingchu area, but also has high artistic, cultural and research value. However, due to its historical development and changes, Tianmen blue calico is facing a serious survival test. In this paper, Hubei Tianmen blue calico rescue protection as the main content, hoping to make a systematic analysis and practical application of its protection and development, form a certain system scheme from the perspective of Tianmen blue calico rescue protection, explore the path more suitable for the development and protection of Tianmen blue calico, and design a series of intangible cultural heritage with the core characteristics of Jingchu culture Raw products.

DEVELOPMENT OF TIANMEN BLUE CALICO

Budding period

In 1821, there were workshops in Tianmen county to produce blue calico. Later, the printing and dyeing industry developed in yuejiakou, ganzhenyi, Zaoshi, yuxianhe and henglinkou（Wang xinyue, Ye hongguang,2015）［1］. In the 27th year of the Republic of China (1938), there were more than 100 printing and dyeing workshops in the county, with an annual output of more than 1 million pieces of Tianmen blue calico. Before liberation, nearly 100 dyers were set up in Tianmen City, and there were 67 dyeing houses in Guandu Lane (formerly known as "Guanlu Shang") at the end of Qing Dynasty, of which the larger one was Xiao Wanglin's "Xiao Hongfa" dyeing workshop. In 1894, it was common for residents to bask in blue calico on the dyke of yuekou town (as shown in Figure 1).

Prosperous period

The peak period of Tianmen blue calico development was the Qing Dynasty and the Republic of China. At that time, the well-known printing and dyeing workshop street was in Guanlu street of the county. Since 1949, the production mode of Tianmen blue calico has changed from a family workshop to a collective management mode, which is well-known all over the world(Chen long, Ye Hongguang,2014)［2］. In 1956, Hubei Tianmen blue calico was exhibited in Japan, Britain, France and other countries, and was praised as an excellent handicraft with Chinese characteristics. In 1959, Tianmen blue calico was sent to Beijing for display in the exhibition hall After the establishment of Menxian arts and Crafts Industrial Company(Zhang Lei,2018)［3］, it attaches importance to the innovative design and expansion of production of blue calico. Its products are exported by the foreign

trade department. The old artists in Duoxiang town are showing their Tianmen blue calico works (as shown in Figure 2). Tianmen blue calico has long been famous and was exhibited in the World Expo as an exhibit in 1964. In 1979, his works won the first prize of Hubei Provincial Arts and crafts exhibition; in 1981, it won the first prize of Hubei Provincial Arts and crafts products; in 1989, Tianmen blue calico was selected into the first national exhibition(Zhang Lei,2018) ［3］;In 1998, blue calico works such as "dragon dancing", "everything goes well" and "pine and crane evergreen" won silver award of "1998 Hubei fine arts and crafts exhibition" by the Second Light Industry Bureau of Hubei Province.

Figure 1: *Villagers in yuekou town bask in blue calico on the dike in 1984*

Figure 2- *Old artists of Duoxiang town show Tianmen blue calico works*

2.3 Decline period

In 1954, printing and dyeing cooperatives were established in Chengguan, yuekou and Zaoshi. Since 1964, due to the development of industry and the shortage of raw materials and dyes, the output of Tianmen blue calico is decreasing year by year. In 1984, the production of blue calico was stopped due to the lack of indigo and poor market. In the late 1980s, due to the development of textile industry, "foreign" cloth invasion, its color diversity, and "native" cloth gradually fade out of people's daily life. The scale of folk hand spinning and weaving has gone from bad to worse, and the production of native cloth is in danger. With the rapid development of machine printing and industrial dyes, the shortage of raw materials and the increase of production cost, the output of Tianmen blue calico is decreasing year by year. As a result, the local people's processing of blue calico has basically stopped, the production of printing and dyeing factories is all based on foreign trade exports, and the sales of blue calico are becoming less and less, which can not meet the original production volume. In the late stage, due to the lack of innovation and fewer and fewer people engaged in this industry, there was no sales volume of Tianmen blue calico products. Finally, many Tianmen blue calico factories closed down one after another. There is only a record in the county annals that the production of blue calico was stopped due to the lack of indigo and poor market. The splendor of Tianmen blue calico is still in the long history.

TRADITIONAL PRINTING AND DYEING PROCESS OF TIANMEN BLUE CALICO

Traditional production tools

The main utensils and facilities for making blue calico mainly include pattern, pattern plate, cutting knife, dye vat, meta precious stone (as shown in Fig. 3), pillow stone, earth spinning float, earth loom, trowel, scraper, drying rack, etc. Tianmen is commonly known as the pattern of "flower", paper. The motifs are based on folk stories, dramatic figures, flowers, birds, insects and fish, etc., which are mostly auspicious and festive. The patterns are designed by dyers themselves and sold specially. In the old days, there were merchants and shops specializing in patterns in Hualou street, Hankou. The printed pattern is engraved on the pasted kraft paper with cutting tools and can be used repeatedly for several times.

Figure 3-*Meta gem for finishing grey cloth*

A pattern represents a pattern. Large scale dyeing houses often have hundreds of flower plates. The cutting tools used for engraving pattern plate can be divided into oblique cutting knife and blunderbuss. Oblique cutting knife: after the iron sheet is cut, it is clamped and bound with bamboo pieces. It is divided into single knife and double knife with inclined mouth. The width of lines carved with double knives is the same. Blunderbuss: a round knife made of iron sheet. It can be divided into several sizes. Its function is to make dots of different sizes required for blunderbuss. In the dye vat, a mesh cylinder cover made of iron wire or bamboo and wood is suspended, and the dye liquor is divided into upper and lower layers. There will be at least ten dyeing VATS in each dyeing house. The function of meta gem and pillow stone is to finish grey cloth or finished cloth. Two for a pair, Yuan gem in the top, pillow stone in the bottom, a single weight of about three or five hundred jin. Yuanbao is named for its shape like "Yuanbao"; pillow stone is named because it is placed below as pillow pad. Earth spinning float and loom. The two are used for textile cloth machinery tools, wood, used by rural families in the old times. A board used for scraping wet mortar, made of ox bone or wood, half moon shaped. The tool used for scraping the mortar is made of iron with sharp edge. The shelf used for drying cloth is usually made of bamboo.

Traditional production process

Tianmen blue calico originated from the ancient medicine spot cloth, and the printing and dyeing method was developed from the ancient dyeing technique, which is roughly the same as that of other regions in China. In the early days of Tianmen, the printing cloth was printed with woodcut convex plate. By the end of Ming Dynasty and the beginning of Qing Dynasty, the printing of woodcut convex plate became the way of missing printing on cardboard, which was more portable and easier to operate. The production process (as shown in Table 1) is as follows: first design the pattern, describe the pattern in the paperboard, then hollow out the pattern in the cardboard with a cutter, and then stick the paperboard close to the blank cloth, and finally scrape the anti dye agent to dry the cloth. In the early days of Tianmen, the printing cloth was printed with woodcut convex plate. The method was: first, the pattern was engraved on the board, and then the printing plate was painted with water color pigment, and then the grey cloth was placed on the board and printed by hand. In the late Ming and early Qing Dynasty, it developed into the printing of paperboard, that is, the pattern of paperboard was hollowed out, placed on the grey cloth, scraped with anti dye, so as to form the background and pattern printing. For a long time, the traditional process of Tianmen blue calico is to use this anti dye printing method of engraving plate missing.

Table 1-*Hubei Tianmen blue calico production process*

Main steps	show process	process	materials
1.Prepare grey cloth		Wet the grey cloth, press it with a piece of meta precious stone weighing three or five hundred jin, and then use gravity and inertia to make the meta precious stone roll and flatten the grey cloth.	Grey cloth, Yuan gem and wooden stick
2.Pattern making plate (design pattern plate, tung oil brush)		Including mounting paper, design patterns, engraving three steps. Draw patterns on the cardboard. After carving, polish the pattern with tools, brush with tung oil, dry and press flat.	Kraft paper, carving knife, blunderbuss, tung oil, brush
3.printing		Scrape the anti dye agent on the pattern plate with a trowel to make the anti dye evenly spread in the hollowed out. The hollowed out part containing the anti dye agent cannot be dyed.	Trowel, stain proof paste (soybean powder and hydrated lime)
4. Dyeing		After soaking the white cloth soft, it can be put into the dyeing vat for dyeing. Take it out after about 20 minutes, then squeeze out the excess water, hang the cloth to dry, and turn blue after the color is completely oxidized.	Water tank, dye (Indigo)
5. Scraping and whitening		After the cloth is dried, scrape the position with the anti dye agent with a scraper to reveal the color of the original gray cloth and form a blue and white pattern with blue.	Scraper, table
6. Sorting out		After scraping and whitening, the cloth needs to be rinsed repeatedly to clean the residual mortar and floating color on the cloth surface. After drying, roll the cloth with Yuanbao.	Meta gem, drying rack

PATTERN ART OF TIANMEN BLUE CALICO

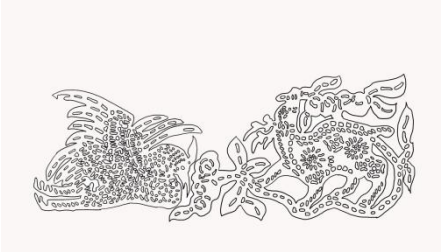
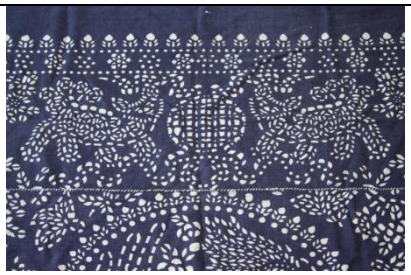
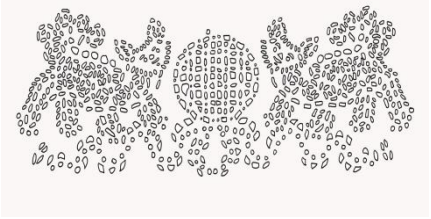
The pattern of Tianmen blue calico has a unique artistic language. It has the elegance, delicacy and delicacy of Nantong and other regions, as well as the atmosphere, roughness and arrogance of its regional characteristics.

Implication of animals

Most of the patterns of Tianmen blue calico are to express people's wishes（Wu Lingshu, Wu Yuanxin，2011）［4］. For example, the word Fu in running script means blessing, while the character Shou in seal script means birthday congratulation. Magpie and sika deer respectively express

people's yearning for a better life as well as prosperity and auspiciousness (Table 2). Magpie has the meaning of power, and there is often the saying of magpie reporting good news. The combination of magpie and sika deer implies the pursuit of people's happy and auspicious life. Lions rolling hydrangeas express the meaning of auspiciousness and joy. Their images are widely used in the folk. Pattern is not an independent individual, but a common carrier of material and spirit. It not only represents the spiritual sustenance of the local people in Tianmen, but also reflects the background of the times, social structure, emotional ideas and folk characteristics. The patterns of Tianmen blue calico are various and have different meanings. Most of them reflect the state of folk life and emotional sustenance, but the patterns of flowers, birds, animals and plants are the same. The pattern of Tianmen blue calico shows the artistic conception beyond the image and the beauty of different regional culture through the combination of connotation and form characteristics.

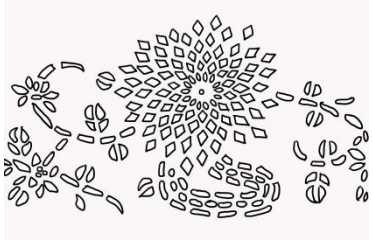
Table 2-*Animal pattern of Hubei Tianmen blue calico*

type	Tianmen blue calico	Pattern extraction
Magpie, Sika Deer		
Two lions rolling Hydrangea		

Implication of plants

People often use various plants to express some abstract meanings. For example, patterns also have certain meanings. Some symbolize auspiciousness, while others indicate many children and many blessings. Most of the plants are rich in connotations and in different forms (as shown in Table 3). The pattern of plum blossom in Tianmen blue calico has five petals, which symbolizes the meaning of "five blessings of plum blossom"（Wang Ni，2013）［5］. The firm quality of plum blossom and the glorious but not luxurious quality of plum blossom are often praised by people; chrysanthemum symbolizes longevity; pine crane symbolizes long life, so-called "pine crane prolongs life"; and "bamboo repaying peace" is a metaphor for peaceful family Letter is a symbol of peace; peony is a symbol of good fortune; pomegranate is a symbol of many sons and blessings(Wu Qingqing,2016)［6］. These symbolic expressions of animals and plants not only express people's satisfaction and belief in life, but also reflect a stable state of society at that time. Auspicious motifs are numerous in the modeling works of blue calico, such as straight pine, hard bamboo, proud chrysanthemum and fragrant plum orchid as "four gentlemen" with noble moral character. They keep their own stances and stand tall and strong. These simple patterns embody people's good wishes and pursuit of ideals, creating poems one after another for blue calico Artistic modeling of meaning.

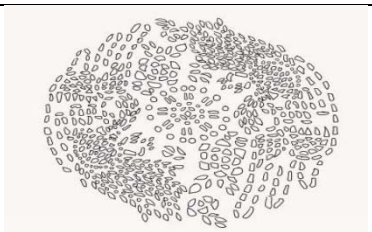
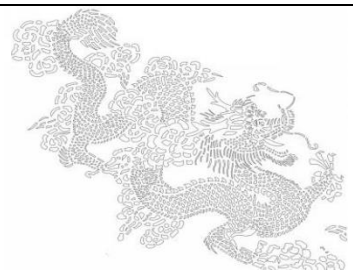
Table 3-*Hubei Tianmen blue calico plant patterns*

type	Tianmen blue calico	Pattern extraction
Chrysanthemum morifolium		
Meilan		

Implication of traditional dragon and Phoenix

In the folk, the dragon and phoenix pattern is sought after and loved by people. The Dragon implies power and power, and is the primate of all things. Phoenix pattern means good luck, long life and good health (Table 4). The combination of dragon and Phoenix has gradually become a sense of protecting the family, and gradually rose to a national spirit. The frame patterns such as pan length and Fangsheng on the bedding surface of Tianmen blue calico have the meaning of "laying a bed with gold bricks, you don't have to worry about eating and wearing". With the local people's daily life and folk life, Tianmen blue calico exists and develops with each other. People always hold full of enthusiasm and good wishes for it, and deeply engrave their life's blessing and hope in the Tianmen blue calico map created by themselves.

Table 4-*Dragon and phoenix of Hubei Tianmen blue calico*

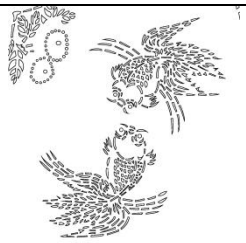
type	Tianmen blue calico	Pattern extraction
Veins of Phoenix		
Dragon pattern		

Implication of homophony

The sound of "Gui" in osmanthus, Fulu in gourd, blessing and longevity in bergamot, happiness in plum branch, cat and butterfly, Golden Jade, Ping'an, shuangqian, Fushu, Fulu, Lianyu and Lianyu have more than one year(Mu Huiling,2013)［7］. The patterns of bats and goldfish imply happiness, good fortune, and surplus every year (Table 5). The animal pattern of Tianmen blue calico is limited

by the production technology, which makes the expression of the pattern itself mainly composed of dots, lines and surfaces. But it is precisely because of these limitations that the pattern becomes more delicate and has more characteristics. The pattern features of the combination of animals and plants not only have different characteristics and their meanings, but also use each other and set off each other, which is more symbolic. The patterns of Tianmen blue calico have distinct primary and secondary patterns, and the large and small patterns are interspersed properly, which reflects people's aesthetic taste and yearning for a better feeling.

Table 5-*The bat and goldfish patterns of Hubei Tianmen blue calico*

type	Tianmen blue calico	Pattern extraction
Bat		
Goldfish		

CONCLUSION

Tianmen blue calico carries thousands of years of Chinese traditional culture, it has a long history and culture. From a practical point of view, Tianmen blue calico is a material product. In the old days, it was widely used in bedding, bed sheets, clothes, bags, door curtains, tablecloths and so on. From the point of view of decoration, it is the sustenance of people's spirit; from the patterns it carves, it is not only beautiful in appearance, but also contains different meanings. At the same time, it reflects the psychological pursuit, traditional customs and aesthetic taste of the local people. Tianmen blue calico has a profound value in both historical background and aesthetic. It is not only the representative of blue calico in Central China, but also the symbol of Hubei regional culture. The rich cultural connotation and long history not only bring a ray of vitality to the rescue protection of Tianmen blue calico, but also provide inspiration for the author's later design works of Tianmen blue calico. How to transform the tradition into a popular carrier of modern society needs the deconstruction, reorganization, integration and innovation of contemporary designers, so as to promote the optimization and absorption of cultural food, and obtain the market affirmation with appropriateness, simplicity and novelty. To extract design elements from national culture, designers should return to the traditional art to seek inspiration. Make the past serve the present, inherit and innovate.

REFERENCE

[1]Wang xinyue, Ye hongguang. Analysis of patterns of tianmen blue printed fabric [J]. Shandong textile economy,2015(03):27-29.
[2] Chen long, Ye Hongguang. On the application of Hubei blue calico in modern fashion design [J]. Tianjin Textile Technology, 2014 (04): 132-34.

[3] Zhang Lei. Research on the technology and culture of Tianmen blue calico [D]. Donghua University, 2018
[4] Wu Lingshu, Wu Yuanxin. Blue calico and Nantong folk culture [J]. International Museum (Chinese Edition), 2011,63 (01): 53-58
[5] Wang Ni. Analysis of the artistic characteristics and application of Hubei Tianmen blue calico [J]. Fashion guide, 2013,2 (03): 89-91
[6] Wu Qingqing. Analysis of the folk symbols in Gaomi's "Jiatang" painting of the ash year [J]. Chinese national art, 2016 (03): 92-97
[7] Mu Huiling. Artistic features of Shandong folk color printed calico [J]. Art and design (Theory), 2013,2 (07): 152-154

RESEARCH OF TRADITIONAL MEN'S FOLK COSTUMES

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Abstract:
Folk costume is a traditional and historical garment, and exists within individual regions, states, or members of a group. The paper describes men's folk costumes in Croatia. Folk costumes in Croatia are characterized by material diversity and the number of shapes and they are just an example of traditional appearance and survival. Ancient folk costumes are no longer used, but they are kept in ethnographic museums and collections, and some are preserved as family heritage.

Keywords: Folk costume, embroidery, design

INTORDUCTION

The role of the costume is to protect the human body from external influences, but it is also very important for decoration. Costumes are conditioned by historical, economic and social circumstances that indicate the degree of cultural development [1]. In Croatia, costumes are diverse and reveal where the person wearing them comes from. They generally exist within individual regions, states, or members of a community, such as ethnic groups or groups of a profession. The costume includes all clothing items that can reveal social status, age, profession, etc. It is made from raw materials offered by a certain community (linen, hemp, cotton, wool, silk, leather, fur, feathers, etc.) and is always the most appropriate response to climatic conditions. With the penetration of civilizational features, the use of industrially produced materials and the demise of handicrafts, folk costumes are gradually disappearing from everyday use, and its representative specimens are kept in ethnographic museums and collections as documents of material culture of past periods. [2,3]

Folk costume in Croatia

A large number of forms, which differ from village to village, can be classified into several basic types, derived in part from the natural features of individual Croatian areas, the peculiarities of climate and soil, and existing branches of the traditional economy. Certain historical and artistic styles can be noticed in certain parts of the Croatian folk costume. Sometime since the beginning of the 20th century, folk costumes in Croatia are increasingly giving their place to urban clothing, so today they are worn only on festive occasions. [3]. In most parts, men were the first to leave the old costume. Although costumes have changed function in the modern world, they still reveal much about the cultural, economic, and political circumstances of the environments and times in which they originated. [4].

Folk costumes also indicate the degree of cultural development and depict the ethnic processes in the past of individual larger or smaller national groups. Croatia is divided into three ethnographic zones in which three basic types of folk costumes have been formed, namely the Pannonian, Dinaric and Adriatic zones. [2,3].

The Pannonian area is characterized by lowland areas with fertile land. It is an area in the extreme northeast of Croatia, along the Danube, on the border of Slavonia and Srijem. In this area, the people, mainly due to fertility, did not feel a shortage, and this fact was reflected in the folk costume, which is richer and more diverse. However, the wealth in the costume of the Croatian north did not depend exclusively on property power, but on the work and effort invested in the production of clothing materials produced mainly in the household. The raw materials for clothing were mainly plant fibers, linen and hemp. Until the Second World War, these two plants were grown in the entire Pannonian area, and covered the need for textiles, especially for basic parts of clothing. [1].

The Dinaric area stretches south of the Kupa and Sava rivers almost to the Adriatic coast. The Dinaric zone is characterized by the breeding of small cattle - sheep and goats, and this area is in a hilly area. The costume of the Dinaric region was adapted to pastoral life because the breeding of sheep and goats was the basis of the economy of that region. To this day, ancient details have been preserved in that costume, such as a hat with fringed tassels and a metal on men's clothing. Most of the costumes were made by tailors from woolen yarn and cloth, and from the cloth only a straight-cut shirt from the shoulders to the lower edge, with straight open sleeves. [3]. The pastoral population resorted primarily to the raw materials that were available. For clothing, lamb and sheep wool were used in textile production, while goat's hair was used for greater needs in economic affairs. [1].

The Adriatic type of clothing refers to the coastal and island area of Croatia. It is important for the folk costume to keep pace with the clothing of the stylistic periods of European peoples, primarily Mediterranean countries. The above items were mostly woven from woolen cloth, In some parts the making of the cloth was given to professional weavers. The canvas was mostly bought in shops, cities or at fairs. In the 19th century, in the Dubrovnik area, domestic woolen fabric was replaced by purchased. Footwear in the Adriatic area shows common features. Former woolen socks are replaced by cotton knitted socks. Instead of opanak, they use low shoes with a flat sole that goes into the spike. Izrađena je od mekane crvene kože i lagana [1].

Figure 1. A guy in an antique sling costume and a girl in colorful silk, Klokocevik, near Slavonski Brod

Figure 2. A man and a engaged woman in antique costumes, Vrlika, Dalmatian hinterland

Figure 3. Former ceremonial costumes, Primosten, Dalmatia

Men's Pannonian costume

Men's clothing was mostly made of domestic linen. The construction of the garment did not consist of cuts, but was composed of flat surfaces of cloth. In this way, men's clothing was performed, long linen pants and a shirt. Such uncut clothing represents the early stage, the one that stands at the transition from unstitched-wrapped to sewn-cut attire. [1].

Men's folk costume consists of underpants and a shirt composed of flat cloths. The type and quantity of canvas, and the way in which clothes were made and decorated, differ in the regions. In the

northwest, men's clothing is made of thicker linen (linen or hemp), in Posavina and Baranja it is made of coarser linen, while in Slavonia the linen is made of cotton. [1,4].

Men's folk costumes appear in the area in several variants, but the shirt and underpants form a whole, and are mostly produced at the same time. *Panties* for everyday wear were mostly narrow, sometimes sewn from one half of the fabric for the leg, while for more formal *pants*, they used 3 to 5 halves for one leg, so such pants were wide and tightened at the waist with a string. In almost all parts they are floor-length, except in Baranja where they are somewhat shorter. As a winter variant, trousers, trousers, chakshirs appear in men's costumes, and they are mostly made of purchased blue or black cloth, and in the past also of white [1].

The shirt, which with the pants forms a whole, is always worn over the pants and falls freely over the hips. The sleeves are tight at the wrist. There is often a small collar that is influenced by urban fashion. Decorative hems appear on the shirt and underpants, and fringes often appear on the bottom of the legs. In the area along the Drava, men wear an apron over their underpants and under their shirts. Such an item of clothing has no function, but only a magical meaning [1].

The basic parts of the outfit include a vest, a *lajbek*. In the west, it is made of red linen or blue cloth, often embroidered and decorated with densely strung lead *buttons*. *The kamizol* is specific to the east, made of black satin or velvet. The Slavonian variant of the fur coat is also known, often rich in leather applications and mirrors. Other upper parts of the garment were formerly made of sheepskin or brown brown cloth.

In Slavonian costume, a short coat knitted from dark blue wool with a decorative border on the sleeves along the lower edge, known as rekla or spencle. That coat protects perfectly from the cold. In the clothes of Slavonia and Baranja, it is necessary to emphasize the silk scarf and ribbon posa, which entered the world fashion of the 18th century. Among the headgear, there is a hat made of black, mostly lambskin, and a hat known as scarlet, slate and a hat. [1].

Figure 3. A guy in a ceremonial Mass costume, Selci Dakovaci, Slavonia

Figure 4.A guy in an old-fashioned shirt and lajbak with a characteristic hat, a plate on a plate, Mrzljaki, Draganicko polje

Men's costume of the Dinaric area

Although the men's folk costume of the Dinaric region is not the same in every part, general characteristics can be determined. The most typical are trousers made of cloth, narrow legs, which in some areas fit snugly to the leg, while in some places they are wider. They are often long or reach to the ankle. For pants, there are terms such as underpants, benevreci, breveneci, etc. Pants are usually made of blue cloth, so parts like Lika are an exception with their natural brown color. [1].

The upper garment mainly consists of several layers of cloth clothing, and is worn over a shirt. These are sleeveless vests (krozet or zubun), and a coat with longer sleeves, often called kumparan. For large ceremonies, a second vest, called a jacerma, is usually worn over the circle, usually made of red or blue cloth. A silver or gilded metal ornament is attached to the chest. Jacerma was a significant item of clothing in men's clothing because it represented the power and position of the person who wore it. That is why every effort was made to have at least one barbecue for festive occasions [1,4].

A coat with sleeves, also called koporan, kanparan, trlagan, is worn as the upper part of the garment or is simply thrown over the shoulders. This part of the garment is decorated on festive occasions and its edges are trimmed with red silk tassels. The upper parts depended on the weather and the festivities [1].

Among the cloth attire is a long cloak or raincoat. It is made of brown or red cloth. It is usually sleeveless, and if there are any, they do not dress. It is hemmed at the ends with red or black choke. An indispensable part of the costume was a long woolen belt. Big influence on this area was left by the Turkish invaders, as evidenced by a specific hat, a towel wrapped around his head. [1-3].

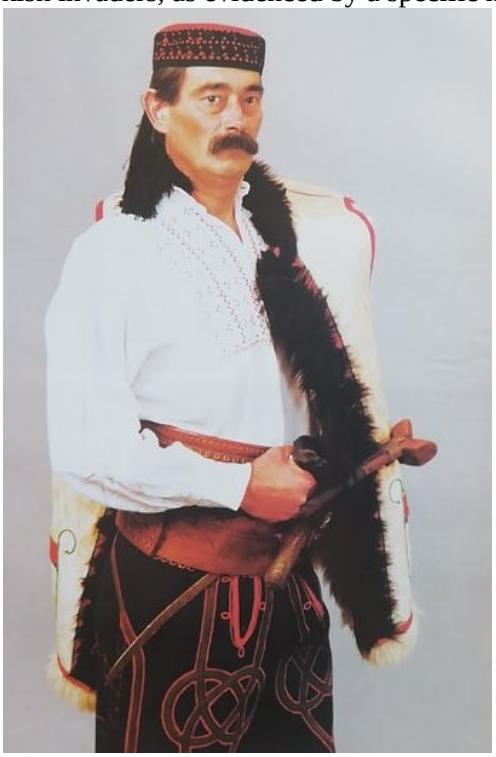

Figure 11. Man in winter costume with transferred fur, Otocac, Lika

Figure 12. A man in a ceremonial costume with a weapon on his belt, Srijana near Omis, Gornja Poljica

Men's costume of the Adriatic area

Men's costumes come in several forms. The costume of the surroundings of Dubrovnik, in Konavle, Zupa and the Dubrovnik littoral is similar to the Dinaric costume, except that the *pants* differ in cut. These are very thin pants that gather at the waist [1]. On the island of Krk, wide pants or bregese are known.

Men wear a shirt, and on top of it a vest, which in some parts is called a koret. On certain occasions they also wear a short coat with sleeves. They wear a hat or sleeve on their head. For the Adriatic men's folk costume, it is necessary to mention an item of clothing that we find throughout the Adriatic area, and it is a long coat with a hood, called kaban, hapot and halja [4-7].

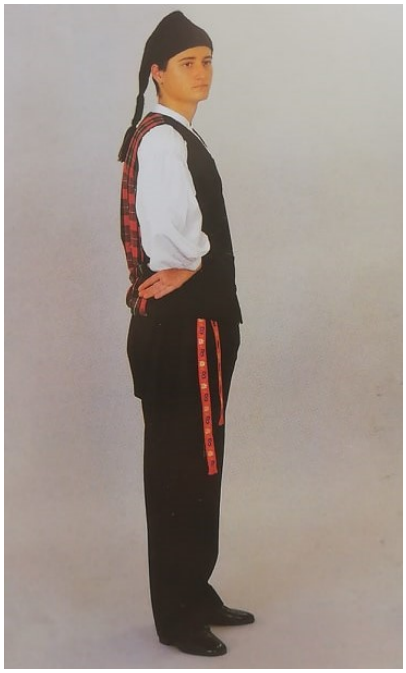

Figure 17. Newer men's costume, Pinezici village, island of Krk

Figure 18. Moštrant from Zrnovo, island of Korcula, Dalmatia

CONCLUSION

Every garment goes through a long process before use, from textile production, garment design and factory production. Clothing design and production involves many people in a variety of roles, from constructors and engineers to workers with a strict division of labor in garment factories, created in a planned series production that takes place on machines. Today, in times of mass production, this process requires teamwork.

Ancient men's folk costumes were made for dressing and arming boys. According to the clothes they wore, it could be determined whether they were unmarried or married men. The costume showed status, both social and family. In large parts of Croatia, men took on the role of tailors, and kept the old costume longer than women. The materials were original, but there were also imported ones.

Today they are worn during various ceremonies, such as folklore parties, competitions, dances, etc. To explore the traditional folk costumes, it is necessary to explore in detail the culture of the area.

REFERENCE

[1] Radus-Ribaric, J., Croatian folk costumes, Zagreb 2013.
[2] Fra S. Kutlesa, Life and customs in the Imoc region, Imotski 1993.
[3] Babic,A., Glibota,M., Folk costume of Imotski region, Lovrec 2009.
[4] Ivankovic, I., Simunović,V., Croatian folk costumes, Zagreb 2001.
[5] http://selo.hr/hrvatske-narodne-nosnje
[6] https://hr.wikipedia.org/wiki/Hrvatske_narodne_nošnje
[7] https://www.kud-prigorec.hr/nosnje.html

RESEARCH OF TRADITIONAL WOMEN'S FOLK COSTUMES

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ABSTRACT:
Folk costume is a traditional and historical garment, and exists within individual regions, states, or members of a group. The paper describes women's folk costumes in Croatia. Folk costumes in Croatia are characterized by material diversity and the number of shapes and are just an example of traditional appearance and survival. In this summary of the most basic phenomena of clothing, it is clear that there are elements of various time periods. Women's folk costumes are more diverse from end to end than men's

Keywords: Women's folk costume, embroidery, design

INTRODUCTION

The main role of folk costumes is to protect the human body from climatic and other external influences, but it also plays a major role in decorating people. Given the great diversity in materials, shapes, colors and decorations of folk costumes, this part of Croatian material culture is unique [1]. Folk costumes include all clothing items, including underwear, basic and outerwear, for everyday and formal occasions and for all seasons, headgear, footwear, jewelery and other types of face and body decoration (painting, tattooing, etc.) and other accessories (bags, decorative weapons, etc.). It was created from raw materials offered by the natural environment of these communities. As the folk costume has disappeared from everyday use, its specimens are kept in ethnographic museums and collections [2, 3].

Folk costume in Croatia

In Croatia, costumes are rich and are an example of a traditional phenomenon. During their long life, the costumes of Croatian peasants were subject to various influences of neighboring cultures and the clothing of higher social strata. Certain historical and artistic styles can be noticed in certain parts of the clothing: antique (Roman) tunics in a shirt from the Dalmatian hinterland; Gothic in the style of Istrian clothing; renaissance in an Adriatic blouse with an ornament of white embroidery and sewn lace; baroque on Posavina vests and winter coats; Rococo, which exudes Slavonian gold embroidery and the like [4]. The specific characteristics of a certain area are reflected in the way of dressing [1]. Fabrics and materials were mostly the result of domestic agriculture, so it can be said that linen was produced from flax and hemp from the fertile plain arable land, and cloth from sheep's wool from mountain and Adriatic pastures. Clothing played an important role in marking affiliation, age, and position in the family. She provided information on the marriage of girls, pregnancy, growing up of a woman, etc. [4]. Folk costumes also indicate the degree of cultural development and depict the ethnic processes in the past of individual larger or smaller national groups. Croatia is divided into three ethnographic zones in which three basic types of folk costumes have been formed, namely the Pannonian, Dinaric and Adriatic zones [2,3].

Women's Pannonian folk costume

Women's Pannonian costume is characterized by numerous varieties in women's clothing, which is reflected in the interweaving of several basic parts of clothing, in the way of decorating, and in the ceremony of the upper layers of clothing. Women's clothing was mainly made of home-made linen. The construction did not consist of cuts, but was composed of flat surfaces. Such uncut clothing represents the early stage, the one that stands at the transition from unstitched-wrapped to sewn-cut clothing. It is in this area that two ways of weaving handicrafts meet. In the northwest, in the villages of Prigorje, Hrvatsko zagorje and Medimurje, during the 16th and 17th centuries, the business of weaving was taken over by men [1].
The basic pieces of women's clothing are a oplecek, a shirt with a vest and an apron. The most pronounced costume is made of canvas made by men, and it is a Prigorje variant of the costume. It is

composed of a wide-sleeved braid over which a scarf is sewn, sewn to a very short vest, kiklisce. The shirt is surrounded by a cloth pasture. The ornaments on the dress consist of cloth stripes, purchased silk accessories and ribbons. That costume was worn by everyone without distinction [1].

The ancient head scarf, known as the peca, was folded in a special way, and was kept as a ceremonial headband for the wedding party. A wedding wreath composed of artificial flowers was an obligatory part of the costume for the bride [4,1].

Southwest of Zagreb, the costume descends in several forms. The Old World equipped its attire for some time after the Second World War, but between the two wars it shortened in some parts of the costume, so it lost its former elongated Gothic line [1].

In the costumes of Kupinac and Bratina, the main parts of the costume are a oplece, a scarf and a linen made of linen, with woven ornaments. The braid has long sleeves, which are tightened with the front and back of the oplece into an opening around the neck. On top of the braid is worn a long scarf which is composed of the lower part. There are strict rules for choosing colors and patterns of clothing. For younger women who were unmarried, a garment interwoven with a red pattern was prescribed, while for married women and mothers it was somewhat darker. The old women mostly had black decorations. The status of a woman in society also reveals the head and the way of combing.

It is specific to the women's costumes of Posavina and Moslavina that it consists of three basic parts, namely blouses, opleca and scarves. All parts are made up of flat pieces of canvas. In certain places, the canvas was pleated and thus adapted to all body shapes. The garment is sewn in two variants, and the first is the old variant where the scarf hangs on strings, and a flat piece of cloth, a pendulum, wraps around the body, and meets the lower part of the scarf at the waist. With such a shirt, an open braid is worn and reaches below the waist. Vrlo široki rukavi sežu do vrata. Another variant is a wide, pleated part of the shirt that is sewn directly to the banner, which is tied at the waist. This second variant was introduced into Posavina clothing only in the 19th century, and later the sleeves became longer and open at the wrist. The braid becomes similar to a blouse. They all had a common foundation of linen clothing, which was the main garment throughout the area [1].

Figure 5. Young woman and girl in formal costumes, Sunja near Sisak, Croatian Posavina

Figure 6. A girl in a former ceremonial costume, Remete, Zagrebacko prigorje

Figure 7. A young woman in a poculica cap covered with a Tibetan slave, Durdevac, Podravina

Figure 8. The bride in an antique wreath, Recica, Karlovac pokuplje

Women's costume of the Dinaric area

The women's folk costume of the Dinaric area was made of woolen yarn and cloth, and some parts of linen. Lamb and sheep wool were used for clothing in the textile industry, while goat's hair was used for greater needs in economic activities [1].

As for women's costumes, there are bigger differences than in the case of men's costumes. For women, a long straight shirt with sleeves is specific, which is worn directly on the body and is belted with a woven woolen belt called a *pas*, a fabric. The belt was a symbol of women's honor and dignity. It is painted dark red and decorated at one end with binder and fringe. In some parts, such as Zadar, it is not visible, because another belt called a *liter* passed over it.

An apron can be mentioned as an indispensable item of clothing. It is mostly woven from homemade woolen yarn. They appear in several variants. It is straight, woven from multicolored wool, and fringed with fringe, and is known for the area of Lika, through northern and central Dalmatia to Vrlika. The second type is widespread in the southeastern part of Croatia, from Sinj through the Imotski region, to Konavle in the Dubrovnik hinterland, and is woven on a loom as an ordinary woolen fabric in four threads [1,4].

Women's clothing is more complete when the fabric parts are worn over the shirt. The difference is in the color of the cloth in the girls. The girl's costume is made of natural white, and the married woman's costume is made of blue cloth. The old names of garments confirm that this rule has long been respected. As an example, we can cite women's long winter clothes called *bilača, bjelača, bjelača*, even when made of black cloth. Often this clothing is also called modrina, although it is not blue, and if it has sleeves it is called a dress or aljina. There is no difference in cut between girls and older women. [1] The other piece of clothing is a sleeveless robe, completely open at the front. The names vary by place. It is often called *sadak*, but in Lika *zobun*, in Poljica *jacerma*, in Konavle *koret* and others. The cloth parts are decorated with a wide hem made of fine purchased cloth called *choha, choja, svita* or *panel*. It is usually red, but also green and blue. These embroideries, unlike the geometric embroideries on the shirt, were drawn quite freely, using wavy lines, which changed depending on the place and the influences of different cultures.

For women's costumes, the equipment of the head and the headband, which represents the position of a woman in society, are extremely important. Girls wear a red cap, those who are ready to marry put a white scarf over the back half of the cap, and the cover for a married woman is a square scarf, called a

krpa, okrugla, jasmak, bosca or *sudar*. The name depends on population movements and influences from various sides. However, women's equipment in Dinaric costumes is not complete without jewelry that is abundant, and focused on the head, chest and hair. For a man, pride is a weapon, and for a woman, her jewelry [1].

Figure 13. A woman in an old folk costume, Srijane near Omis, Gornja Poljica

Figure 14. Zoe Borelli Alacevic, A Woman from the Imotski Area in Folk Costume (1925)

Women's costume of the Adriatic area

Women's folk costume of the Adriatic area is made mainly of wool, linen and silk. The type of Dinaric costume prevailed in Konavle, although geographically the area belonged to the Adriatic costume, so it differed the most from this type. The Zadar coast was also a mixture of Dinaric and Adriatic costumes. Here we encounter a colorful silk embroidery that originated in the Renaissance. The shirt is white as are the embellishments that were mostly lace. The most skilled lacemakers are from the island of Pag, which is why the Pag weight is well known [4,1].

In coastal costumes, the shirt retains a straight cut with wide sleeves. On top of the shirt is worn an upper garment, which was made of homemade woolen weaving. Outerwear lists three different types of clothing. Two appear on the islands, and one is a type of antique clothing in Istria. In the first two types of clothing, a skirt appears, folded into thick and sharp folds. The clothing is simple in its construction and still belongs to the type of uncut dress composed of a straight thread of fabric. The upper garment is also a skirt with a vest that is tailored to go with the body. The vest is usually sleeveless and deeply open, so even the sleeves of the shirt can be seen. For this reason, the shirt is decorated with embroidery or lace.

In the area of the northern Adriatic, a skirt made of sheepskin with fleece facing the body is also known, and it was worn in winter. As for the old costumes, the costumes from Istria stand out. In this garment the upper part is cut in the whole piece, from the shoulders to the upper edge. The Istrian costume is not cut from straight poles but composed of wedges, so it is narrow at the shoulders and wide at the bottom.

The Adriatic area is the most diverse in terms of clothing, which is understandable, because it is connected to world events by the sea [5,6].

Figure 19. A young woman in an old-fashioned costume with a characteristic headdress, Novalja, island of Pag

Figure 20. Girl in an old summer costume with a hat, Blato, island of Korcula, Dalmatia

Figure 21. Girl in a festive city costume, Split, Dalmatia

Figure 22. Girl in a lanet costume, Ponikve, Zupa Dubrovačka

CONCLUSION

In the past, folk costumes were made by hand, mostly at home and often only one person was enough. The tailors were self-taught, so the costume is characterized by a simpler cut. Today, in times of mass production, this process requires teamwork. Women's folk costumes were made to adorn girls, and it was possible to recognize from the clothes whether they were girls or older women, married or unmarried, women who were grieving and more. The materials used were mostly original. Exploring the folk costumes of the whole of Croatia, it can be said that the clothing is diverse, especially in the Adriatic area because of the sea that opens the area to the world, and connects with world events .

REFERENCE:

[1] Radus-Ribaric, J., Croatian folk costumes, Zagreb 2013.
[2] Fra S. Kutlesa, Life and customs in the Imoc region, Imotski 1993.
[3] Babic,A., Glibota,M., Folk costume of Imot region, Lovrec 2009.
[4] Ivankovic, I., Simunović,V., Croatian folk costumes, Zagreb 2001.
[5] https://narodni.net/odjeca-razvoj-narodne-nosnje-dalmaciji-okolici
[6] selo.hr/hrvatske-narodne-nosnje

PATTERN MAKING DESIGN AND MODELING OF WOMEN'S GARMENT FOR THE UPPER BODY

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ABSTRACT

The shirt is a garment for the upper body and its way of wearing as well as different models has changed over the decades. The aim of this paper is to make modeling based on a given image and a technical sketch of a woman's upper body clothing, it is a shirt. For this purpose, the basic construction of a women's blouse as well as a two-piece sleeve was made on the basis of a predetermined body and construction measure for size 38. The shirts an inevitable component of any woman's clothing that can be combined in various ways, and a lot of modeling of women's shirts is performed.

Key words: shirt, construction, modeling, design

INTRODUCTION

A shirt is a cloth garment for the upper body from the neck to the waist. The world's oldest preserved garment, discovered by Flinders Petrie, is a "highly sophisticated" linen shirt the shoulders and sleeves have been finely pleated to give form-fitting trimness while allowing the wearer room to move. The small fringe formed during weaving along one edge of the cloth has been placed by the designer to decorate the neck opening and side seam (Barber Wayland E., 1994).

The shirt was an item of clothing that only men could wear as underwear, until the twentieth century (Brown W. L., 1999). Although the women's chemise was a closely related garment to the men's, it is the men's garment that became the modern shirt (Burnham D.K., 1973). In the Middle Ages, it was a plain, undyed garment worn next to the skin and under regular garments. In medieval artworks, the shirt is only visible (uncovered) on humble characters, such as shepherds, prisoners, and penitents (Cunnington C.W., Cunnington P., 1992). In the seventeenth century, men's shirts were allowed to show, with much the same erotic import as visible underwear today (Cunnington C.W., Cunnington P., 1992). In the eighteenth century, instead of underpants, men "relied on the long tails of shirts ... to serve the function of drawers (Baumgarten L., 2002). Eighteenth-century costume historian Joseph Strutt believed that men who did not wear shirts to bed were indecent (Baumgarten L., 2002). Even as late as 1879, a visible shirt with nothing over it was considered improper (Brown, W. L., 1999).

The shirt sometimes had frills at the neck or cuffs. In the sixteenth century, men's shirts often had embroidery, and sometimes frills or lace at the neck and cuffs and through the eighteenth-century long neck frills, or jabots, were fashionable (Cunnington C.W., Cunnington P., 1992). Coloured shirts began to appear in the early nineteenth century, as can be seen in the paintings of George Caleb Bingham. They were considered casual wear, for lower-class workers only, until the twentieth century. For a gentleman, "to wear a sky-blue shirt was unthinkable in 1860 but had become standard by 1920 and, in 1980, constituted the most commonplace event" (Pastoureau M., Gladding J., 2001).

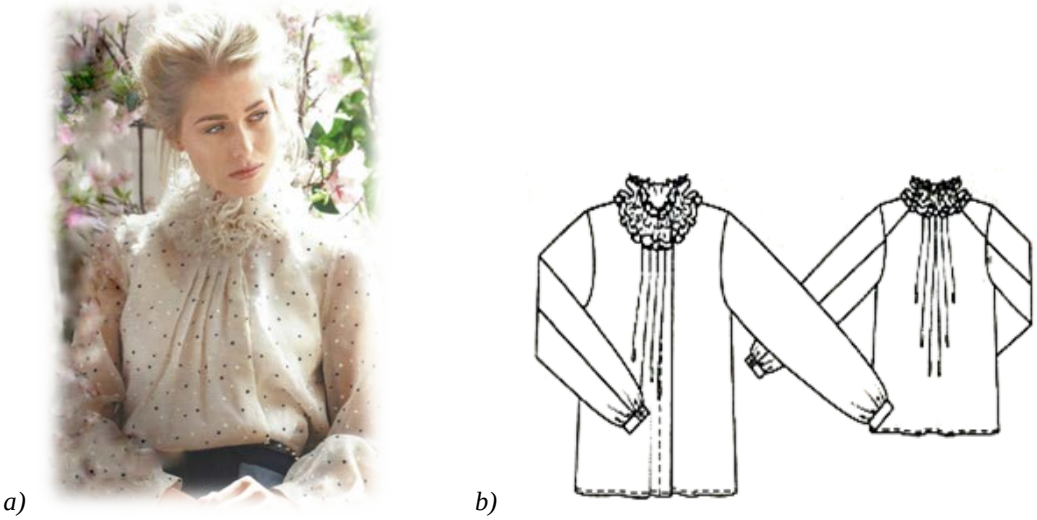
European and American women began wearing shirts in 1860, when the Garibaldi shirt, a red shirt as worn by the freedom fighters under Giuseppe Garibaldi, was popularized by Empress Eugénie of France (Buck A., 1984, Young J. D., 1902). At the end of the nineteenth century, the Century Dictionary described an ordinary shirt as "of cotton, with linen bosom, wristbands and cuffs prepared for stiffening with starch, the collar and wristbands being usually separate and adjustable". The first documented appearance of the expression "To give the shirt off one's back" happened in 1771 as an idiom that indicates extreme desperation or generosity and is still in common usage.

The aim of this paper is the modeling of women`s shirt on the base of pattern making design of blouse and two-piece sleeve.

EXPERIMENTAL PART

Modeling of a woman's shirt was made on a previously made basic blouse construction. The default model of the shirt is presented in the image and technical sketch in Figures 1a and 1b. The model description for this shirt is as follows:

- The front consists of two pieces that secure 2/3 of the front of the shirt, with 5 pleats at the neck that are sewn in length (approximately 8 cm) and extend to all length of the shirt.
- The back is made up of two parts, with folds in the middle of the neck, sewn in lengths (about 8 cm) that extend to the length of the seam.
- Two-piece sleeve with 6 cm cuff.



a) *b)*

Figure 1: a) Image and b) Technical sketch of lady`s shirt

RESULTS AND DISCUSSION

The basic pattern design of a women's blouse and a two-piece sleeve, size 38, was made, (Ujevic D. *et al*., 2000) shown in Figure 2. Construction measures were calculated on the basis of a body dimension.

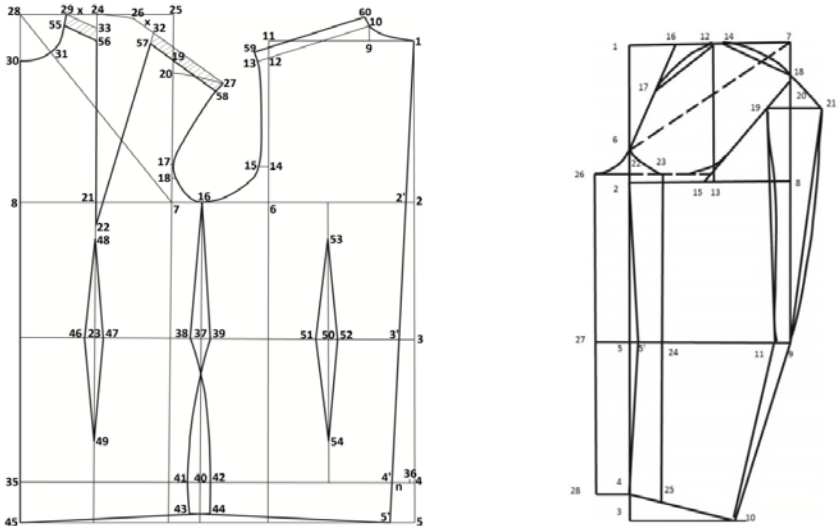


Figure 2: Basic construction of women's blouse and two-piece sleeve

Modeling of the front

The modeling of the front part starts with closing the dart on the shoulder and opening the dart at the waist to the hemline and extending the armhole opening by 1-2 cm (Figure 3 - first phase).
Part of the dart be deducted by the side, and the other part of the dart was added in the width of the front (Figure 4 - second phase). The whole width of the front part is divided into two parts respectively 2/3 and 1/3 (Figure 5 - third phase). Draw a horizontal line which shows a two front part and cuts along it.

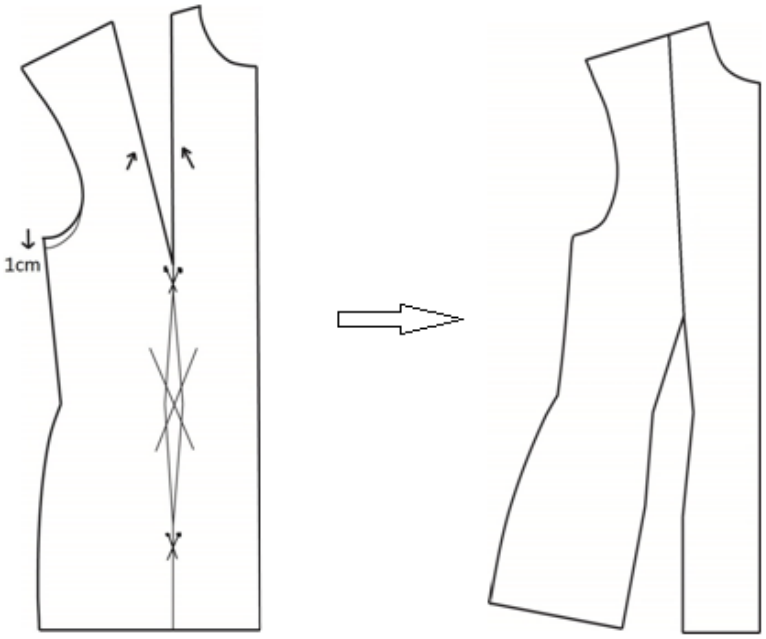


Figure 3: Preparing the modeling of front part - 1 phase

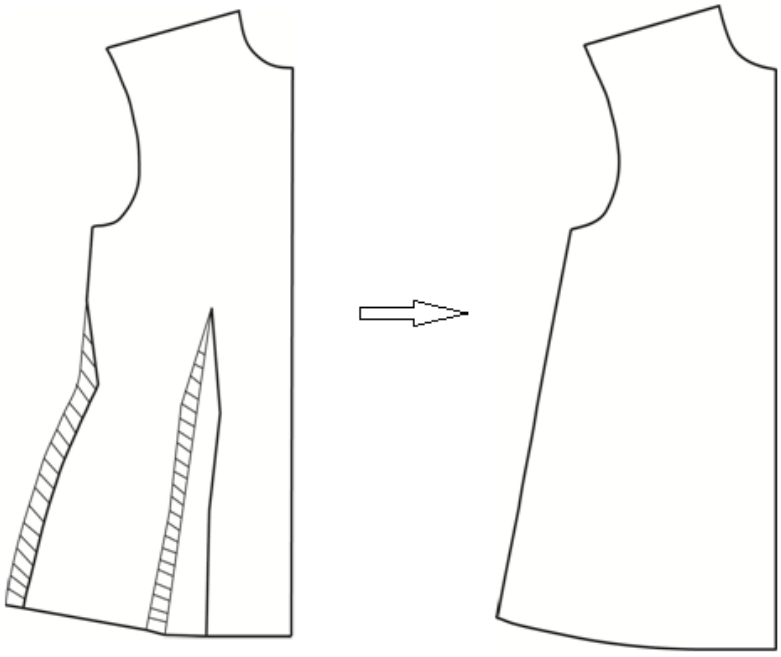


Figure 4: Modeling the front part - 2 phase

- One front part is (2/3) has 5 pleats with a width of 3 cm each and a space between is 1 cm each. The pleats are sewing 8 cm from the neckline in length. The locking hole has 7 clips and 7 tabs (Figure 6).
- The second front part has 1 pleat and 1 half pleat with merge with the other half (on the latching hole).
- The collar is made up of two parts. The first part a) is 115 cm length and 9 cm width, and the second part b) 115 cm length and 13 cm width. The collar is obtained in this way (Figure 10).

Figures 3, 4 and 5 shows the modeling the front in the more phase. Figure 6 shows the method of obtaining modeling on the two front parts - left and right cutting pieces. All cut pieces have a seams allowance of 1 cm each, except for the hem which is 2 cm seams allowance.

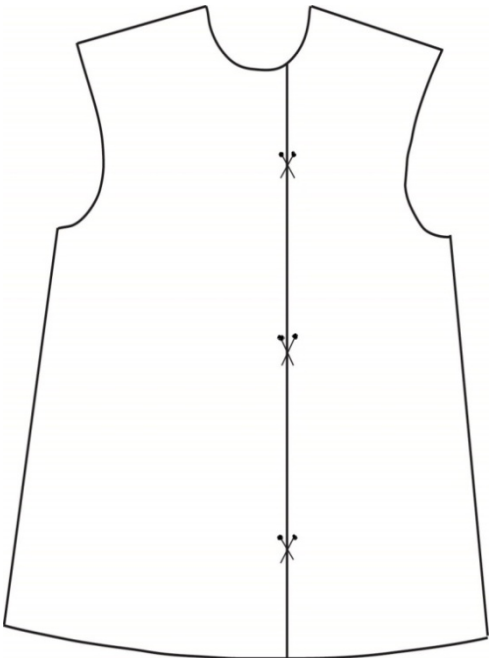


Figure 5: Modeling the front part on 2/3 and 1/3 - (third phase)

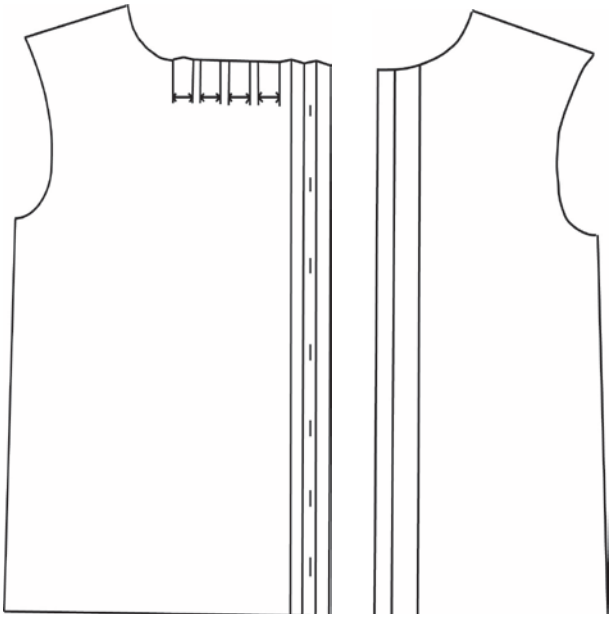


Figure 6: Modeling of two front's part - left and right cutting pieces

Modeling of the back

Modeling of the back begins by marking the bottom line of the shoulder with point 1 and from point 1 down to point 2 measured 11 cm mark with point 3. From the middle of the shoulder to back center from point 4 to point 5 measured 2 cm, and points 3 and 5 are connected. A new back part is obtained. From point 5 to point 6 measures 2 cm and from point 6 to beck center on the neck mark 3 pleats with a width of 3 cm each and a space between them 1 cm. The outer part is sealed so that it gets the width of the blouse. From point 2 downward is measured 1 cm on the armhole and is marked with point 7. The dart on the back is taken in the width of the shirt. A figure 7 and 8 shows the method of obtain modeling of the back.

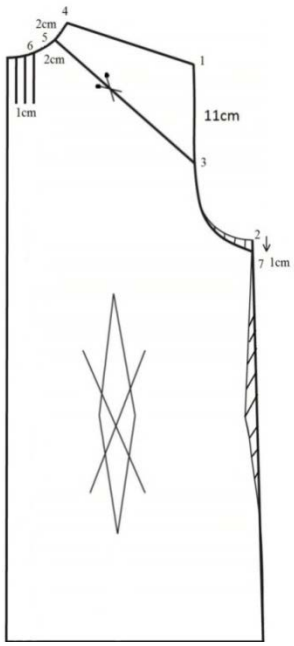


Figure 7: Modeling of the back on the shirt - 1 phase

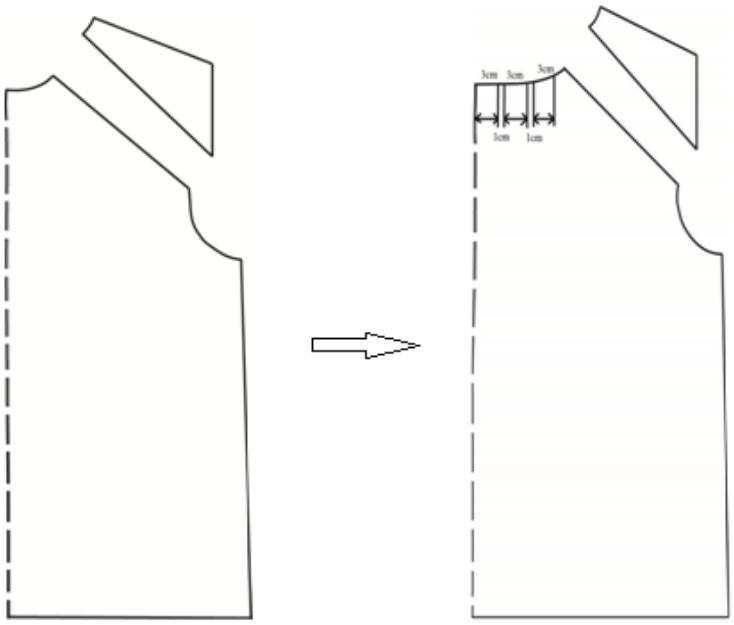


Figure 8: Modeling of the back on the shirt - 2 phase

Modeling two-piece sleeve

Modeling of the two-piece sleeve begins with the extension of the front and back of the sleeve by 3 cm. The cuff is 6 cm in width and 33 cm in length.
Figure 9 shows the two-piece sleeve modeling.

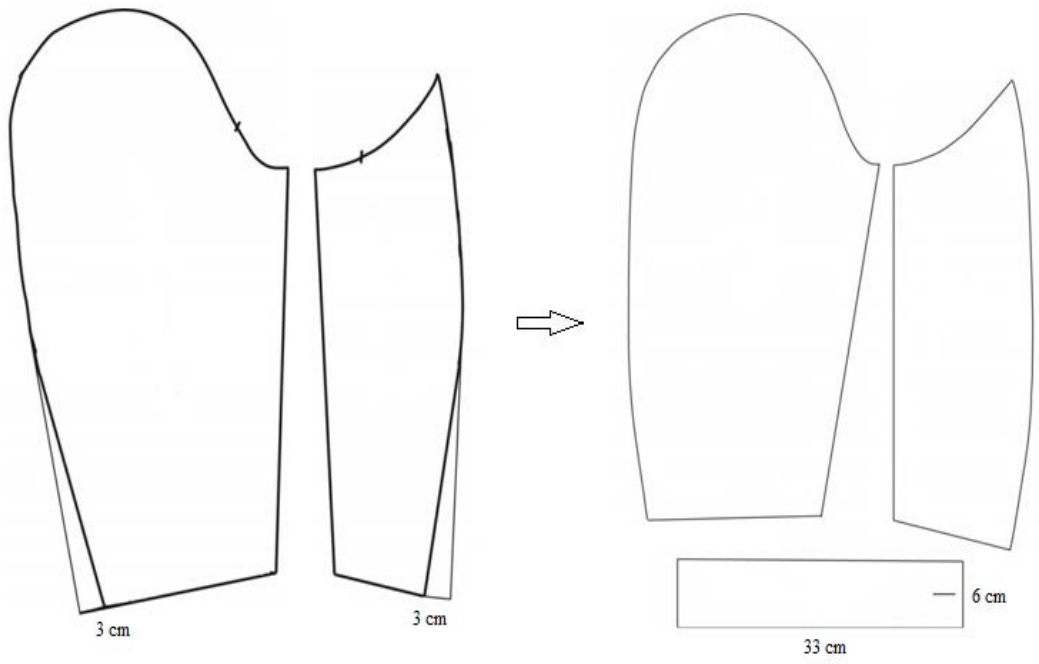


Figure 9: Two-piece sleeve modeling

Figure 10 shows a collar on shirts that is made up of 2 parts.

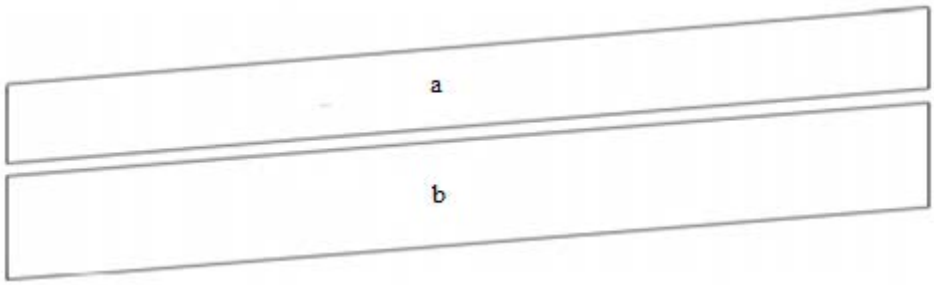


Figure 10: Collar from 2 parts

CONCLUSION

Constantly there are changes in fashion pieces we carry. Each season brings its own contributions and changes, as in patterns, materials, colors and trends. Ideas are everywhere. Certainly, each of us is credited with its dressing and whether they like it or not and to create your own style.
The modeling shirt is derived from the pattern making of the blouse. The possibilities are great so we can make a lot more models that are required for women's shirts.
The aim of this paper is to present a way of modeling a given model of a women's shirt based on a technical sketch of the model.
Modeling determines the type of material that has many and gives us an even better look for the model who wants to be made.

REFERENCES

https://en.wikipedia.org/wiki/Shirt
Barber Wayland E. (1994). *Women's Work*. The first 20,000 Years, Norton & Company, New York, p. 135
Brown L.W. (1999). *Some Thoughts on Men's Shirts in America*, 1750-1900, Thomas Publications, Gettysburg, PA, p. 7.
Burnham D.K. (1973). *Cut My Cote*, Royal Ontario Museum, Toronto, Ontario, p. 14.
Cunnington C.W., Cunnington P. (1992). *The History of Underclothes*, Dover Publications Inc., New York, pp. 23-25.
Cunnington C.W., Cunnington P. (1992). *The History of Underclothes*, Dover Publications Inc., New York, pp. 54.
Baumgarten L. (2002). *What Clothes Reveal: The Language of Clothing in Colonial and Federal America*, The Colonial Williamsburg Foundation, Williamsburg, Virginia, in association with the Yale University Press, New Haven, Connecticut, p. 27.
Baumgarten L. (2002). *What Clothes Reveal: The Language of Clothing in Colonial and Federal America*, The Colonial Williamsburg Foundation, Williamsburg, Virginia, in association with the Yale University Press, New Haven, Connecticut, pp. 20-22.
Cunnington C.W., Cunnington P. (1992). *The History of Underclothes*, Dover Publications Inc., New York, pp. 36-39.
Cunnington C.W., Cunnington P. (1992). *The History of Underclothes*, Dover Publications Inc., New York, pp. 73.
Pastoureau M., Gladding J. (2001). *The Devil's Cloth: A History of Stripes*, Columbia University Press, New York, p. 65.
Buck A. (1984). *Victorian Costume*, Ruth Bean Publishers, Carlton, Bedford, England
Young J. Ditto. (1902). *The Rise of the Shirt Waist*, Good Housekeeping, pp. 354–357.
Ujevic D., Rogale D., Hrastinski M. (2000). *Tehnike konstruiranja i modeliranja odjeće*, Tekstilno-tehnološki fakultet, Zagreb, Zrinski d.d. Čakovec

APPLICATION OF CAD System for LADIES' Dress Design WITH DRAPERIES

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ABSTRACT

Fashion is changing very fast today both in terms of design and different types of materials. The choice of material to be used to make the model is very important for the final appearance of the model. The draperies are the most interesting 3D element in fashion design. According to the ways of their construction, they are the most interesting 3D element for the process of pattern making too. The draperies are used in every type of ladies' clothing but maybe the ladies' dresses give possibilities for the more interesting designs. At the same time, the computer program of designing, modeling and making markers enables us to quickly reach the final model. The aim of this work is to make a 2D transformation from a well-known model designer using the Gerber computer program, where the basic construction of a woman's dress is first made, then modeled and made a cut marker.

Key words: CAD Method, dress, drape, design

INTRODUCTION

In addition to mass industrial production of various types of clothing, small-scale production of all types of clothing is increasingly being made. These are designers who create and sew their own clothes while working in a team. This happens at a time when consumers cannot find what they want and so they decide to take such a step. Women's dress is one of the most sought after outfits that can be made for any occasion from casual to an evening dress designed to the customer's preference. A dress (also known as a frock or a gown) is a garment traditionally worn by women or girls consisting of a skirt with an attached bodice (or a matching bodice giving the effect of a one-piece garment) (Condra J., 1984). It consists of a top piece that covers the torso and hangs down over the legs. A dress can be any one-piece garment containing a skirt of any length and can be formal or casual.

A dress can have sleeves, straps, or be held up with elastic around the chest, leaving the shoulders bare. Dresses also vary in color. The hemlines of dresses vary depending on modesty, weather, fashion or the personal taste of the wearer. Dresses are outer garments made up of a bodice and a skirt and can be made in one or more pieces (Picken M. B., 1957). Dresses are generally suitable for both casual and formal wear in the West for women and girls. In fashion design, 3D elements in the detail of clothing are used in the creation of interesting models. Some variants of a basic model of ladies' dress with different types of 3D elements, in her study presented (Kazlacheva Z., 2015). The clothing item must fit the dimensions and specific features of the human body. Every piece of clothing is sewn together from several pieces of fabric, which then give it its specific shape. The pattern allows customization to the body (Kocijančić Đ., 2018). The prototypes of characteristic models are made to verify patterns, which then, in turn, represent individual groups of patterns. The subsequent examination is there by carried out, and the correctness of the previously made basic model pattern is established (Knez B., 1990).

CAD systems connect with CAM (Computer-Aided Manufacturing) systems to manage and control technological operations in the clothing production, where computer guide and manage certain technological processes (Aldrich W., 2008). The application of the CAD System involves the whole process, from the idea and the sketches of the model, as a 2D / 3D design to the prototype model with site planning and monitoring from preparation to production (Burke S., 2006, Petrak S. *et al*., 2011). According to fashion design and pattern making the draperies are the most interesting 3D element. They can be classified as free and fixed types. In clothing' design, both types can be used as only decorative or combined decorative and constructional elements. The draperies are used in every type of ladies' clothing but maybe the ladies' dresses give possibilities for the more interesting designs.

Some researches (Divena P. *et al*., 2016) presented the study of all possible ways of designing and patterns of drapes with decorative and structural function in the fashion design of women's dresses. The aim of this work is to make a 2D transformation from a well-known model designer using the Gerber computer program, where the basic construction of a woman's dress is first made, then modeled and made a cut marker.

EXPERIMENTAL PART

Dress designers often use flat pattern making and draping techniques for dress design. The draping pattern design is the art of wrapping the fabric around the desired form and fastening it into a particular shape. Flat pattern making involves shaping a piece of fabric according to the curves of a human figure. The functions pattern making lies between production and design. The dress used for our further experiment is from the famous fashion designer Valdrin Sahiti, (Figure 1).
He has used a lot of this kind of modeling (making the drapes) and playing with those patterns, using the mannequin doll of pattern making.

Figure 1: Dress design by Valdrin Sahiti

The designer has used sequin, very thin fabric. Draping is made directly on the mannequin doll using pins. Gathers doesn't seem equal on the front bottom part. The bottom part has two parts, left and rights which apparently are crossed one over another. The basic construction of women`s dress and sleeve and modeling with draping front pairs will be doing with the 2D transformation of pattern making design using computer program Gerber. Finally, a cut marker was made for the cut pieces of the modeled dress. From the cut pieces obtained, one can see how the fronts of the dress models that give the drapery look. The back and sleeves are also shown.

RESULTS AND DISCUSSION

Computer pattern making design of ladies` dress

The computer construction of the basic ladies` dress pattern and tight sleeve was made for size 38 with the following major body measures in Table 1 and Figure 2 shows the computer design using the AccuMark Explorer computer program. For modeling use the basic dress with two darts on the front and two darts on the back as a base for our modeling.

Table 1: Main body measures

Main measures	
Body height, BH	164 cm
Bust, B	88 cm
Waist, W	66 cm
Hip, H	96 cm

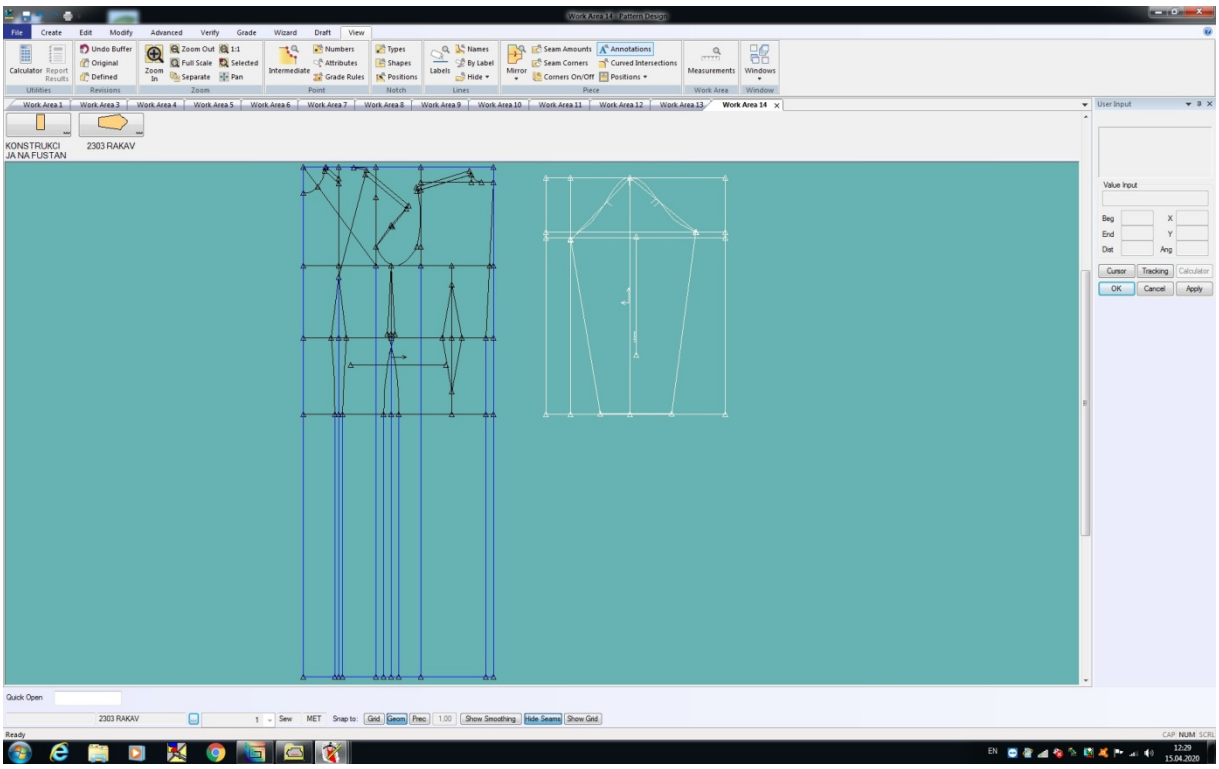

Figure 2: Basic construction of front, back part and tight sleeve of pattern ladies' dress

Modeling upper front part

In this case, it is used the whole front part of the base, not half as is mostly used to do.
Top and bottom pieces from the front part are divided on the waistline. By closing the shoulder dart, the bust dart is getting opened. Slash lines are drawn as the showed on the picture, and they become lines for further drapes.
The top part should have a V-neck line in the end that means the last part is falling out, (Figure 3).
Openings are made on the slash lines on 1-2 cm distance between the parts. After opening the darts, ending points are connected with a curve line. On those points are marked notches, (Figure 4).

Modeling bottom front part

The bottom part can be divided into the left and right parts. First, on the bottom the dress is shrinking for 2 cm from each side. Second, from the left dart, the central line is adjusted to the end of the dress. From that point, both sides are created new points on 2 cm distance. Slash lines are drawn on the left and right sides as shown in the picture below. For the left part, a new side dart is opened by closing the right dart, and by closing the left dart a new deeper side dart is opened as caused by the left dart. Each dart (from the slash lines) is getting opened so the drapes can be done. The right part of the dress is made as same as the left part of the dress, just now the right part has more slash lines (more openings). After opening the darts, ending points are connected with a curve line. On those points we mark notches, so the sewing will be correct, (Figure 4).

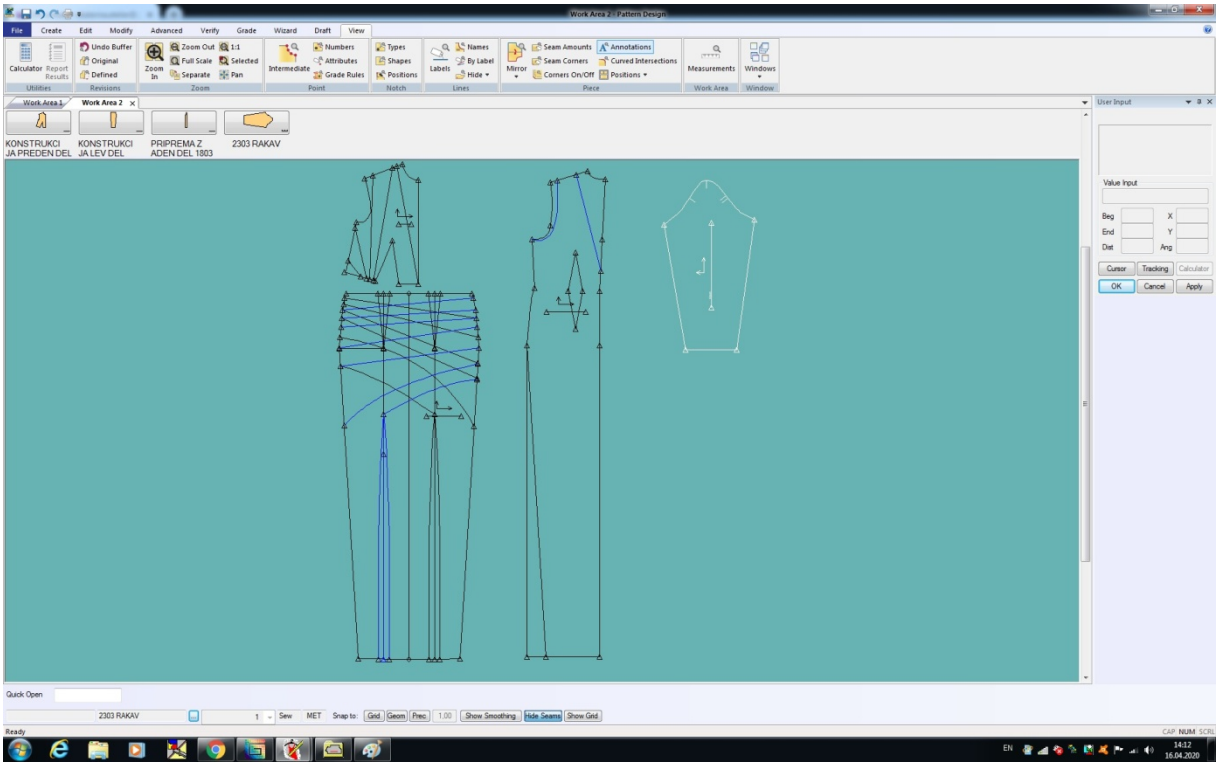

Figure 3: Modeling the dress design - front and back parts

Modeling back part

The back is shrinking on the bottom for 5 cm on side and V - deep neck is drawn as shown in Figure 3 and marks the notch points on the waist line.
The sleeve is a basic tight sleeve with no other modeling done on it.

Completion of cut parts

After modeling, the completion of pattern parts, the seam as well as the marking, were made (Figure 5). For the production of a women's dress, the following parts are required:

- ✓ Upper front part 2X
- ✓ Lower front left part 1X
- ✓ Lower front right part 1X
- ✓ Back part 2X
- ✓ Sleeve 2X

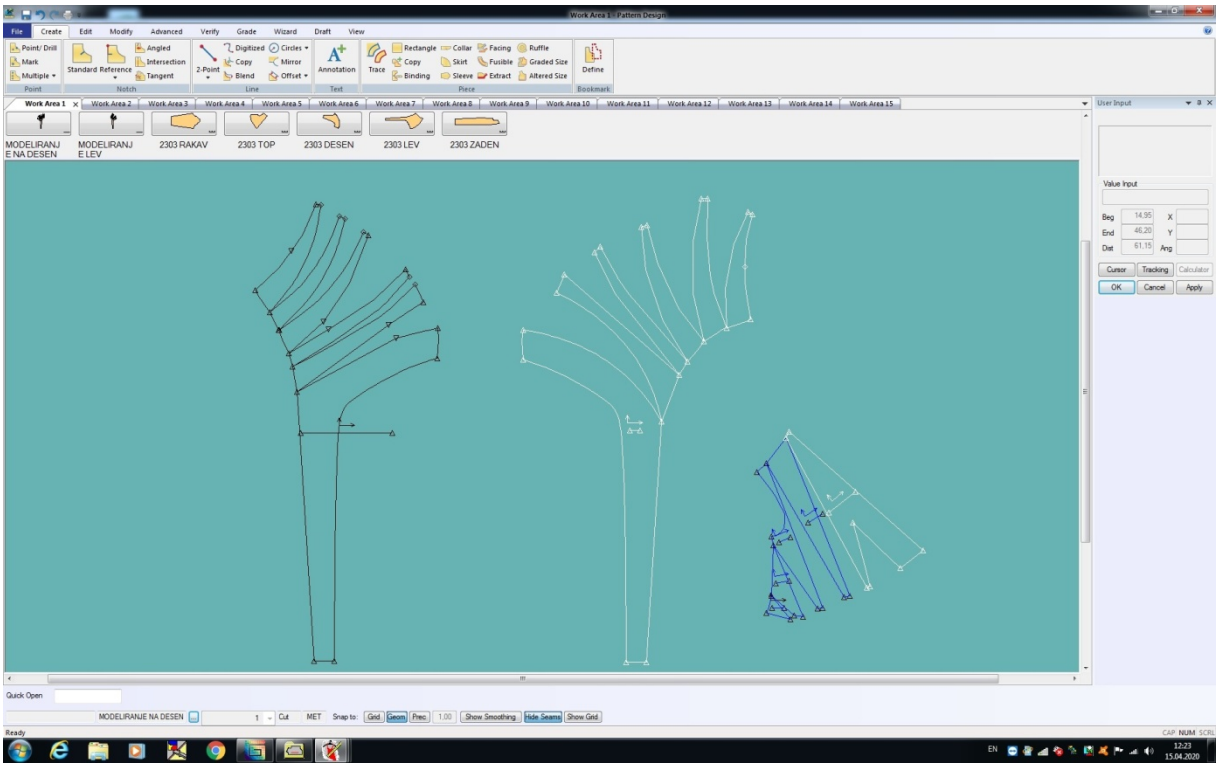

Figure 4: Modeling of front part - upper and bottom

On every piece is added 1 cm seam allowance on every side, (Figure 5).

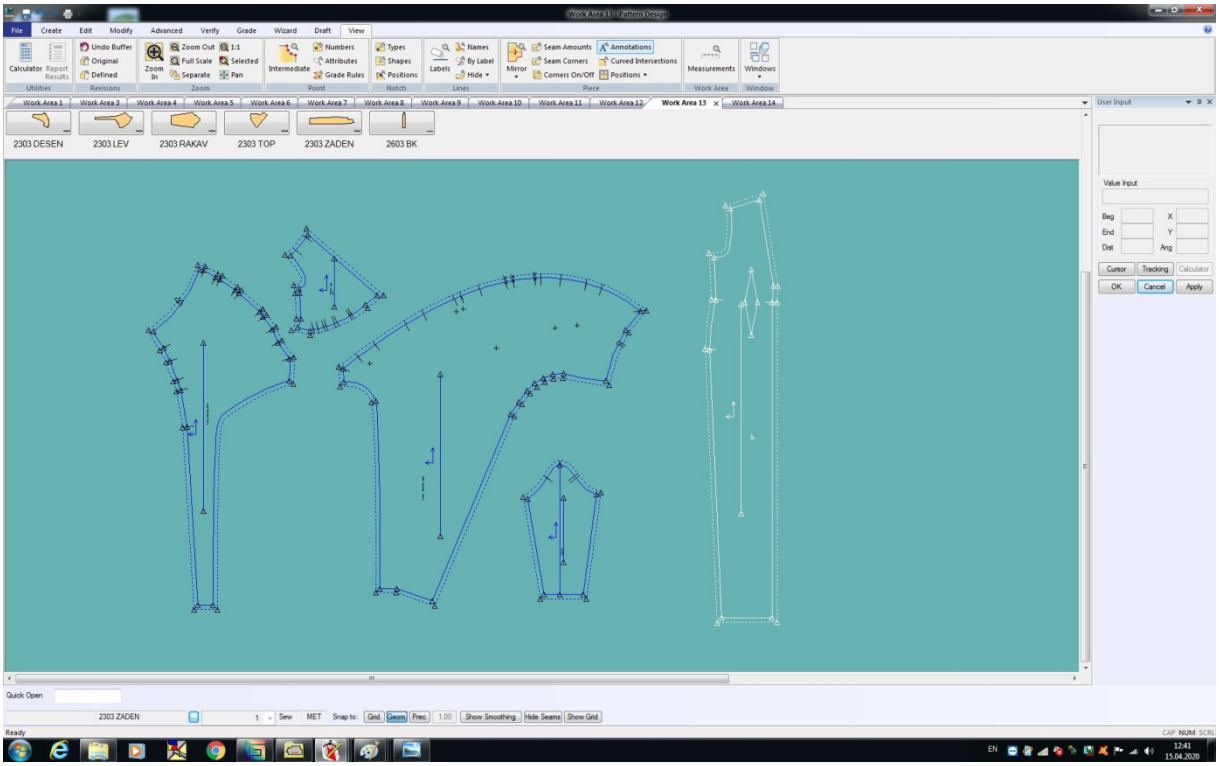

Figure 5: Completion of cut pieces with seam allowance

Figure 6 shows a made cut marker for a modeled dress of size 38.

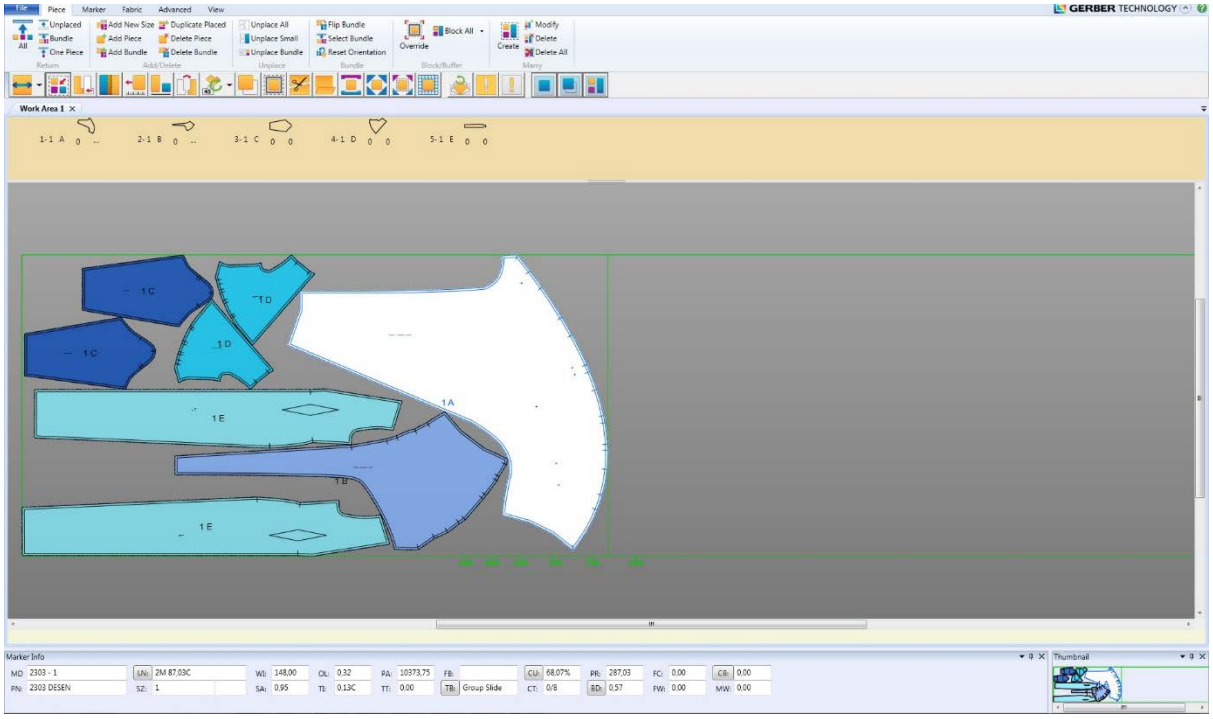

Figure 6: Cut marker for dress model

CONCLUSION

In conclusion, draping is an important process, as it helps fashion designers to experiment with fabric, to use their creativity to see where darts, tucks and other design elements fit better, and to play with the way fabric behaves on the body. That could be done on a mannequin or with flat pattern making, with or without corrections after that.

The inspiration was the creation of a dress by fashion designer Valdrin Sahiti, where one can see his eccentric impression, not only in this dress but throughout his work. Based on where he creates his creations on a mannequin doll, in this paper a 2D transformation of that dress was elaborated with the use of Gerber's computer program, where construction, modeling and a cut marker were made.

REFERENCES

https://en.wikipedia.org/wiki/Dress

Condra J. (1984). *The Greenwood Encyclopedia of Clothing Through World History: 1801 to the present*, Greenwood Publishing Group. p. 59.

Davis M. (2007). *Art of dress designing* (1st ed.). Delhi: Global Media

Picken M. B. (1957). *The Fashion Dictionary: Fabric, Sewing, and Dress as Expressed in the Language of Fashion*. New York: Funk & Wagnalls Company

Kazlacheva Z. (2015). *Variants of a Lady's Dress with 3D Transformations*, Journal of Textile Science & Engineering, 5(3), 1-2.

Kocijančić Đ. (2018). *Research and Investigation of Women's Dress Pattern*, Textile-Leather., 1 (3-4), 100-113.

Knez B. (1990). *Konstrukcijska priprema u odjevnoj industriji*, Zagreb: Sveučilišna naklada d.o.o.

Aldrich W. (2008). *Metric pattern cutting for women's wear*. Oxford: Blackwell publishing

Burke S. (2006). *Fashion Computing: Design Techniques and CAD*, UK: Burke Publishing

Petrak S., Mahnić M., Rogale D., Ujević D. (2011). *Computer Design of Textile and Clothing Collection* – Assumption of Contemporary Remote Business, Book of Proceedings of 11th World Textile Conference AUTEX, 08-10 June, Mulhouse, France, 1162-1168.

COMPOSITE REINFORCED KNITWEAR AND DEFORMATION PROCESS WITH GEOMETRIC MODELS

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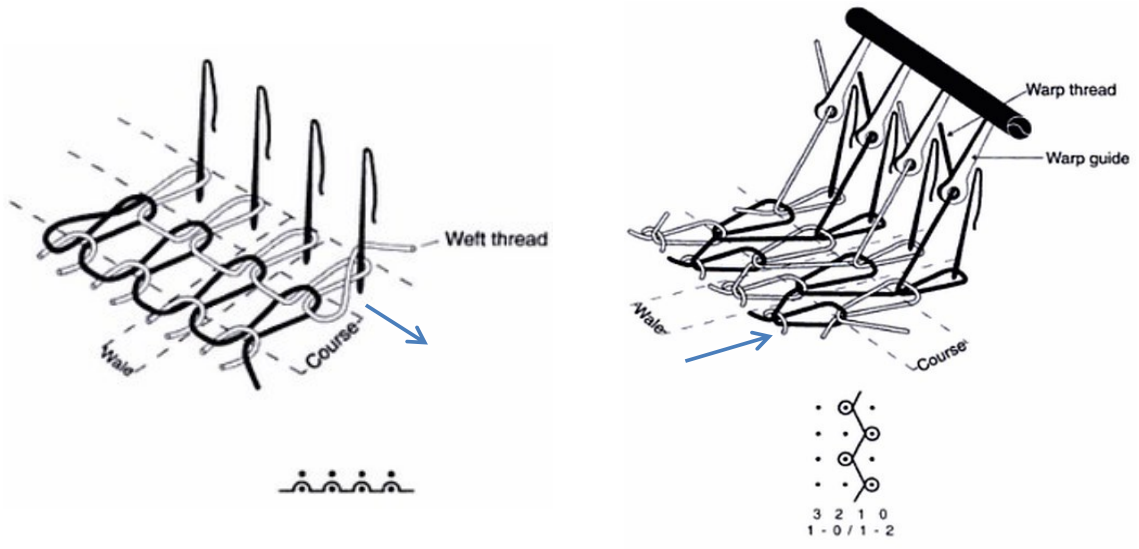
ABSTRACT

The paper deals with the processing of knitwear such as reinforced knit composite that deforms accordingly. Three typical processes of deformation of knitwork are shown. straight segments connected by articulated joints. Many authors have assumed that knitting is a set of unbreakable yarns, and the yarn intersection is simulated as a swivel joint where no slip occurs, and the yarn segment between the joints was a straight line. The primary disadvantages of continuous and two-component models include their inability to model the interaction of the yarn, which is significant in the process of deformation of the knit. External forces are applied to each yarn interaction.

Key words: *knitting, composite, deformation, slip, yarn crossing, modeling, forces*

INTRODUCTION

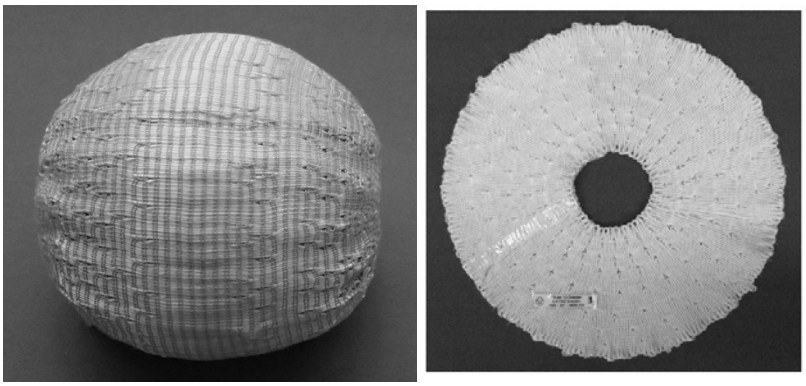


(a)Weft knitting (b)Warp knitting

Figure 1.Schematics of Knitting [1,14,15]

Figure 2 shows two knits produced by biaxial weft knitting [2]. The left picture is a nearly spherical shape, and the right picture is a spirally circular disk.

Near-net shape fabric manufacturing technology has potential for the composite industry. However, numerical simulations of near-net shape knit are rarely seen, possibly because knit patterns are too complex to numerically formulate by simply identifying and assembling unit cells. For near-net shape knit without unit cell feature, a full field modeling is necessary.

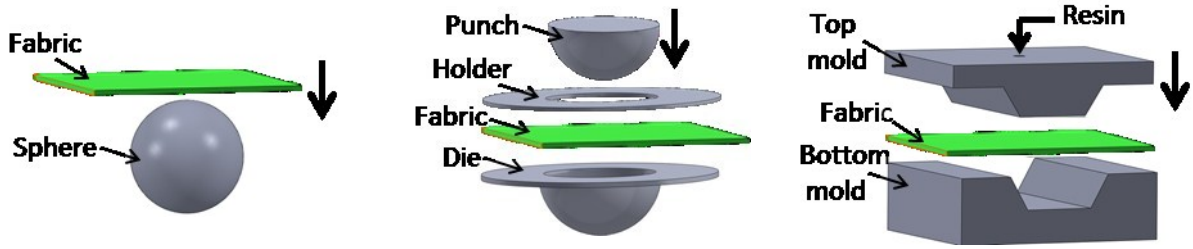


(a)Spherical shape (b)Spirally circular disk

Figure 2. Biaxial Weft Knitted knit [2]

Components of reinforced knitwear and processes of knitwear deformation

After the knit is created, it is also processed into the target product, such as a reinforced knit composite. The knit is deformed accordingly. Figure 3 shows three typical processes of knit deformation. In the process of draping, typically soft knits naturally attach to a specific body (For example, a Sphere) due to gravity, as shown in Figure 3a. mold, as shown in Figure 3b.Usually the punch is a resilient body, such as silicone rubber. The holder reduces border irregularities during the stamping process. In the casting process, the fabric is placed on the bottom mold and then the top mold is slowly moved downwards, as shown in Figure 3c. Knitted clothing matches the shape of the cavity created in both forms. In the meantime, resin is injected from the top mold to consolidate the knit into the component. Although the details vary, there are common simulation issues among the processes, such as the representation of knit and rigid or elastic body and how to model knit and body contacts. Correct modeling of such behaviors leads to accurate prediction of knit deformability and micro- and macro-geometry of reinforced knit composites.



(a)Draping (b)Stamping (c)Molding

Figure 3.Common knitwear Deformation Processes

Research focusing on the simulation of the knit deformation process can be categorized into two primary groups [3]: geometric and mechanical models. Both models are discussed in this section.

Geometric Model

The geometric model, also called the fishnet model, describes the knitwear by straight segments connected with pin joints, as seen in Figure 4.The rigid body is discretized into three- or four-node elements. Nodes of knitwear are geometrically mapped to nodes of the rigid body accordingly.

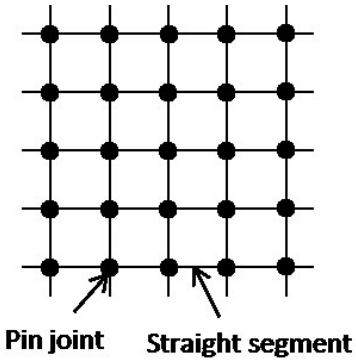


Figure 4. Geometric Model

Basic mapping steps can be summarized as follows [1][2]:

1) 1) Discretize the knit into pin-connected straight segments and discretize the body surface into three- or four-node elements;
2) Choose initial points on both knittig and body surface;
3) Choose two perpendicular constrained lines passing the initial point on the knitwear and map them onto the body surface;
4) Map all other points on fabric to the body surface according to geometric relations with constrained lines.

A deformed knit after the mapping process is illustrated in Figure 5

Figure 5. Knitting Geometrically Mapped to a Sphere

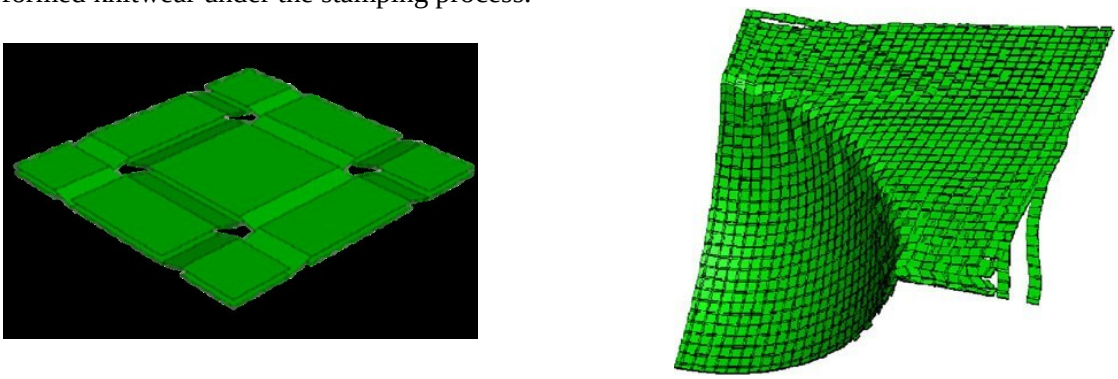
The geometric model was introduced by Mack and Taylor [3] in the 1960s. In their model, woven cloth was assumed to be an assembly of inextensible yarns, and the yarn crossing was simulated as a pivoting joint where no slippage occurs. Yarn segment between the joints was a straight line.

Other research works using one kind of finite element but with two different properties assigned can be found in literatures [7]-[9]. One example is shown in Figure 5. In this unit cell, the four outer elements represented tows/yarns and the diagonal elements modeled shear effect. E_L denotes yarn longitudinal modulus, and σ_s defines shear stress which is a function of shear strain ε_s. Both tow and shear elements were implemented with the truss element but with different assigned stiffness.

Knitwear in Discrete Model

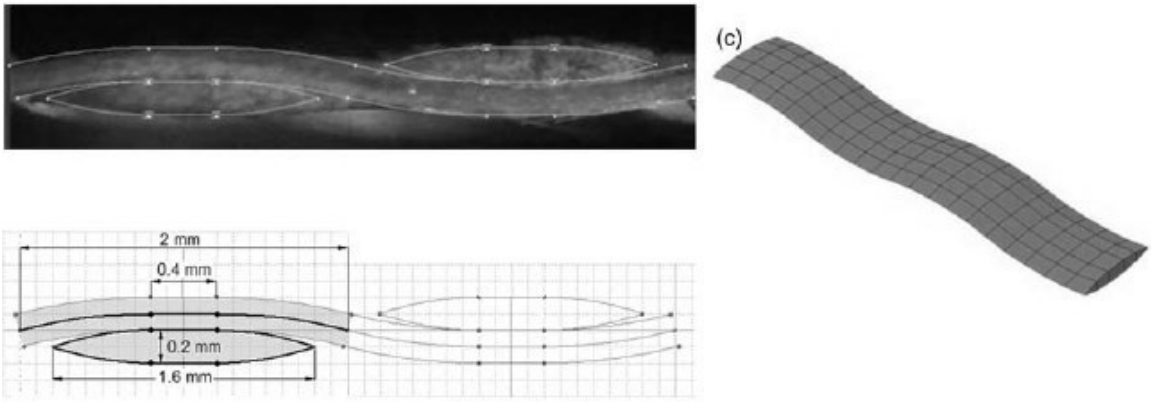
Primary disadvantages of continuous and bi-component models include their inability to model yarn-to-yarn interaction, which is significant in the knitt deformation process.In the discrete model, each individual yarn is identified and modeled by finite element representation. External forces are applied to each yarn and yarn-to-yarn interactions can be modeled.

Boisse et al. [1-13] developed a discrete model based on their previous semi-discrete model [10]-[12]. Figure 6 a shows the unit cell model of an undeformed plain weave knitwear. Each yarn was modeled by a set of finite shell elements, and tensile force can be directly applied to each yarn. Yarn-to-yarn contact and yarn-to-yarn sliding were also taken into account. In this case, in-plane shear behavior was naturally reflected. Figure 6b shows the simulation result of a quarter of the deformed knitwear under the stamping process.

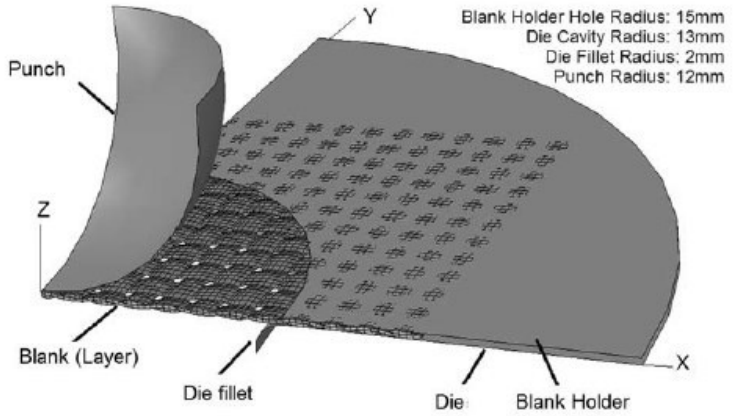


(a)Undeformed unit cell (b)A quarter of the deformed knitwear

Figure 6. Discrete Model (Shell Element) for Stamping [3]



(a) unit cell and yarn models



(b) Initial settings of stamping process

Figure 7. Finite Element Model for Stamping [13]

Most recently,Tavana et al. [14] described knit and yarn models based on experimental investigations in order to simulate the damping process. Figure 7a shows microscopic images and numerical models of unit cell and yarn. Yarn was expressed by linear eight-node brick elements and linear six-node triangular prism elements with assigned transversely isotropic elastic properties. Figure 7b demonstrates the initial finite element model for the stamping process. Only a quarter of the knitwear was modeled. All forming tools, including the punch, die and blank holder, were described as rigid surfaces.

Figure 8 shows a plain weave knitwear, in which a yarn is represented by 19 digital fibers. It is feasible to simulate the deformation process of fiber-level fabric with modern computer power.

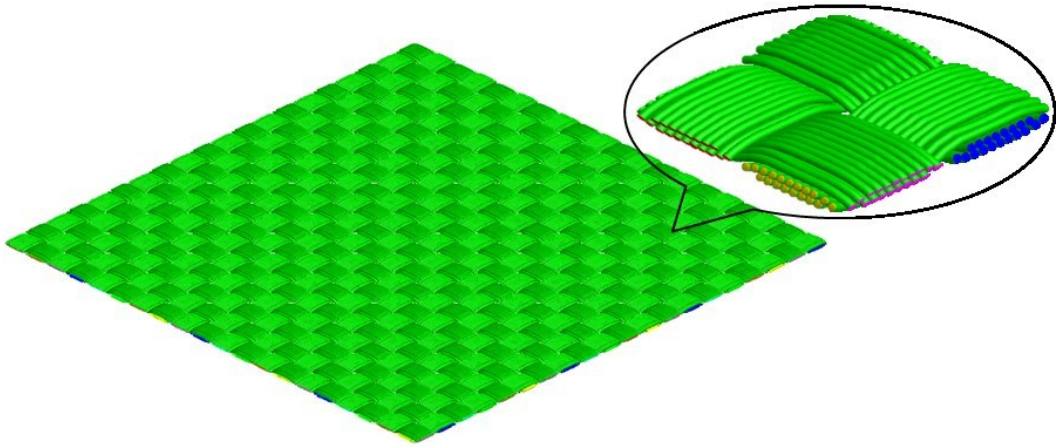


Figure 8: Fiber-level Fabric

REFERENCES

[1]. Fayala, F., et al., Neural network for predicting thermal conductivity of knit materials Jurnal of Engineered Fibres and Fabrics, 2008.3(4).p.53-60.
[2]. Stankovic, S.B., Popovic, D., and Poparic, G.B., Thermal properties of textile fabrics made of natural and regenerated cellulose fibers. Polymer Testing, 2008. **27**(1): p.4148.
[3]. Kothari, V.K. and Bhattacharjee, D., Prediction of thermal resistance of woven fabrics. Part I: mathematical model. Journal of The Textile Institute, 2009. **99**(5): p.421 432.
[4]. Rengasamy, R., Das, B., and Patil, Y., Thermo-physiological comfortcharacteristics of polyester air-jet-textured and cotton-yarn fabrics. Journal of The Textile Institute, 2009. **100**(6): p. 507-511.
[5]. Zhu, F. and Li, K., Determining effective thermal conductivity of fabrics by using fractal method. International Journal of Thermophysics, 2010. **31**(3): p. 612-619.
[6]. Das, A.,Alagirusamy, R., and Kumar, P., Study of heat transfer through multilayer clothing assemblies: a theoretical prediction. AUTEX Research Journal, 2011. **11**(2): p. 54-60.
[7]. Kothari, V.K. and Bhattacharjee, D., Prediction of thermal resistance of woven fabrics. Part I: Mathematical model. The Journal of The Textile Institute, 2008. **99**(5): p. 421-432.
[8]. ASTM D 1518-85: Standard test method for thermal transmittance of textile materials. 2003, American Society for Testing and Materials.
[9]. Cabeza, L.F., et al., Use of microencapsulated PCM in concrete walls for energy savings. Energy and Buildings, 2007. **39**(2): p. 113-119.
[10]. Brown, R.C., Rasberry, J.D., and Overmann, S.P., Microencapsulated phase- change materials as heat transfer media in gas-fluidized beds. Powder Technology, 1998. 98(3): p. 217–222.
[11]. Hawlader, M., Uddin, M., and Khin, M.M., Microencapsulated PCM thermal energy storage system. Applied Energy, 2003. **74**(1-2): p. 195–202.
[12]. Huang, M., et al., Microencapsulated phase change slurries for thermal energy storage in a residential solar energy system. Renewable Energy, 2011. 36(11): p. 2932 2939.

[13].Arthur Shapiro., Finite Element Modeling of Hot Stamping,: 23 April 2010.
[14].Vojislav Gligorijevic.,Technology of Knitting: Theoretical and Experimental Analysis,ISBN-13: 978-3659852503 .,ISBN-10:3659852503.,LAP LAMBERT Academic Publishing (April 8, 2016).
[15].Vojislav Gligorijevic, Projecting transfersely knitted,ISBN-10**:** 3659918342 ISBN-13**:** 978-3659918346 weave.,LAP LAMBERT Academic Publishing (July 19, 2016).

METHODS FOR ANALYSIS OF DEFORMATION PROPERTIES OF TEXTURED MULTIFILAMENT POLYESTER YARNS

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ABSTRACT

The paper presents a method for the analysis of deformation characteristics of textured multifilament yarns. The method is based on the analysis of the dependence of forces - elongation of textured multifilament yarn during stretching to break, on a dynamometer. The obtained dependence of forces - elongation is approximated into the functional dependence of these two parameters. By analyzing the function, the elastic limit, creep limit, end of creep zone, yield limit after creep and break of textured multifilament yarn are defined. The analysis of the obtained parameters can predict the behavior of the yarn in the following technological processes. The obtained data can also be used to predict the characteristics of textile products formed from textured yarns.

INTORDUCTION

In the texturing process, smooth monofilaments are formed into curly threads. Under the influence of thermal and mechanical action, thermoplastic fibers get a wavy appearance. The textured yarn shaped in this way is very voluminous and stretchy [1,2].

The mechanical properties of textured multifilament yarn are mainly evaluated based on the values of their breaking forces and elongations. However, although the breaking characteristics are very significant, they are not sufficient to predict the behavior of textured yarns in subsequent technological processes. The forces acting on the yarn in the following technological processes can cause the appearance of plastic deformations. Therefore, products made of such yarns will be of lower quality. In order to prevent such a change in the structure of textured multifilament yarns, it is important to know the limit values of the forces with which the yarns can be loaded in the following technological processes.

The elastic limit, the creep limit, the end of the creep zone, the yield after creep are mechanical characteristics that provide information about changes in the structure of textured yarns during stretching. Therefore, the paper will present methods for the analysis of these key parameters of textured multifilament yarns.

Method of analysis of deformation characteristics of polyester yarns

The breaking characteristics of the experimental material are determined on an automatic dynamometer in accordance with the standard SRPS EN ISO 2062 [3,4].

Using software, the typical force-elongation curves for the tested textured yarn pattern are defined (Figure 1).

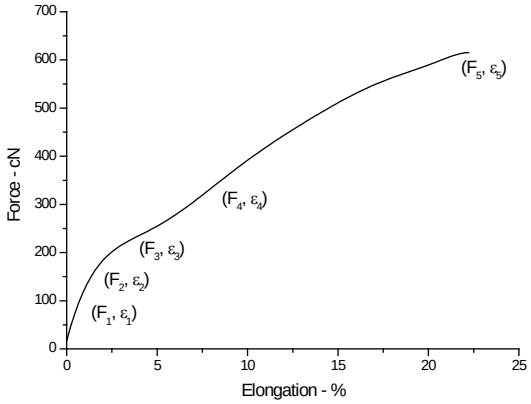


Figure 1 Curve F(ε) of multifilament polyester yarn

Typical curves are presented in the form of a function of a ninth degree polynomial, with the coefficients of determination being about 0.999 [5,6].

The analysis of the elongation force function determines the elastic limit (F_1, ε_1), the creep limit (F_2, ε_2), the end of the creep zone (F_3, ε_3), the yield after the creep zone (F_4, ε_4) and the break (F_5, ε_5). These limits depend on the properties of the starting multifilament and on the production process parameters. In the case of textile materials, there is mainly talk of zones dominated by some kind of deformation.

When stretching the yarn, the curls, which were formed in the process of texturing, are initially straightened. Initially, a higher slope of the curve is noticeable, ie a faster increase in force in relation to the stretching of the textured yarn to the point (F_1, ε_1). This point simultaneously represents the end of the elastic zone. Immediately after the elastic limit is the creep limit (F_2, ε_2). During further stretching, significant changes occur in the structure and all the way to the point (F_3, ε_3) there is a noticeable decrease in the slope of the force - elongation function. Then the slope increases again to the point (F_4, ε_4) and finally decreases until the textured yarn is interrupted at the point (F_5, ε_5)

Determining the elastic limit of textured multifilament yarn

The elastic limit defines the recommended allowable load of textured yarns at which irreversible deformations of the material will not occur. The elastic limit of textured multifilament yarn is determined by analysis of the function of the force - elongation. In order to show more clearly the changes during the stretching of the yarn, the dependence of F(ε) to the yield point, ie to the point F_4, ε_4 of the graph of the function is shown (Figure 2). By defining the local maximum of the first derivative of the function (Figure 3), where the second derivative of the function is equal to zero (Figure 4), the elastic limit is determined, as well as the parameters of forces and elongation at the elastic limit.

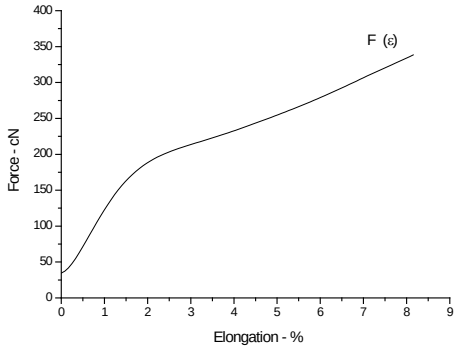


Figure 2: Dependence of F(ε) to the yield point

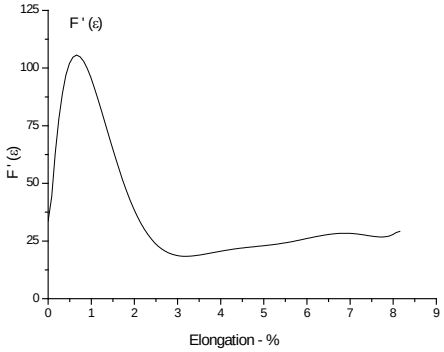


Figure 3: Dependence of F'(ε) to the yield point

Determination of creep limit of textured multifilament yarns

Creep of textured multifilament yarns occurs by applying a load that causes stress in the yarn above the elastic limit. It is determined at the point of local minimum of the second derivative of the function (Figure 4), ie at the corresponding zero of the third derivative of the function (Figure 5). At a given limit, the values of force and elongation up to the creep limit are determined. The creep limit of textured yarns is the upper acceptable load limit, to which the yarn can be subjected in subsequent technological processes, while the properties of the yarn are still acceptable for the production of textile products.

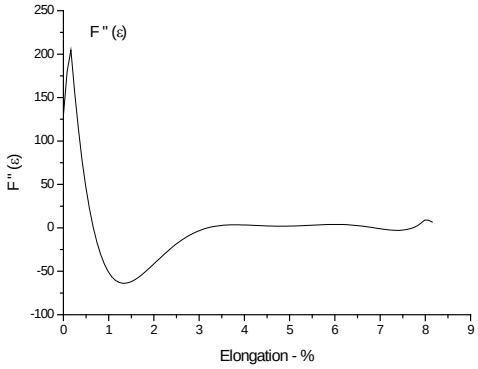


Figure 4: *Dependence of F''(ε) to the yield point*

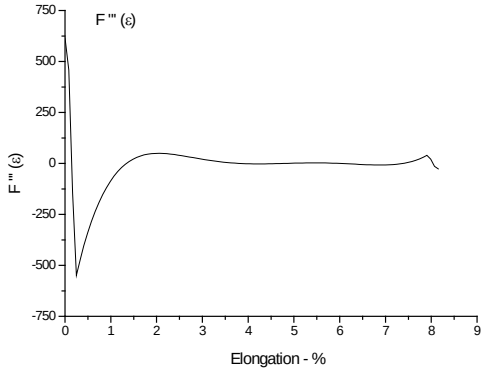


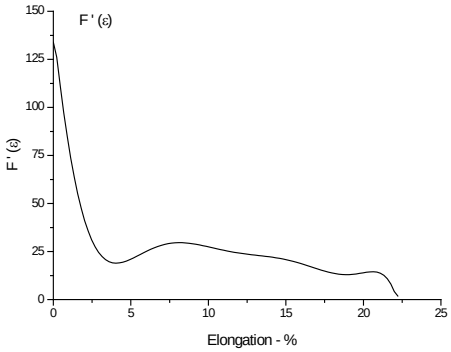
Figure 5: *Dependence of F'''(ε) to the yield point*

The creep zone begins at the creep limit and lasts until the textured yarn stops stretching faster and begins to provide significant resistance to the tensile force again. The end of the creep zone is determined at the minimum point of the first derivative of the function (Figure 3), ie at the point where the second derivative of the function is equal to zero (Figure 4).

Determination of yield and break limits of multifilament yarn

After creep, the multifilament textured PES yarn again provides greater tensile strength and increases the slope of the tensile force curve. This increase in force lasts until the moment when significant changes in the structure of monofilaments occur again due to stretching. The yield limit after creep is determined at the point of local maximum of the first derivative of the elongation force function (Figure 6), ie the zero of the second derivative of the function at a given point (Figure 7). This point on the graph can represent the maximum stress that the textured multifilament yarn will withstand in the

processes of exploitation, to deform but still not break, which is important for application in technical textile materials.



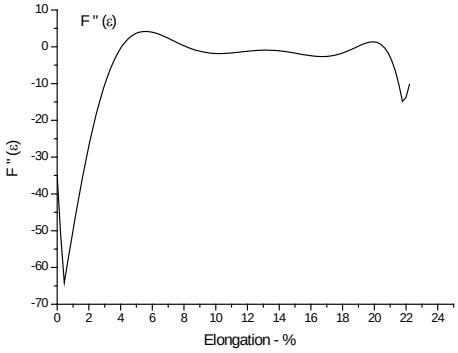


Figure 6: *Dependence of F''(ε) to break* ***Figure 7:*** *Dependence of F'''(ε) to break*

Further stretching causes significant changes in the structure of the textured multifilament yarn, destruction of individual monofilaments and finally the multifilament yarn breaks, which is marked by a dot (F_5, ε_5) on the graph (Figure 1).

CONCLUSION

By analyzing the force - elongation function, significant data can be obtained that indicate the properties of textured yarns, as well as the influence of certain production parameters of production on these properties.

The results of the analysis of the characteristics of textured yarns in the zone of elastic deformations, then in the zone of creep, as well as loosening can contribute to the understanding of structural changes of yarn during stretching.These results can be used to correctly predict the limit loads to which the textured yarn may be subjected in subsequent processing processes, so that the yarn does not change its properties. Also, the parameters on the elasticity limit, on the creep limit, the yield can be used to predict the characteristics of textile products from these yarns

This method of analyzing the characteristics of textured yarns can also be the starting point for the development of a new method for predicting the characteristics of textured multifilament yarns in accordance with the future purpose. The development of a method for predicting the deformation characteristics of textured yarns can contribute to the optimization of energy consumption in the production process of textured multifilament yarns.

REFERENCES

[1] Hearle, J W S, Hollick, L, Wilson, D K . Yarn texturing technology, Woodhead Publishing Limited, Cambridge, 2001.
[2] Atkinson C., False twist textured yarns: Principles, processing and applications. Woodhead Publishing Limited, Cambridge, 2012.
[3] SRPS EN ISO 2062, Текстил - Пређа из намотаја - Одређивање прекидне силе и прекидног издужења појединачних нити употребом уређаја са константном брзином истезања (CRE), 2012.
[4] P. Stojanovic, M. Savic, D. Trajkovic, J. Stepanovic, M. Stamenkovic, M. Kostic; The effect of false-twist texturing parameters on the structure and crimp properties of polyester yarn, Chemical Industry & Chemical Engineering Quarterly, 23(3) (2017), 411-419 .

[5] Jovana Stepanović, Dušan Trajković, Nenad Ćirković, Nataša Radmanovac, A new method for the determination of a crimping degree of textured PES filament yarns, Advanced technologies, 7(1), 69-73, 2018.
[6] Jovana Stepanović, Tatjana Šarac, Nataša Radmanovac, Dušan Trajković, Jovan Stepanović, Crimping analysis of textured polyester multifilament yarn, Industria textila, No.5, 2019., 463–469.

APPAREL E COMMERCE

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ABSTRACT

What is „E commerce"? How big is the influence of „E commerce" ? Cost and benefits of online shopping. Retail vs E commerce, strenghts and weaknesses comparison. What is online marketing? How effective is online marketing in the nowadays? Prices of digital marketing in the social media(facebook, instagram) and how to promote your product online. All of the above will be conducted to the apparel industry. 38,6% of all apparel sales is going through online shopping.

Keywords: E commerce, online shopping, online marketing

INTRODUCTION

What is e commerce? Electronic commerce or e commerce is a business model that lets companies or individuals to buy or sell things online. E commerce was invented back in the 1979, but the real usage in the world became popular at 1995.

We can say Amazon was one of the reasons that helped the e commerce to become as popular as it is now. Amazon.com did grow fast, reaching 180,000 customer accounts by December 1996, after it's first full year in operation, and less than a year later, in October 1997, it had 1,000,000 customer accounts.

As early as 2002, management guru Peter Drucker (2002) forecasted that e-commerce (EC) would significantly impact the way that business would be done. And as it was predicted by Peter Drucker, the world is embracing EC, which makes Drucker's prediction true.

E commerce is not only buying and selling stuff online, it is a lot more, but conducting all kinds of business online such as servicing customers, collaborating with business partners, delivering e-learning, and conducting electronic transactions within organizations.

There are 3 types of buying and selling online:
Business-to-Business (B2B) EC refers to transactions between and among organizations. Today, about 85% of EC volume is B2B. For Dell, the entire wholesale transaction is B2B. Dell buys most of its parts through e-commerce and sells its products to businesses (B2B) and individuals (B2C) using e-commerce.

Business-to-Consumer (B2C) EC includes retail transactions of products or services from businesses to individual shoppers. The typical shopper at Amazon.com is this type. Since the sellers are usually retailers, we also call this **e-tailing**.

In **consumer-to-business (C2B)**, people use the Internet to sell products or services to organizations. Alternatively, individuals use C2B to request bids on products or services. Priceline.com is a well-known organizer of C2B travel service transactions, where people place a request for offers at a price they are willing to pay for a specific trip.

Statistics show that e-commerce is now an essential tool for the fashion industry. In 2018, the industry generated a worldwide revenue of $481 billion. In 2019, that statistic rose higher to $545 billion and is projected to rise further to $713 billion by 2022. The strongest of those sections is the accessories and bags sector, which grew by a huge 15.6% in 2018 and is projected to still grow by 8.7% by 2022.

- 43% of purchases are made after personalised recommendations (via advertisements)
- 75% of consumers brands to personalise messages, offers, and products

- China was the most free-spending nation in 2019, spending $740 billion on ecommerce. That is $179 billion more than was spent in the USA (the second largest market).
- 77% of people in South Korea made an online fashion purchase in 2019. That is the most of any nation

As a result of the COVID-19 pandemic,57% of purchasing managers are spending more on marketplace ecommerce sites, with 22% spending significantly more. When it comes to B2B marketplaces, 89% are buying at least the same amount or significantly more.

B2B ecommerce sales have grown from $1.1 trillion in 2019 to $1.3 trillion in 2020, with B2B marketplace gross merchandise volume growing from $16.58B in 2018 to $22.56B in 2019 to $31.19B in 2020.

COVID-19 accelerated many trends, including brands looking more toward third-party sellers. **Amazon** is of course emerging as a dominant force in this arena, set to top $52B in gross merchandise volume by 2023.

The benefits of e commerce comparing to retails

First benefit of e commerce is low financial cost, it is very simple to start up an online shop, whilst it's rather expensive to open a retail. For example, one person is able to do an „online store" while for the retail you would need to pay the rent for the store, workers, store design, store inventory, staff, equipment depending on the size of the store.

The working hours, your website is working 24/7, but the retail store is usually working 12h a day. Many people are at work whilst the retail is open so they resort to online shopping. That's a lot of customers lost, also there are people who do not like the crowded places like shopping malls or the „black Friday jams".

One of the important benefits is that it's much easier to find the product you are looking for on a website than in the store. But, at least, here in Serbia, people have the urge of going to the store for buying clothes, for example i have not ever bought a pair of jeans online(but i did buy a lot of other stuff), so people are searching for the „perfect fit" pshysically.

Long queues are also a thing that people do not like to see, nobody likes waiting in the line, buy online, problem solved. Due to COVID-19 regulatives in the most of the countries, it seems like online shopping is a must, for almost everything. Companies that only had retail stores suffered big loses, and it is a question if they are going to be able to recover from it.

With digital marketing you will be able to do a better targeting of your customers. At the modern age it is really easy to collect customer information, you can track the customers buying habits and target marketing strategy and promotions in a better, more accurate way. All of us got the „recommended for you" when we were searching for clothing online.

Some people want to see the product, and that is i would say the biggest benefit of retail. Some people do not believe in the security of online shopping so they tend to retail stores, one of the things they can't do online is the „handfeel" of the product. Also, nothing to do with the apparel, but cars are really difficult to sell online, so car dealerships are still going to stay as retails. Simply, there are products that are almost impossible for online shopping.

Online marketing is the key to e commerce and also retail. It is essential to promote your product and one of the best ways to do it in the modern age is definitely online marketing. Online marketing is

marketing that takes place exclusively on the internet. Marketing professionals use various methods to attract a specific audience(targeting) to a specific website via different ways like „emails, banners, ppc, advertisements, click baits, applications. Social network marketing is a part of online marketing, and it's a quick developing part. Anybody can get a sponsored commercial online, especially on the social networks. Digital marketing is pacing at an 11% compound annual growth rate between 2016 and 2021 with the biggest growth occurring in online video. Investment in paid search, display advertising, social media advertising, online video advertising and email marketing is predicted to account for 46% of all advertising by 2021.

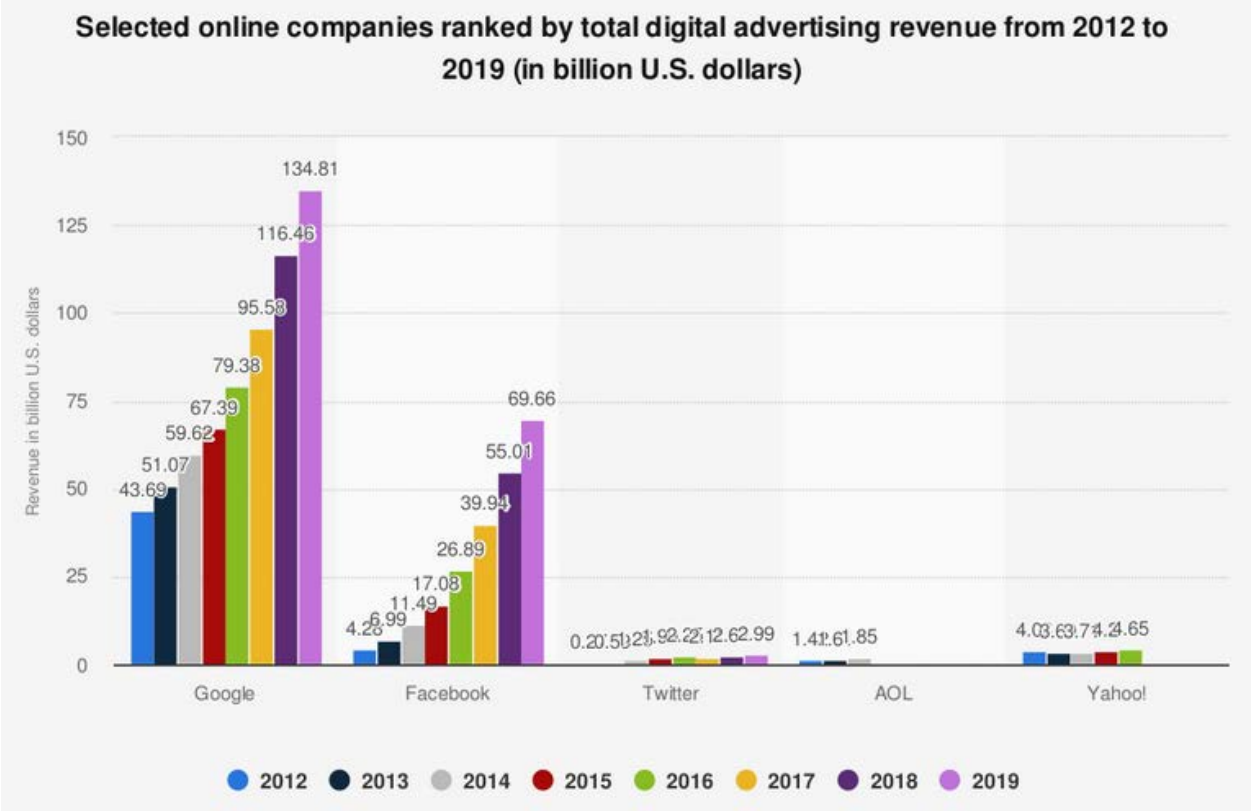

***Figure 1**:The chart represent the growth of digital marketing on social networks from 2012-2019*

It's quite easy to start your own marketing „campaign" on instagram for example, you can start with even 1$ per day but the max for new profile is 1000$ per day, for a campaign of that can last from 1-30 days, you can start as many campaigns you want. Promoting pictures, profiles and send people to your direct messages. The more money you invest the bigger reach you will have, you can manage your target groups based on age, sex, location and interests.

	Results	Cost	Reach	Total spent	Clickthrough %	CPM
Page Likes	45	$0.57	1,268	$25.65	3.55%	
Clicks to landing page	6	$4.01	1,814	$24.06	0.33%	
Boosted post	35	$0.74	4,078	$25.90		$6.35
Overall	86	$5.32	7,160	$75.61	0.95%	

Figure 2: prices and reach of facebook ads

To invest in the social network marketing is always a good idea, of course, the best thing to do first is find a product that you will sell online. After that the first thing should be activating profiles on the social networks, i think instagram is currently the best network for advertisements, so the goal is to reach more „followers“ and „likes“ the so called „profile hits“. The best way to do that is also by investing, but there are different „cheaper“ ways, the profile should attract your customers, so it should be professional, the pictures and the biography and the content needs to be on a high level. Connect all your profiles facebook to instagram and a link to your website.

It is not that easy to make a good shopping website, but there are free videos how to do it and it’s possible to hire a professional to make it for you(which is probably the best thing if you are already investing). A good website needs to be simple for the customers, easy to find what they are looking for.
Instagram commercials and sponsored posts are probably the leaders in online marketing, because instagram grew to a number of 1 billion active users in June 2018. There is over 500 million instagram stories per day. Some of the facts about instagram:

- 41% of Instagram users don’t watch television on any sort of regular basis
- Kylie Jenner(influencer) earns an estimated $1.3 million per sponsored post
- Fashion influencers account for 25% of sponsored posts
- Somewhere between 80-92% of marketers believe influencer marketing is effective
- 2 million advertisers use Instagram on a monthly basis
- Instagram ad revenue as a share of Facebook ad revenue is set to rise from 9% in 2017 to 30% by 2020

So if you are preparing to promote a brand or start up a online shopping website, my suggestion would be to start promoting from instagram and facebook, it takes a lot of work and commitment, but „Rome wasn’t built in a day“. There are a lot of youtube videos and free tutorials that can help you in the begining. Start slowly, and you will progress. After the first earnings, it all starts to get together.

With the social networks and online shopping, the world has improved a lot, Europe is not No. 1 in online shopping, but that trend is agressively taking over, especially during these hard times. Whatever

you produce, sell or buy, make sure it's a good quality product, that was the past and it will soon be the future again, customers always return if they buy a good quality product from you.

CONCLUSION

In the future, we will be looking back on Covid-19, but online shopping is the past, the present and the future. Some of the statistics are showing that retail is going to go up for 12% in the next year and 22% of that money will be spent online. From every five dollars spent, one dollar will go online, that is a fascinating fact, comparing to the 2017, when online shopping was taking 12% less then the nowadays. Retail is still staying strong, but online shopping is growing each day. 43% of global shoppers research products via social networks, because it is much easier.

Apparel industry is also taking it's percentage in the online shopping, for example, 56% of the American citiziens bought some piece of clothing in between 2018 and 2019. There are many new applications day by day, which „help" you find the „perfect piece of clothing" for you. The technology has improved a lot so now you can find an app where you can dress yourself to see how the clothes fit you. Who knows, maybe, in 10, 20-50 years, robots will try clothes and we will all buy it online.

We should all focus to build a better tommorow. That's our goal, as humans. Stay safe.

REFERENCES:

[1] Springer Texts in Business and Economics
[2] Influencer, Brittany Hennessy
[3] Hannes Mueller ESB Business School Reutlingen University

SUSTAINABLE FASHION AS AN ECOLOGICAL NECESSITY

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ABSTRACT

The paper presents sustainable fashion, which contributes to social stability and quality of life because it is a movement and a process of nurturing changes in fashion products and the fashion system towards greater environmental integrity. All the shortcomings and problems of unsustainable fashion are covered, due to which we have to change habits and turn to the circular economy in textiles, as well as how much consciousness is changing and that it is becoming a future and a trend or just an ecological necessity. The connection between fashion and sustainability, the influence of fast and the need for slow fashion in the world as well as in Serbia is presented on the basis of conducted research. Based on all the above, it can be concluded that sustainable fashion will provide a new market for additional employment opportunities, continuous cash flow in the economy, reduction of raw materials and export resources, attitudes towards consumption and use, change in attitudes and behavior of individuals, awareness of strategy for its production.

Key words: fast fashion, slow fashion, recycling, circular economy, green strategy.

INTRODUCTION

An important segment of the fashion industry is in sustainable fashion, which in many ways contributes to social stability and quality of life.
Sustainable fashion is a movement and process of nurturing changes in fashion products and the fashion system towards greater environmental integrity and social justice.
The bad thing about unsustainable fashion is that cheap, affordable and trendy clothes have become available to the masses. The economic concern of fashion is that low-paying people now have access to “updating” their closets as often as high-paying ones. People don’t buy quality goods, they buy too much and too cheaply. The economic concern of fashion also means that many sustainable fashion solutions, such as buying high-quality goods that last longer, are not available to people with fewer resources.

The impact of the textile and clothing industry on the environment

Manufacturing industries do not have as much impact on the environment as the textile clothing industry. Fashion has equalized, if not suppressed, the primary functional purpose of clothing, making aesthetics almost the most important feature because fashion creates a special, unique style, individual taste and design at the center of its existence. Only mass production can respond to the impact of the environment and easily changing trends, which leads to global problems within the textile industry. In conflict are the need for economic development, production and profit as well as limited resources which brings us to the question of what is the possibility of meeting the needs of future generations. In today's linear economic order, the balance between development, production, profit and sustainability is difficult to achieve.

Although the concept of sustainable development may not be the first association when we talk about fashion, there is a connection between fashion and sustainability. Sustainable fashion implies *slow fashion*, a fairly new movement in the fashion industry, which is emerging in response to the currently growing and aggressive (*fast fashion*). Fast fashion is considered unsustainable because it leads to excessive consumption of fashion products, their uniqueness and poor quality, and because its business model entails many social issues such as the use of natural resources and the quality of working conditions. The term “slow fashion” describes a socially conscious movement that is in

conflict with the ever-accelerating fashion cycle from production to disposal. Slow fashion products are those products that are not produced in accordance with the ideals of the fast fashion business model and do not respond to rapid changes in fashion trends.

Sustainable awareness allows the innovation of fashion solutions by preserving the environment, establishing a healthier economy and addressing social inequalities, and first tries to alleviate the contradictions between fashion and sustainability with sustainable fashion. This will be achieved when designers and other actors within the textile industry who dictate trends and production begin to give up the high frequency fashion industry by adopting flexible design, focusing on all aspects (from designers, through production workers to consumers) and, of course, the ecosystem.

Figure 1. The course of the circular economy - the emergence of the garment

Fast fashion as an environmental polluter

Fast fashion has led to the fact that today the textile industry is one of the biggest polluters of the environment. From raw materials, such as cotton, which is one of the most polluted materials due to the use of various harmful pesticides to improve growth, and today it is the most common in terms of clothing. The textile industry is the cause of water, air and soil pollution. Furthermore, in order to make the production process as cheap as possible, apart from cheap and health-contaminated materials, mass production also "requires" work in sweatshops, exploiting workers who often work in inhumane conditions, earning well below the average salary in the country. According to the chamber, as much as 50,000 tons of textile waste is produced annually in Serbia, which is approximately 12 kilograms of waste per capita.

It is necessary for the society to become aware of the problem of actively working on projects of scientific-research nature, where they follow new, intelligent technologies in the field of fashion and industrial design, cooperate with individuals, organizations and institutions and thus create sustainable collections. fashion shows and other various events, and on its own website. Instead of manufacturing, designers create their own creations and thus participate in the production process from its beginning to the end.

This way of production is the key to slow fashion. States must prepare even more actively for the transition to a circular economy because they know that in the current global crisis and climate change, it is no longer a matter of good will, but of bare survival. The story of sustainable fashion is inevitably connected with the concept of a circular or circular economy, which is also almost unknown in Serbia, according to numerous experts.

Figure 2. Example of a circular or circular economy - for cotton and cotton products

Circular economy

One of the elements of the circular economy and a prerequisite for its implementation is sustainable waste management, ie it is the first step to implement the concept of circular economy in practice. The circular economy is a revolutionary concept of the economy of the 21st century that responds to the global crisis. Sustainable development in the fashion industry is implemented through the idea of sustainable fashion and implies a responsible attitude towards textile waste as a useful raw material for the production of new clothes or even extending the life of a garment by redesigning it.

Sustainable fashion includes not only the use of sustainable or organically produced materials, but also a responsible attitude towards all workers and subcontractors in the clothing production and distribution chain. The circular approach insists on the efficient return to life of used items, which brings additional opportunities for growth and new business opportunities in the production process because it implies the launch of completely new industries. Estimates of the application of the circular economy in the EU reach productivity growth of 30% by 2030 with 1% GDP growth and the creation of two million new jobs. The design, environmental and usage standards of the circular economy bring savings estimated at 600 billion euros a year in the EU.

Figure 3. Circular economy as the future

Possibility of commercializing sustainable fashion

Therefore, in order for the concept of sustainable fashion to be commercially viable, a market must first be created that will demand such an offer. In today's society in which the success of the economy is seen through the production and sale of as many short-term low-cost products as possible, pushing sustainable fashion is not in the interest of powerful groups that financially manage today's world. At the moment, it seems the opposite, the trend of fast and cheap fashion will strengthen, and sustainable fashion will remain an alternative, not a commercially viable trend that we need to change.

It is a matter of time when we will put profit and fashion and clothes aside because it is evident that with such an unsustainable, unconscious and anti-ecological way of life we will be forced to better set priorities and fight for our own life and health, the current "produce - use - throw" economy swallow everything in front of it. It is important that we all understand that we are responsible. Not only politicians and governments are responsible, citizens are also responsible, and they can show their responsibility by everyday actions such as waste selection, saving water and energy, using more environmentally friendly means of transport, buying fewer clothes, but also other items that are used longer. "

CONCLUSION

Without improvements in the way clothes are made (e.g. the use of a green strategy), this way will increase with each production. Some companies have teamed up to tackle environmental and societal challenges together, helping to accelerate change and mitigate the risks of working on these challenges themselves because sustainable fashion is a necessity. Additional steps that fashion companies can take to eliminate some social and environmental risks and are part of fast fashion are: develop standards and practices for clothing design that can be easily reused or recycled, invest in the development of new fibers that will reduce the impact of production and manufacture life-saving clothing, support the development of mechanical and chemical recycling technologies, establish higher standards of operation and environmental protection for suppliers. A more sustainable way of production can cost more but can encourage innovation and protect companies from supply chain shocks and reputational risks, leading to greater resilience and greater profitability.

REFERENCES

1. J.Stepanović, S. Janjić: Mechanical textile technology, University in Banja Luka, 2015. 2. Technical information of the manufacturer Mesdan, 2016. 3.
2. D. Radivojević, M. Đorđević, D. Trajković: Textile testing, High School of Textile Textile, Leskovac, 2016. Investigation of the influence of qualitative characteristics of fabrics on thermophysiological properties of clothes - doctoral dissertation – Mirjana Reljić – Leskovac 2016.
3. https://oradio.rs/sr/vesti/drustvo/odrziva-moda-buducnost-ili-trend-9621.html
4. https://www.nedeljnik.rs/tag/odrziva-moda/
5. https://www.movem.rs/vesti/odrziva-moda/84
6. https://www.beforeafter.rs/tag/odrziva-moda/

THE INFLUENCE OF SOCIAL NETWORKS ON TODAY'S FASHION

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ABSTRACT

Everyone has a different view of fashion, some believe that fashion is dictated by big fashion houses, and that a famous person is popularized. In today's fashion, social networks have a huge impact. The younger generations are fascinated by today's social systems, which can be interpreted differently, both positively and negatively, because it has its good and its bad side, which we talk about in this paper, which are social networks as users function and use.

Key words: trends, social networks, style, influencers, fashion.

INTRODUCTION

Today, everyone has a different view of fashion. Some believe that fashion is dictated by big fashion houses, and that celebrities popularize it. Some still think that everyone should have their own style, and wear what they like, regardless of fashion trends. Fashion has changed drastically over the centuries and different styles have emerged.

Fashion design is the skill of applying design, aesthetics and natural beauty to clothes and their accessories. It is influenced by cultural and social attitudes and varies in relation to time and place. Fashion designers work in numerous ways in designing clothes and fashion details.

Because of the time it takes to bring clothes to market, designers must anticipate changes in consumer tastes. Designers conduct research on fashion trends and interpret them for their audience. Manufacturers use their specific designs. This is the essence of the design role; however, there are differences within this, which are determined by the sales approach and product quality; for example, retailers will use cheap fabrics to interpret trends, but high-priced retailers will use the best available fabrics.

Social networks have a huge impact on today's fashion. The biggest impact began in mid-2012 when Instagram became popular. The younger generations are fascinated by today's social system, which can be interpreted differently, both positively and negatively, because everything has its good and its bad side. In the past, children bought magazines to find out who wore what for the red carpets, and today all that is followed through social networks.

Influencers also have a great influence, as social networks that are used today to follow new trends are: Instagram, Pinterest, TikTok, Tumblr.

INSTAGRAM

Instagram is a free application that allows its users to process and share photos on social networks. Instagram was created and launched in October 2010. In April 2012, Facebook bought Instagram for approximately one billion US dollars. The online service quickly gained great popularity, with more than 100 million active users. It was originally intended only for devices such as iPhones, iPads, etc. In April 2012, it also became available for devices with the Android operating system. Instagram was originally a photo processing service, but in June 2013, the publication of videos on the same service

was introduced, lasting up to 15 seconds and there are almost no young people who do not use Instagram today and do not follow fashion trends on the application, which leads to that fashion trends are placed and dictated to us precisely through social networks.

Figure 1. Icon for the Instagram app

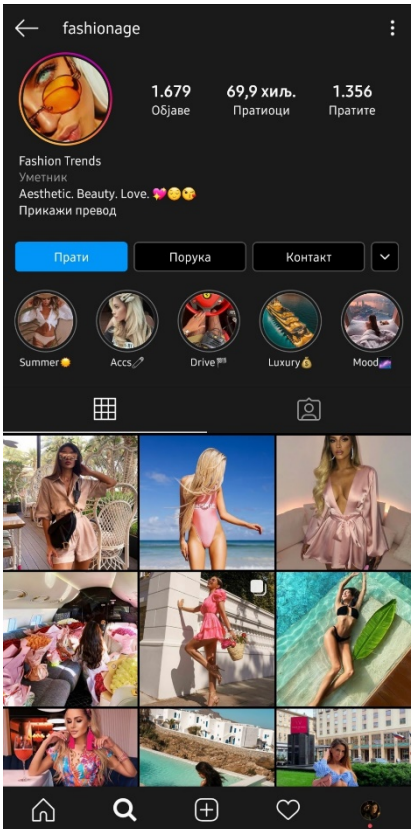

Figure 2. Instagram profile dedicated to fashion trends

PINTEREST

Pinterest can also be classified as an application that has a great impact on fashion trends, such as clothing, footwear, home textiles, interior design, furniture, and even decoration. In fact, Pinterest is a web and mobile application company that uses software designed to reveal information on the Web, using mostly images and to a lesser extent, GIF animations and videos. Pinterest has reached 200 million active users since September 2017.

It can be said that this company is also an application as a "catalog of ideas" that inspires users to do something, instead of as a social network based on images.

Figure 3. Ikon for Pinterest

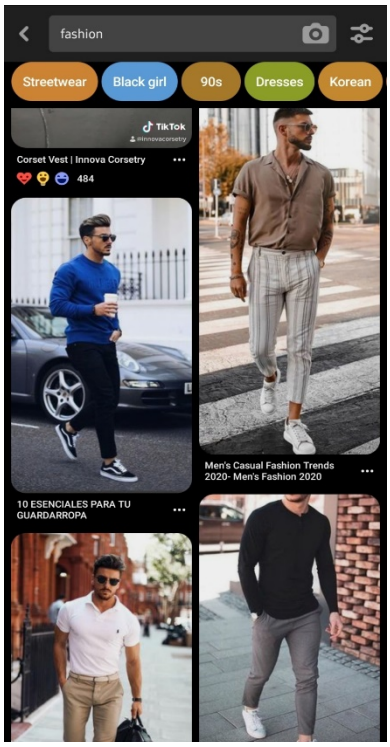

Figure 4. Search on Pinterestu

TikTok

TikTok is a social video-sharing network owned by BiteDance, a Beijing-based company. It is used to make short dance videos on reproduction, entertaining videos and recordings of talent that has conquered the world in a very short time, so it is not necessary to emphasize how much influence it has, especially with younger people.

The application became available in markets outside China for iOS and Android in 2017. It allows users to create short music videos with a length of 3 to 15 seconds and videos with a length of 3 to 60 seconds. It is popular in Asia, the United States and other parts of the world, while the TikTok application is not available in China.

Figure 5. Ikon for TikTok

TUMBLR

Tumblr is a blogging platform that allows users to publish texts, images, videos, links and quotes on their tamblogs.
Users are able to "follow" other users' tamblogs, as well as see their content on their dashboard.

Figure 6. Ikon for Tumblr

Figure 7. Search on Tumblr-u

The influence of INFLUENSER on fashion trends

When we talk about influencers, we are talking about a very fluid category that changes every day. Last year's influencers don't have to be this year's either. Last month's hit Instagram profiles may "shut down" this month.
The number of followers used to be the main indicator, ie. metrics whether someone is an influencer or not. However, there is now talk of micro-influencers - Instagram personalities who do not have a

large number of followers, but who have "influences", a greater influence than large influencers to whom followers have become even a little suspicious due to obvious cooperation with brands in most photos.

Based on this, an influencer can be a person followed by 150,000 people, but also one followed by only 5,000, or in some niches only a hundred of them.

Often more important than the number of followers is the niche of the influencer. Whether an Instagramer falls into the Beauty, Fashion, Lifestyle, Food, Gaming, Fitness, Photo, Teen, Music or Business category has a big impact on the way brands perceive them.

It is understood that influencers in one category have a significantly higher number of followers than influencers in another category. For example, Teen influencers generally have over 100,000 followers, while Food influencers can have 10,000 and still be relevant. Beaty and Fashion categories are "more massive" in our country than Gaming.

That is why the numbers at the end of the day are not the most important factor in the ranking of influencers, but what they place certainly has an increasing influence today and it is important what and to what extent they place us.

Figure 8. Influensers

Figure 9. Numerous social networking applications

CONCLUSION

New generations see fashion as something obligatory, as something that should be copied and forced, but the essence is completely opposite. Fashion is optional, without borders, everyone should have their own special and unique style of dress. The attitudes of influencers who will

impose their styles and standards of beauty are not crucial, everyone has the opportunity to do it in a special way, in a way that only he wants. Fashion is what designers offer you four times a year. Style is what you choose.

Observing the fashion trends in the last couple of years, their placement through social networks, we come to the conclusion that designers rarely come up with something new, constantly follow each other and copy each other. Clothes that were popular before are slowly being stored in our wardrobes, we can all confirm that from our own experience, and then it is placed and promoted and with the help of social networks it goes easier and faster. Some trends need to go back and peak again, but some trends really need to stay where they left off, they just need to be forgotten.

REFERENCES

1. Vasilije M. Petrović: (2006), Modern technologies in the clothing industry, II Scientific Conference of the Textile Industry of Western Serbia, Regional Chamber of Commerce of Užice, September 2006, Ivanjica.
2. Vasilije M. Petrović: (2004), Inclusion of the clothing industry of Serbia and Montenegro on the market of the European Union, I Scientific-professional meeting of the Textile Industry of Western Serbia, Regional Chamber of Commerce of Užice, 21-23. October 2004, Arilje
3. https://istorijamodee.wordpress.com/
4. https://wannabemagazine.com/
5. https://www.famousbirthdays.com/people/michael-heverly.html

DEVELOPMENT AND CREATION OF A FASHION COLLECTION

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ABSTRACT

A fashion product is the most complex element of the marketing mix from the point of view of fashion marketing managers. The task of the marketing service in clothing companies is to constantly adapt products to consumer requirements. Ideas about new clothing products are developed mainly in two ways: by adapting existing products and developing new products, which the paper talks about, as well as about the development of clothing from inspiration, fashion sketches, technical and construction.

In order for clothing products to be available to consumers at the right time, it is necessary to coordinate the complex activities of fashion designers, manufacturers and shops. To achieve this, a fashion calendar is created that defines the schedule of design, production, distribution and retail sale of clothing, usually on an annual basis, which will be developed in the paper.

Key words: collection, fashion sketches, technical sketches, collection, fashion movement

INTRODUCTION

A fashion product is the most complex element of the marketing mix from the point of view of fashion marketing managers. The task of the marketing service in clothing companies is to constantly adapt products to consumer requirements.

Ideas for new clothing products are developed mainly in two ways:
- Adaptation of existing products
- By developing new products

In order for clothing products to be available to consumers at the right time, it is necessary to coordinate the complex activities of fashion designers, manufacturers and shops. To achieve this, a fashion calendar is created that defines the schedule of design, production, distribution and retail sales of clothing, usually on an annual basis.

The creation of a new collection of fashionable clothing items is done in advance and a year in advance. For either of the two collections, spring / summer or autumn / winter, ideas for a new collection (next year) are created during the sale of the existing collection. This allows collections to be prepared for one collection for the next year at the end of the sales period. This ensures that the good ideas of the existing collection, which have been accepted by customers, are applied in the collection for the next year as such or something changed.
For retailers, it is very important to plan the time and distribution of products correctly.

THE PROCESS OF DEVELOPING NEW CLOTHING PRODUCTS

Changes in the fashion products market are accelerating. In order for a clothing company to be competitive on the market, it is necessary to enable acceptable models of clothing to be available to customers at the right time and in the right place. This requires coordinating the complex activities of fashion designers, manufacturers and retailers.

The most important segment in this process is certainly the completion and submission of technical documentation for the solution of a new clothing product. Before the adoption of the conceptual solution, completion of technical documentation, it is necessary to undertake activities such as: planning the development of new products, determining the terms of reference, defining the product development plan, development of conceptual design, consideration of conceptual design, adoption of conceptual design, prototype modeling, model verification and production decisions, decision on acceptance of regular production, followed by completion and submission of technical documentation for regular production. In Picture 7.1. a flow chart of the new product development procedure is shown.

Planning the development of new products or modifications of existing products is done on an annual basis, in the form of an annual development plan that includes the following segments:
- Spring Summer,
- Autumn winter,
- additional collection (inputs of new products during the mentioned seasons),

The starting point for planning the development of new products or modification of existing products is the Decision on preliminary product specifications, which is made on the basis of market analysis or from the observed trends of fashion trends. The necessary document in the development of new products is the Annual Product Development Plan which contains data on the planned product, all activities related to its development as well as data on the material and its suppliers for the new product.

From the Annual Product Development Plan, the project task for product development is determined and this represents the activity of further concretization of the realization of the annual plan.
If the development of completely new products is approached, all necessary preparatory activities are carried out. Preparation is completed when the project task for development is identified. If the modification of existing products is approached, it is necessary to provide preliminary conceptual solutions, counter-samples and documentation related to that project.

The project task for the development of new products is written on an appropriate form which should contain general data on how many new models the collection will have, in what percentage individual items are represented, who is responsible for which job, realization deadlines, etc.
Based on the terms of reference for product development, a detailed product development plan is defined, which must be in accordance with the terms of reference. It is formed quarterly and monthly. It must also contain timelines (deadlines) for all tasks and phases in the implementation of the product development plan. It must be clear from the plan how many new products there will be in the new collection, which lines will be represented in the assortment, what percentage of the collection consists of individual garments, how many old models will be modified and what is modified on the models. The required documentation for old models is also listed.

Deadlines are specified for all activities. The detailed Plan also defines the priority list of suppliers, based on the existing list of suppliers. This plan also gives the specification and approximate quantities of materials by clothing models. After that, it is checked whether the task and the plan are harmonized.

If the task and the plan are not in accordance with the requirements, their harmonization is approached, ie a new plan is made. If the task and the plan are harmonized (determined), the development of conceptual solutions is approached. Creating a conceptual solution is the basic task of a creative team. We approach the drawing of a conceptual solution or the procurement of similar samples on the market, so by observing and elaborating we come up with our own solutions (ideas). Designers are obliged to always respect the principle of functionality, fashion trend in colors and previous market analysis when adopting new models. The conceptual solution is drawn on the appropriate form in the final phase. It is necessary to draw a complete conceptual design with all the necessary details (button, thread, labels, packaging, etc.)

Based on the documentation on the conceptual design and market requirements, a decision is made on the adoption of the conceptual design. Based on the Decision on the adoption of the conceptual design, an order is given for the production of counter-samples to the production sector, which is practically realized through the designer who submits the order to the construction preparation. If the conceptual design is not adopted, it is necessary to start drafting a new conceptual design.

The same procedure is applied for the modification of the old model, except that the documentation on the conceptual design states only the changes that need to be made on the existing counter sample.

Based on the order on the production of the counter-sample (model) and the documentation of the conceptual solution that is submitted to the production, the production of the counter-sample is approached. Responsible persons from the production sector must adhere to the correct instructions from the documentation, but also propose a new way of production if they believe that it will enable more efficient and better production, and thus facilitate or simplify the subsequent production process. It is necessary to follow the production of the counter-sample or the change of the existing product, if it is a modification of the existing product, taking into account the specified production time. On the basis of the completed counter-sample, in addition to the cutting patterns, a record of the counter-sample is also made.

The record on the counter-sample and the counter-sample itself shall be submitted for inspection to the appropriate services. After considering the counter-sample and examining the compliance with the conceptual design, they make a decision on returning the counter-sample for processing or approve the counter-sample and give an order for regular production. Based on that, the procurement service received information on the necessary raw materials and approached the procurement of the same according to the already established procurement procedure.

Based on the order for regular production and in accordance with the precise deadlines, a work order is made and all development technical documentation necessary for the production process is completed. From the moment the work order is issued, the regular production process begins according to the defined procedure.

Today, the clothing industry is facing a series of problems for the solution of which it is necessary to constantly find new solutions. One possible solution is a more serious approach to the development of new clothing products. Therefore, the paper proposes an appropriate procedure for the development of new clothing products, which is the most complex technological segment in the manufacture of clothing because it requires the production of new products in a very short time, which carries very high risks of making products that customers may not accept customers for new products. In order to reduce these risks to a minimum, the procedure proposes a procedure that includes undertaking the following activities: planning new product development, determining the terms of reference, defining a product development plan, conceptual design, consideration of conceptual design, adoption of conceptual design, prototype modeling , verification of models and decisions on production, decision on acceptance of regular production followed by completion and submission of technical documentation for regular production

DEVELOPMENT AND CREATION OF A FASHION COLLECTION

Fashion clothes are usually made for two collections (spring-summer or autumn-winter). The collection that is inspired by the Top Model is the autumn-winter collection. A work order has been prepared for each garment, which includes, among other things:
• number of pieces;
• range of clothing sizes ;
• materials used (basic and auxiliary) ;

• material consumption;
• production time;
• cost price;
• delivery time;

The creation of the collection includes the performance of all construction preparation tasks:
The order of activities of work in the creation of the collection, related to the work of constructors and models in construction preparation are:
• determining the structure of the collection ;
• making cuts and patterns for model prototypes;
• making cuts and patterns for all models;
• preparation of supporting documentation (model description, rulebook).

Figure 1. Example of inspiration Picture 2. Inspiration-based model Picture 3. An example of inspiration

Figure 4. Inspiration used for models made in this paper

Fashion sketches made on the basis of inspiration and technical sketches of models

Figure 5. Fashion sketch of the model

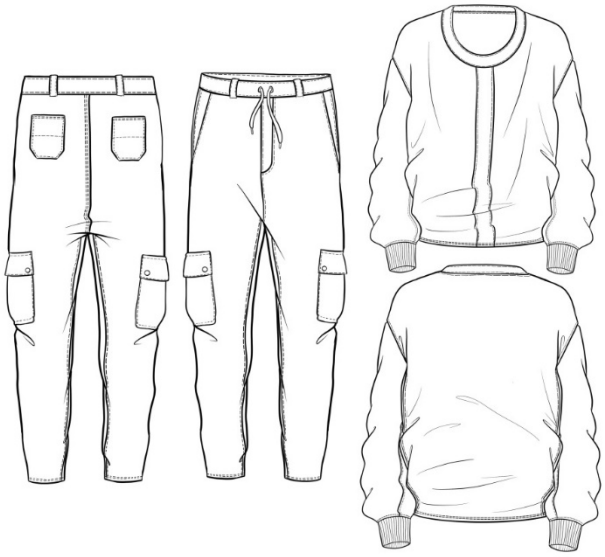

Figure 6. Technical sketch of the model

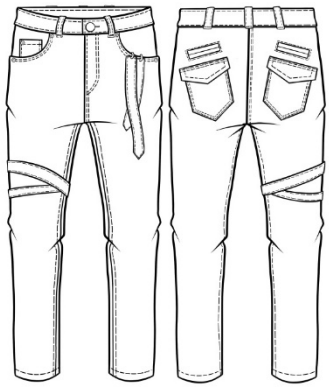

Figure 7. Technical sketch of the model 2

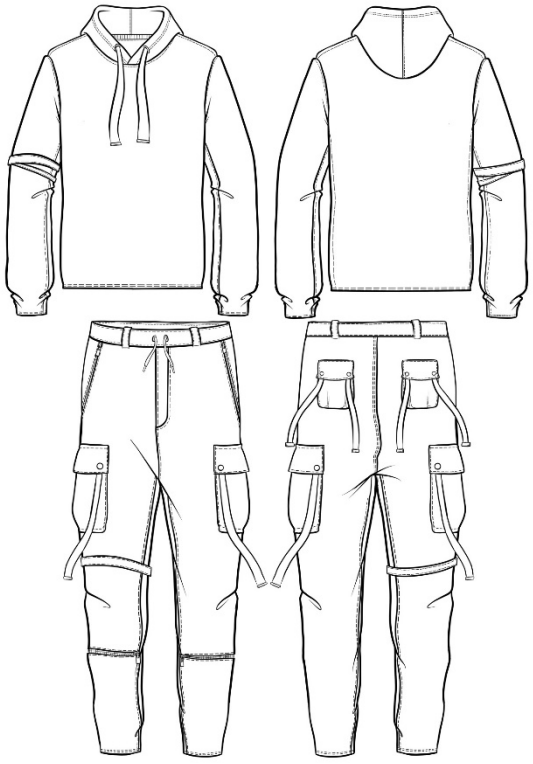

Figure 7. Technical sketch model 3 example collection

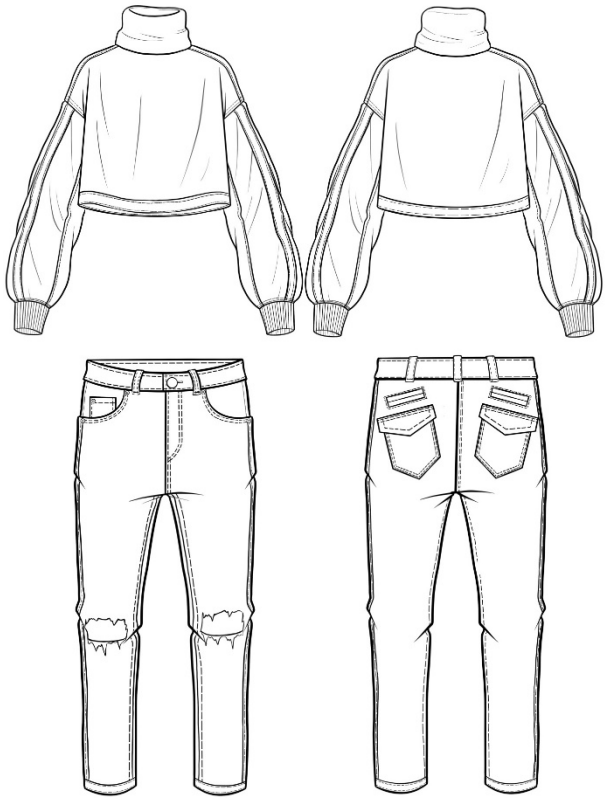

Figure 8. Fashion sketch model 4

Construction preparation of the garment - model 2

Size 34/33

Main and auxiliary measures of the body:
VT= 180 cm
OP= 86 cm
OB = 104 cm
ONK =46 cm
OND = 38 cm
DM = 5/8 VT – (2 do5) cm = 110cm
DS= 1 / 4 OB =26 cm
DK = 4/8 VT – (3 do 5) cm = 84 cm
VK = 1/2 DK - 1/10 DK = 50,4 cm
PŠP =1/4 OB-1cm =25 cm
ZŠP = 1/4 OB + 1 cm= 27 cm
PŠS = 1/20 OB +3 cm = 8,2 cm

Elaboration of measures for basic construction

Front and rear leg construction:
Draw a vertical line and mark point 1.
1-2 = 1,5 cm
1-3= DS = 26 cm
3-4 =DK= DM-DS=84 cm
4-5 =VK= 1/2 DK +1/10 DK =50,4 cm

195
3-6 =PŠS = 8,2 cm
From points 2, 3, 4, 5 i 6 draw horizontal lines to the right.
6-7 = PŠP= 25 cm
From point 7 draw a vertical line and mark the points 8 i 9.
7-10 = 1/20 OB = 5,2 cm
6-11 = 1/2 (6-10)
From point 11 draw a vertical line and mark the points 12 i 13.
12-12a = 12-12b = 1/4 ONK -1cm = 10,5 cm
13-13a = 13-13b = OND-1 cm = 8,5 cm
Connect the points with straight lines 6, 12a, 13a, 13b, 12b i 10.
Mark a point 14.
8-15 = 1cm
Points 8 i 7 connect with a straight line, and points 7 i 14 crooked line.
Points 1 i 15 connect with a curved line.
15-16 = 1/4OP+ 2 cm = 23,5 cm
Mark the intersection of the center line and the belt line with a point 17, and draw the seam by point 17
We measure left and right by 1cm.
17-18 = 9 cm
12b-19 = 1/2(12b-14), and from point 19 draw a horizontal line of length, and then shape the curve
The line between the points 12b and 14.
Connect the points with a curved line 16-6-12a.
From point 10 measure right 10 cm then draw the front one more time and mark the dots 3, 11, 12, 12a, 12b, 13a i 13b.
12a-20 = 2cm
12b-21 = 2cm
13a-22 = 2cm
196
13b-23= 2 cm
Points 20, 22, 23 and 21 connect with straight line.
11 - X = 2 cm
X - 24 = 1/4 ZŠP = 6,8 cm.
3-3a=3 cm
Points 3a i 24 connect with straight lines.
From point 24 draw a line at right angles to the line joining the points 3a i 24.
24-25 = ZŠP = 27 cm
Points 20 i 25 connect with straight line, and the intersection with the belt line mark the point 26.
12-27 = (12-26) + 2cm, point 27 is obtained in the intersection with the line starting from the point 24.
Points 26-27 connect with straight line.
27-28 = 1/4 OP +2 cm = 23,5 cm
28-29=1 cm
Points 27 and 29 connect with straight line.
X-30 = X-25
Points 21 and 30 connect with straight line.
21-31=(12b-14) measured at the front.
Points 21 and 31 connect with a curved line. A line connecting the dots 23, 21 and 31
is the step line of the last part of sock.
Connect the points with a curved line 29, 25 and 20.
27-32 = 1/2 (29-27)
From point 32 draw a line that is normal to the line joining the points 27 and 29.
32-33 = 6 cm
Next to the point 32 measure left and right by 1 cm and draw a seam on the back of the pants.
The model has a lowered waist, so you should measure:197

15-34=4 cm
16-35=4 cm
Points 34 and 35 connect with a curved line .
29-36=4 cm
27-37=4 cm
Points 36 and 37 connect with straight line.
36-38=3 cm
37-39=5 cm
Points 38 and 39 connect with straight line.
Thicken the contour lines of the front and back of the pants.
Draw pockets on the front and back.

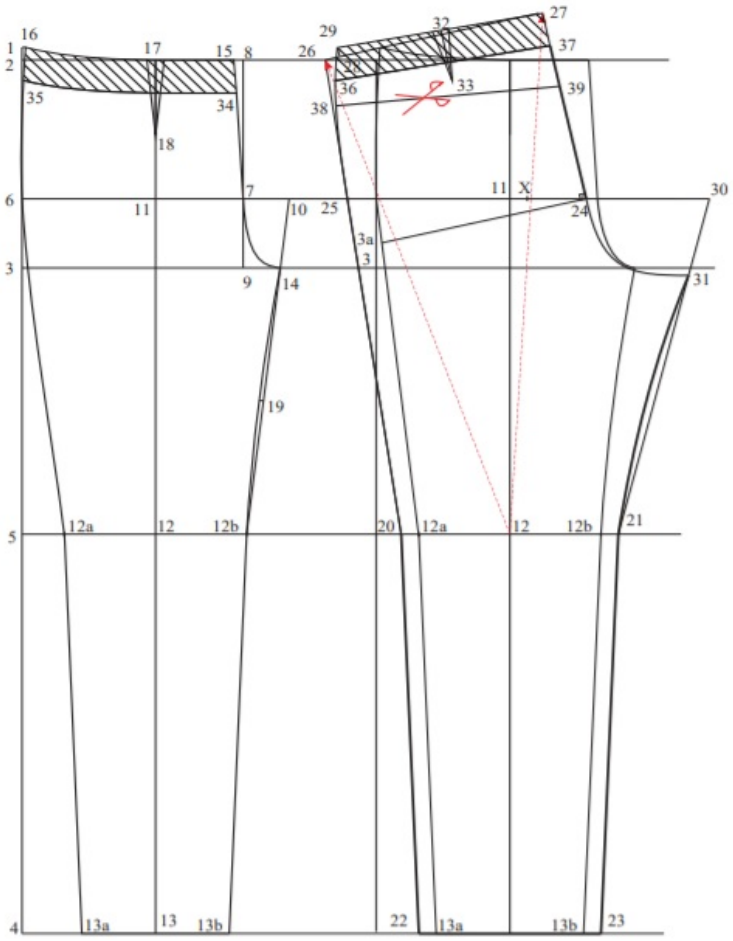

Figure 9. Basic construction of men's jeans (Model 2)

CONCLUSION

In order for clothing products to be available to consumers at the right time, it is necessary to coordinate the complex activities of fashion designers, manufacturers and shops. In order to achieve this, a fashion calendar is made that defines the schedule of design, production, distribution and retail sales of clothes, usually on an annual basis, which will be elaborated in the paper.
The task of the marketing department in clothing companies is to constantly adapt products to consumer requirements due to the complexity of the work. This is briefly explained and presented, as

well as the development of clothing from inspiration, fashion sketches, technical sketches of models and construction.

REFERENCES

1. Vasilije M. Petrovic: (2006), Modern technologies in the clothing industry, II Scientific Conference of the Textile Industry of Western Serbia, Regional Chamber of Commerce of Uzice, September 2006, Ivanjica.
2. D. Rogale, D. Ujevic, S. First Rogale, M. Hrastinski: Clothing production technology with study of work, University textbook, Faculty of Textile Technology, Zagreb, 2000
3. Popov-B.D, Petrovic V., Jovan Stepanovic: Analysis of installation and design of workplaces in the process of making clothes, Textiles and practice.
4. https://www.tumblr.com/search/fashion+design
5. https://www.hisour.com/fashion-illustration-17483/
6. https://www.wikipedia.org/

OPPORTUNITIES OF FASHION INDUSTRY DURING THE COVID 19

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ABSTRACT:

The fashion industry is the second largest polluter in the world. The environmental damage is increasing as the industry grows. But cumulative of population growth, explotation of energy and natural resources waste and pollution are straining the limits of the environment to support curent levels of consumption. This paper compare sustainable fashion and fast fashon and its imapct on the environmental and social aspects. In order to see the overall information and awareness of consumers in Serbia about sustainable fashion, the survey was conducted. Its results are shown in this paper. The main obstacle that sustainable fashion must overcome in order to be accepted in Serbia is to have better promotions.

Keywords: Sustainable fashion, pandemic, textile industry

INTRODUCTION

Pandemic makes us into difficult situation, but also brings some new opportunities to us. In this paper it is represented a way how can we turn adversity into opportunity to promote fashion industry development well, and to focus on sustainable fashion.

The COVID-19 pandemic and the resulting economic shutdowns have created unprecedented challenges for the fashion industry, including declining consumer spending and disrupted supply chains. This situation may accelerate the shift to greener, more sustainable supply chains, which will not only be decisive for businesses, but also impact the future of the fashion industry as a whole[1].

The fashion industry is the second largest polluter in the world just after the oil industry. And the environmental damage is increasing as the industry grows. But cumulative of population growth, explotation of energy and natural resources waste and pollution are straining the limits of the environment to support curent levels of consumption [2].

Clothes shopping used to be an occasional event – something that happened a few times a year when the seasons changed, or when we outgrew what we had. But about 20 years ago, something changes. Clothes became sheaper, trend cycles sped up, and shopping became a hobby. Enter a fast fashion, and the global chains that now dominate our high street and online shopping[3].

Situation in Textile industry

The fashion industry has created one of the largest consumer goods markets, with highly sophisticated value chains of significant economic importance[2].

Moreover, the fashion industry plays a central role in the creation of income and jobs, employing over 60 million people worldwide, and in some countries, the sector is a vital contributor to national industrial output and domestic value added[2].

A pandemic caused by a corona virus, has led the global fashion industry into crisis with a significant number of companies that are expected to collapse in the next period that puts millions of jobs at risk[2].

Global sales are projected to fall by up to 30 percent in 2020, and the luxury part of the market will be hit even harder, with a decline of up to 40 percent[4].

Textile and apparel production in Serbia have a long standing tradition and for many years have been one of the main export industries. This sector used to employ more than 250,000 workers and exported more than 5 billion dollars. Now days, there are around 1,800 active companies with more than 43,000 employees [5].

After a solid growth of 4.2 percent in 2019, Serbia is facing a recession of 3 percent in 2020 due to the crisis caused by Covid -19 [5].

Despite the slowdown in the economy, the unemployment rate in the second quarter of 2020 was at a historic low of 7.3 percent, thanks to the state program of fiscal incentives [5].

Still, helping the economy to overcome the pandemic has come at a high price: fiscal stimulus now accounts for nearly 13 percent of GDP, leading to a projected fiscal deficit of a record 7.6 percent.
The deficit could increase further if certain contingent liabilities are realized, which would significantly increase the public debt[5].

TEXTILE AND FASHION INDUSTRY AFFECTED BY COVID -19

The COVID-19 pandemic created a dramatic contraction in demand and production. The fashion industry has been among those sectors more severely hit by the crisis.

The first wave already hit the sector as fashion brands and retailers experienced a sudden drop in demand. Consumer purchases in retail stores recorded a deep fall in March, April and May that was not compensated by the growth of e-commerce in the same period.
A similar shock hit suppliers all over the world with the cancellation of orders, even of completed or near-complete orders by buyers.

Reducing the size and geographical concentration of orders can help to ensure the stability of the supply chain. It is expected that larger brands manage their supply chain disruption risks in the future by placing more value on stable business-to-business relationships, certifications about workers' safety, and environmental sustainability practices, rather than depending only on price in the selection of a supplier.

The shift to more sustainable business models and supply chain management is an essential step for businesses to survive.
European governments in particular are taking exceptional financial measures to support a post-COVID-19 green economic recovery. This recovery will also contribute to shaping the fashion industry's development over the next decade. It is an extraordinary opportunity to take a significant step towards a more sustainable future.

In the following figre it is shown the five areas of fashion industry that could be affected by Covid -19

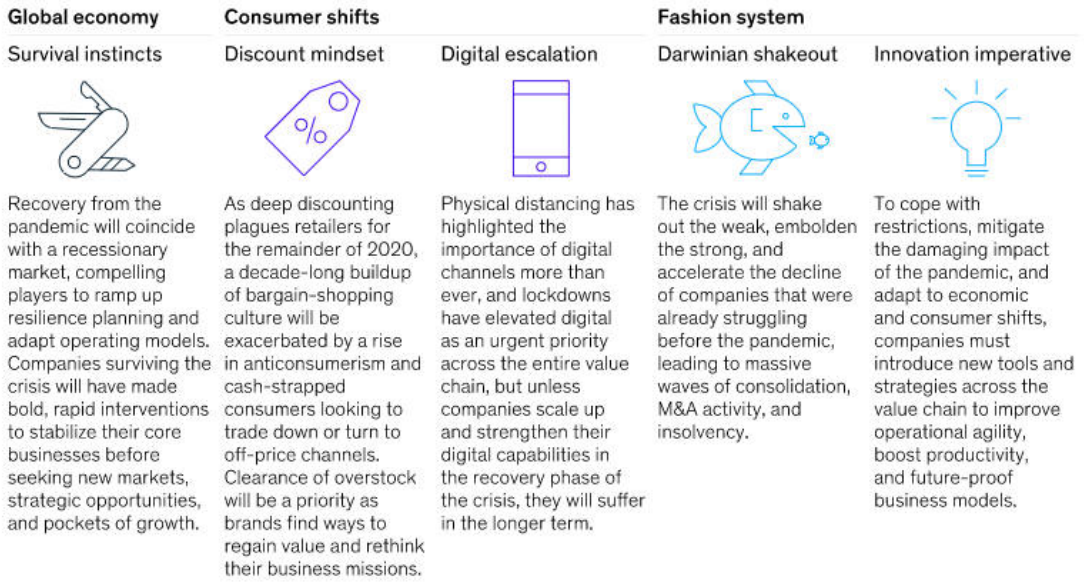

Figure 1. Five areas of fashion industry that could be affected by Covid -19 represented by McKinsley company

THE OPPORTUNITIES FOR SUSTAINABLE FASHION IN COVID-19 ERA

COVID-19 presents an opportunity for reconceptualization and retraining of designers but also of consumers. It means thinking smaller—not a 60-piece collection, but maybe a 16-piece one, that is beautiful and wearable, made with less waste, by workers who are treated fairly.

According to many designers couture is the antithesis of ready-to-wear: one-off pieces rather than mass-produced; timeless rather than trend-led. Arguably, this makes it inherently more sustainable.. **Fashion designers such us Van der Kemp** and **van Herpen** are using for fashion creations the materials and leftovers from other brands instead of sourcing new fabrics. Viktor Horsting and Rolf Snoeren are using patchwork technique to design their high fashion clothes (figure 2).

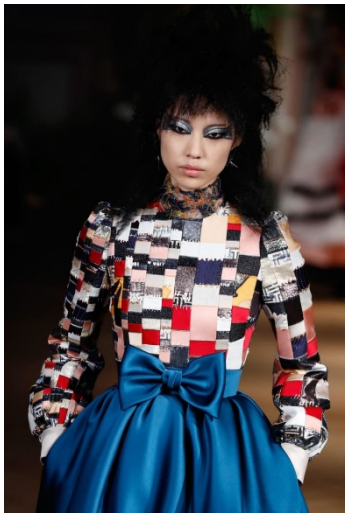

Figure 2: A patchwork as a way of sustainability in couture fashion

Figure 3: Iris Van Herpen Haute Couture 2019/2020

In today's world we see a lot of digital and technology transformations pushed by COVID-19. One of the most unusual transformations might become real in the world of fashion. There are more and more requests from consumers on everything sustainable. The role of influencers is increasing as they are actually replacing traditional marketing activities of the companies. Fashion companies are transforming into media companies themselves. In the modern world, fashion companies need to make mobile or digital first experience or at least merge consumers' online and offline experience, offline is the next step.

Figure 4: Shudu first digital supermodel

During this pandemic crysis the digital avatars or models became more more popular (figure 4). Digital models change not only the rules for modelling but empower designers' creativity. They are ageless, beautiful and fascinating. There are plenty of examples from the gaming world where people spend tons of money for different clothes of their characters. So there could be some probability that our avatars in the digital world could wear digital clothes too.

Digital transformations in the fashion industry started several years ago with the communications process. Consumers want to interact, belong, influence and represent the brands from which they buy. This is just a start of the huge shift where the fashion companies become not only digital savvy with their marketing and sales through digital channels. What we witness this year with COVID-19 pandemic is that fashion companies become digital-first. The Paris Haute Couture shows will go digital only this July.

The story of fashion moves into the digital world faster and faster. And we welcome it in our technology media.

CONCLUSION

The coronal virus pandemic has brought the global fashion industry into crisis with a significant number of companies that are expected to fail in the coming period. Global sales are projected to fall by up to 30 percent in 2020, and the luxury part of the market will be hit even harder, with a decline of up to 40 percent. After a solid growth of 4.2 percent in 2019, Serbia is facing a recession of 3 percent in 2020 due to the crisis caused by Covid -19.

The COVID-19 crisis can become a catalyst for change, for the industry to become more responsible, inclusive, and resilient in response to the severe socio-economic challenges and supply chain disruptions caused by the pandemic. It calls on companies to live up to their responsibilities in terms of decent work and the climate emergency. And to make an impactful contribution, policymakers and industry actors must have the right tools to meet their commitments to the Sustainable Development Goals of the 2030 Agenda.

REFERENCES

[1] https://www.unido.org
[2]https://www.sustainyourstyle.org/
[3]https://goodonyou.eco/what-is-fast-fashion
[4] https://www.mckinsey.com/
[5]http://www6.serbianapparel.com/

PHYSIOLOGY OF SPECIAL PURPOSE CLOTHING

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ABSTRACT

The textile and fashion industry expects a rapid growth in the demand for clothing in the coming period. The next trend of the clothing industry is described in the paper as well as the special purposes of clothing, its physiology, radiation, mechanical protection and thermal protection. The children who have various possibilities are described, starting from the possibility for automatic change of appearance depending on the biometric data of the one who wears it, all the way to the possibility of regulating the pressure and body temperature. Electronic clothing, as a new branch of the textile and fashion industry, has a potentially large market. It is currently calculated that only a few estimates of the population are ready to buy and use one that is explained in the paper as well as the reason for that.

Key words: physiology, special purposes, radiation, mechanical protection, thermal protection.

INTRODUCTION

Clothes used for special (special) purposes, according to the latest division, belong to the field of technical textiles. Such clothing protects people in various risky and even life-threatening situations (protection from high temperature and fire, mechanical influences, various radiation sources, biological and chemical agents, etc.), but it is also used in the so-called. clean spaces in the electronics industry, **medicine** and a number of other human occupations that are characterized by clothing that defines these activities. Such clothes are used in regular professional occupation, but also in recreation and sports.

Since these are special clothes, in the **theoretical part** of the paper, attention is paid to the fibers and materials from which such clothes are made. The physiology of clothing is processed, the division is made and the various materials from which clothes for special purposes are made are mentioned and presented and explained.

CLOTHING PHYSIOLOGY

Knowledge in the field of clothing physiology has advanced a lot today, and with it the requirements that individual users set when choosing clothes, today they are much higher than they used to be. Today, it is assumed that the following functions must be fulfilled by certain clothes:

- Aesthetic - must meet fashion requirements (color, shape, material), must meet special occasions, should best represent a person's personal character.
- Ergonomic - must have an appropriate cut, clothing must be elastic, to follow the shape of the human body, we must not interfere with movement..

Physiological - must stimulate the balance of body temperature so as to protect the body from cold, ie, allows the flow of excess heat in the form of evaporated sweat from the skin surface to the environment, must satisfy the thermal and physiological comfort of wearing, must satisfy skin-sensor comfort.

PHYSIOLOGICAL COMFORT OF CLOTHES

The comfort we feel when wearing clothes is a subjective reaction that is a consequence of the action of various causes. Clothing must provide a certain thermal insulation, a high degree of moisture permeability and good ventilation, in order to maintain optimal thermal regulation of the human body.

The result of balanced interactions in the "man - climate - clothes" system is expressed in human comfort when wearing clothes. Comfort is not an authentic characteristic, but the result of a man's decision. Various causes have been studied, which affect our perception of comfort, ie the inconvenience of wearing clothes. They are divided into three different categories:

1. Category includes physical causes: climatic values of the thermal environment, degree of physical activity, characteristics of textiles / clothing: type of fibers and textile construction, ability to transfer heat and moisture, air permeability, elasticity, touch.
2. Category includes psycho-physiological causes: environment, end use, special occasions in which we wear certain clothes, fashion trends, touch visual aesthetic impression.
3. Category of causes is the “memory modifier”, which is based on: our past experiences, prejudices, the expected notion of wearing comfort, lifestyle.

In technology, for the needs of the textile or clothing industry, within the science, which is called the physiology of clothing, skin-sensory, thermal-physiological and other forms of comfort are studied..

TEXTILE MATERIALS FOR SPECIAL PURPOSE CLOTHING

EXTREME COLD

Cold protection requires products with a high degree of insulation, good / relative comfort, and to always allow good mobility for useful work.

However, air is a poor conductor of heat, so insulation requires a layer of air between the skin and a source of heat or cold. The best insulation always goes from the bottom up, and along the neck from thicker or other poultry feathers. The industry has tried to mimic insulation properties, with varying degrees of success, but all types of filling fibers are increasingly being used, such as high-loft and high-bulk fibers, as well as products to create even more airy insulation. space..

Figure 1. Overalls for low temperatures

BALLISTIC / MECHANICAL PROTECTION

This area includes soft "armor" that protects the body from various cuts and / or cutting hazards, such as saw chains, metal, glass, knives or other sharp edges, as puncture-resistant materials.
The most significant progress in the field of ballistic protection is the development and use of para-aramids, such as DuPont - Kevlar, which replaces nylon as a ballistic barrier. This fiber is of high strength, as well as that used in rubber cables, composites, etc .; it is used in soft armor with loose stacking of layers (16+) of (usually) filaments of aramid fibers, each of which provides progressive resistance to bullets or a penetration fragment. Similar technology with rigid composites results in superior light but "heavy armor", so as such it is used for helmets and the replacement of heavier steel areas such as vehicle armor or aircraft armor.

Figure 2. Body armor

Radiation

This area includes protection against radioactive particles. Most clothing is used to prevent leakage and application of particles to the skin and absorption into tissues. Protection against penetration and permeation is provided by special co-polymer coatings or laminates with a wide range of resistance to chemicals. The fabric base acts as a protector and / or a strong factor that will ensure durability and durability during wearing. Typical for this group would be polyethylenes coated with Tivek fabric or other nonwovens, such as polyester or olefins..

Figure 3. Radiation protection clothing

The American Savannah River Site uses a suit made of special coated fabrics for protection against tritium. The encapsulated suit is made of polyester fabric laminated on each side, with layers of film, which consist of a co - polymer injected with CPE (polyethylene chloride) / EVA (ethylene vinyl acetate) / PVDC (polyvinylidene chloride), (Saran - Plastic) /EVA. Saran suits (plastic, PVDC) / CPE with or without nonwoven fabric are also in use.

Since most areas of nuclear facilities do not include protection against radioactive hazards, lower levels of protective clothing are usually used for overalls, aprons, work blouses, etc. Standard cotton or polyester and blended cotton and Tivek or other nonwovens are used herein; more in the category of work clothes, but also provide some protection against accidental exposure to particles. Powerful companies usually have specific ensembles that they use in different conditions in a nuclear power plant, depending on the risk of exposure.

SPECIAL PARTICLES

Protection from special congratulations means protection of those who work with asbestos or similar substances. The clothes are mostly made of non-woven fabric, although some types of knitted polyester / cotton or 100% cotton clothes are also used. Standard clothing is usually one of three types:

1. Uncoated tyvek,
2. Kimberly Clark 3-layer SMS (Spunbond,Meltblown,Spunbond)
3. KleenGuard olefin fabrics,
4. Various nonwovens such as spunbonded olefins.

Similar clothes are worn by those who work with lead, then painting, and similar hazardous environments that contain dangerous micro particles.

New products often do not cost much or are not competitive - they do not provide greater benefits to justify higher costs. Workers use the suit only once and can change 3 or 4 a day. The income of the worker is extremely high, due to the high heat stress factors involved.

As with most protective clothing, permeability and "comfort" in use are major problems. The body tries to maintain its internal temperature during exertion through sweating and evaporative cooling. If the moisture cannot evaporate, the body temperature rises and there is "heat stress" which causes a collapse, or at least the user is uncomfortable. Good clothes must enable the transfer of moisture - steam, while still providing protection. The heat stress effects of protective clothing, including asbestos mitigation, continue to be investigated in an effort to develop materials and structures that are effective and less stressful.

BACTERIAL/VIRAL PROTECTION

Protective clothing in medical textiles, by our definition, is stimulated (its development) by AIDS-related concerns, hepatitis and other life-threatening communicable diseases. are being developed, along with antibacterial finishes, for use by hospital and medical staff, emergency services such as ambulances, firefighters, and police.A good example in this area are DuPont Biowear materials to protect against pathogens conceived in the blood.

Anti-bacterial materials are sought in this area. Most finishes are thematic, with varying degrees of longevity. The Japanese product, Bactekiller (Kanebo), has a bactericide embedded in the polyester fiber in the extrusion (extrusion) process. The agent for killing bacteria, based on zeolite salts, remains in the fiber even after ironing, processing, washing. bactericide (sodium aluminosilicate), allows its application where moisture removal, deodorization and absorption capacity are essential. Other products are also available.

Several manufacturers are developing fibers with built-in bactericides. We are also working on hospital blankets, draperies and other applications, using other methods, so we should expect extensive development of this type of technology.

Anti-odor products are also promising in the field of protective clothing. Molecular sieve-based products have also been developed that are effective in combating odors in the field of medicine. This and similar developing technology using encapsulated finishing materials (in capsules), which are designed to be released under predetermined (appropriate) conditions, can be used in the form of fibers or fabric to provide better bacterial / viral protective clothing.

The increased use of laser surgery creates a demand for non-flammable materials in the manufacture of coats and curtains that are normally found in the operating room. There are chances to make new cheap flame-retardant materials in medicine.

As in other applications, new non-woven meltblown microfibre products are being developed to provide effective protective materials with superior levels of comfort. Improved coating and delamination are also developing.

PROTECTION AGAINST HARMFUL CHEMICALS

Clothing used for protection against chemicals is categorized from weaker to lower level, ie. levels A to D. Level A is clothing in which a person is totally encapsulated, with "sealed" seams, negative pressure, and with their own oxygen apparatus, to protect themselves from various chemicals, gases

and harmful fumes. Level B, for very dangerous chemical sprays, is similar to level A, except that the harmful chemicals must contain resistance to different grades of chemicals. Level C provides safe protection against the spraying of harmful chemicals, and may or may not contain a respirator. Level D as the last in protective clothing from harmful chemicals contains raincoats (covers) and boots that serve to protect from splashes and dirt.

Figure 4. Reusable gas-tight overalls - chemical protection

The most commonly used fiber for making clothes in this area is twisted Tyvek (spunbonded Tyvek), which is a non-woven olefin fiber and is used alone or coated with some other fiber. As it is used for special protection at relatively low levels of spraying, or in not so dangerous chemical parts for work. For higher levels. Tiwek is wrapped in polyethylene or other polymer fibers and as such is used for suits against chemical spraying or for protection against many dangerous liquids.

Even a higher degree of protection is possible with Tivek when mixed with Saranex, ie. by Dow Chemical Saranex, the multi - layer film has a low polyethylene outer layer that is twisted to the degree of resin and a copolymer of vinyl chloride (Saran) coated with a layer of ethyl vinyl acetate (EVA) acts as an adhesive for twisting Saranex to Tivek. Properly constructed and sewn clothing offers a high degree of protection for a wide range of chemicals. DuPont has added to its line of clothing and clothing made of Tivek material, which contains raincoats for specific works at lower prices.

Encouraged by Tyvek's lack and desire to make a product that would offer high protection at reduced cost, several manufacturers have made special coats or laminations with substrate variations including polyester and olefin dry-laid nonwoven nonwoven fibers (spunbonded) or meltblown. Coats / laminations from olefin-coated polypropylene to exotic copolymers can offer a high level of protection against chemical penetration. These clothes are not too expensive, even lower than $ 1000, compared to 3-5000 $ which should be set aside for clothes that are more coated with fibers, such as Teflon or other fibers. But even the most effective coating from Teflon has limited use and maximum can cost $ 3000.

Durable clothing is made of nylon or polyester, or a mixture of poly (synthetics) and cotton, coated with chemically resistant polymers such as Teflon (DuPont), butyl PTFE, EDPM, Viton (DuPont), etc. They are mostly used in level A because they use self-contained breathing apparatus. After use, they are mostly decontaminated or recycled. While weaker (lighter) clothing provides similar chemical protection, durable clothing is used more because it has proven to be better in use. Considering the nature required by protective clothing, several materials, ie if some of these materials are comfortable to wear, will require special care on cooling vests, external cooling devices, etc.

THERMAL PROTECTION

Fire and extreme heat protection as well as the need to work around fire and heat, has provided a long need for protective clothing. The primary problem was firefighters, as well as those working in the metal industry with liquid metal and in similar areas that involve high temperatures such as welding, foundries, ceramics production, etc.

The non-flammability of the material is expressed by the oxygen index:

$$(OI)=(OI)_m+f(FR)$$

where are $(OI)_m$ oxygen index of intact material, and $f(FR)$ non-flammability function.
The thermal properties of textile fibers, which include OI values, are given in Table 1.

Table 1. Thermal and non-flammability properties of some fibers

Fiber	T_f (°C) Glass transition	T_m(°C) Melting	T_p(°C) Pyrolysis	T_c(°C) Burning	LOI (%)
Wool	-	-	245	600	25
Cotton	-	-	350	350	18,4
Viscose	-	-	350	420	18,9
Triacetate	172	290	305	540	18,4
Nylon 6	50	215	431	450	20-21,5
Nylon 6,6	50	265	403	530	20-21
Poliester	80-90	255	420-477	480	20-21,5
Acrylic	100	>320	290	>250	18,2
Polypropylene	-20	165	469	550	18,6
Modacryl	<80	>240	273	690	29-30
PVC	<80	>180	>180	450	37-39
PVDC	/17	180-210	>220	532	60
PTFE	126	>327	400	560	95
Oxidized acrylic	-	-	>640	-	55
Nomex	275	375	310	500	28,5-30
Kevlar	340	560	590	>550	29
PBI	>400	-	>500	>550	40-42

Fibers with high temperature-resistant properties are: Nomex, Kevlar, PBI, FR rayon, Kermel, P84 and fiber-based pre-oxidizing PAN, in addition to these there is also FR processing on cotton and new fiber blends that have made far more efficient clothing possible. Many of these fibers have been developed to replace asbestos in high heat areas. Thermal protection is the starting point for the development of many new high temperature fibers.

Ballyclear Special Products, UK has recently developed a fire-resistant set of firefighter safety clothing. The outer fabric is made of PBI Gord, and the flame-retardant fabric is made of Hoehst Celanese. and the chemical stability of polybenzimidazole (PBI) with aramid fiber strength. PBI Gold is stable even under simulated glow conditions at 950oC. The fabric is also resistant to puncture, tearing and tearing.

Firefighters' clothing is multi-layered clothing, the participation of the outer coat and pants, as well as generating fibers and fabrics enable the development of clothing. The outer part is usually Nomex,

Kevlar or Kevlar / PBI - a compound woven into 7.5 oz / yd2 twill fabric. This "shield" provides primary fire protection and resistance to abrasion. It usually contains light-reflecting strips for visibility and identification.

Below the outer part, there is a barrier that prevents water from entering and making hot steam inside the clothes, when there is a fire nearby. It is made of cheap neoprene coated with an impermeable fabric, and the membrane is made of PTFE breathable fiber, which enables the transfer of moisture (sweat, steam) from the body in order to reduce heat stress.

Behind the vapor barrier is a thermal lining that serves to provide increased air space, adding multi-layered insulating properties to clothing. The most commonly used material is woven Nomex or very airy materials, often made of processed fibers, sewn with woven Nomex.

Protective clothing must have a high degree of sophistication with regard to fire resistance and chemical spills. In emergencies, in addition to fire and chemical spills, chemicals can also ignite. By considering FR clothing, we can conclude that chemically resistant clothing provides moderate resistance to flame, and provides minimal protection against flame against chemical splashes. Various and complex risks are involved, so the type and compatibility of clothing must be taken into account, depending on the size of the flame and fire.

TYPES OF CLOTHES - REFRACTORY CLOTHES

An interesting product comes from Denmark. Its main purpose is to help firefighters fight fires (Picture 2) Picture 2. Intelligent refractory clothing This is the so-called IP Firefighter system which consists of a jacket intended for firefighters. The jacket is intelligent. Jacket intelligence is a product of various biometric sensors that measure the heart rate, fire temperature, ambient temperature, analyze the chemical composition of smoke and the like. This data is collected by a microprocessor chip housed in a jacket, and wirelessly using internet protocols. It sends this data to the base station of the fire truck, and from the vehicle to the central server, where the obtained data is analyzed, and then the appropriate instructions are sent to the firefighter.

Figure 5. Firefighting clothing

ELECTRONIC BRA

The company Triumpf iy Munich has produced a sports bra for women that has a built-in heart rate monitor. The bra comes with a digital display that is worn around the wrist as a fashion detail. a bracelet that shows a pulse.

SOLAR CLOTHES

A specific type of intelligent clothing are those that have sensors for collecting solar energy. This energy is converted into electricity by special mechanisms and can still be used to charge mobile

phones, iPads, digital cameras and similar devices. The clothes were launched by the manufacturer Indira.dtx from Argentina..

Figure 6. Solar jacket

CLOTHING FOR COMPUTER NETWORKING

These are clothes produced on the basis of a joint project of the company "Lewis" and the electronic company "Philips". The project has been intensively worked on for more than three years. It is equipment with a fully integrated computer network. (Picture 3. Intelligent clothing with computer networking. It allows the user who wears it to always be connected to the global network - the Internet.

CLOTHES FOR HUMAN HEALTH CONTROL

"Phillips Design" has been working for several years on the development and production of clothes that will be used to monitor people's health, using the fabric as a conductor of electricity. Special attention is paid to mothers by creating models that would be able to detect the pulse of the fetus or clothing for older people that allows a direct computer connection with their home doctors. This type of techno wardrobe also has its drawbacks, the fall of the computer network or the impact of heavy rainfall and thunderstorms on techno clothes when worn by the user.

CONCLUSION

In the coming period, the textile and fashion industry expects a rapid growth in the demand for clothing, which incorporates something from the top information and communication technology - in the material itself or as a functional accessory. The next trend in the clothing industry will be the so-called electronic clothing. It’s not just one new and unusual fashion diyajn. It's something more. These are clothes that have a variety of possibilities, starting from the possibility of automatically changing the appearance depending on the biometric data of the wearer, all the way to the possibility of regulating the pressure and body temperature. Electronic clothing, as a new branch of the textile and fashion industry, has a potentially large market. It is currently estimated that only a few estimates of the population are ready to buy and use electronic clothing. The high price of such models has a great influence on that.

REFERENCES

1. Gelev, S. & Geleva, I. (2013). *“Intelligent clothing and computer equipment as a fashion detail ”. Faculty of Electrical Engineering Radoviš*
2. Albo - personal protective equipment.
3. https://albo.biz/product-category/lzo/lzo-odeca/lzo-odeca-odeca-visoke-vidljivosti/

4. Vasilije M. Petrovic: (2006), Modern technologies in the clothing industry, II Scientific Conference of the Textile Industry of Western Serbia, Regional Chamber of Commerce of Uzice, September 2006, Ivanjica.
5. D. Rogale, D. Ujevic, S. First Rogale, M. Hrastinski: Clothing production technology with study of work, University textbook, Faculty of Textile Technology, Zagreb, 2000

KEY ELEMENTS OF A QUALITY ASSURANCE SYSTEM OF CLOTHING

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ABSTRACT

Quality assurance consists of various activities that are carried out in the quality system in order to meet the requirements and objectives for a particular product, service or activity, which is explained and described in detail in the paper. It is a systemic measure to control the process and prevent errors in the production of certain products. In order for a certain product to remain high quality or for the company to operate well in the long run, it is necessary to constantly learn and improve to achieve quality improvement, but also to get satisfied and loyal users, the essence of such business is the elementary key to quality assurance.

Key words: quality assurance, system, product control.

INTRODUCTION

In general, it can be established that there are numerous difficulties in introducing the main settings of the systemic approach to quality assurance in practice and its management. The system is complex and it is not easy to notice all the elements that make it up. It is even more difficult to assess the true function and significance of individual elements in achieving quality and their connection and optimal place in the system. Therefore, it is understandable that a lot is said and written about this issue in the professional literature, unfortunately, sometimes with insufficient comprehensibility. The main question is: How to put clear settings and principles of individual concepts of quality management into practice?

The questions to which you need to know the right answers for this purpose are numerous, and here are a few:

- What are the main elements of the system?
- How are they interconnected?
- How to organize work in the company on a practical level in order to realize the principles of the new philosophy of quality and for the system to be effective?
- What tools should be used to make the action effective?
- How to motivate employees for a new approach?
- If the system is introduced, how to provide users (customers) with credible guarantees in this regard?

These and many other questions will be answered in the following chapters.
It should be noted that the general approach to the introduction of quality systems in practice is the same, regardless of the type of company and activity in question, so in this sense it should be borne in mind the following settings common to all:
The establishment of a quality management system is primarily the domain of the company's quality policy and should certainly be initiated at the level of company management, and at that level its successful implementation and effectiveness must be ensured and guaranteed. Therefore, company leadership has a key role to play.

The first phase, ie. phase of introduction, requires serious motivation of all workers involved in the process of creating and placing products on the market. They need to truly believe that quality is an important argument in the fight for the market.

Motivation should be based on the knowledge that the establishment of a quality system generally makes a significant contribution to the development of the company and the success of the business and becomes a guarantor of the company's competence for the work it performs. Without proper education of workers at all levels on this topic, it is impossible to achieve their high motivation.
Activities aimed at raising quality should always be evaluated in terms of costs, ie. by considering the ratio of profit costs, and it is desirable to assess the contribution of an individual worker.

In the phase of conceptualization of the quality system, the most appropriate appropriate model should be selected and all measures and activities that will ensure its realization should be foreseen, which should be clearly elaborated and stated in the quality manual.
In particular, the measures and activities in each individual case must inevitably be adapted to the specifics of the company, the activity to which it belongs, as well as the specific requirements for products and the expectations that customers have regarding the product.

Evolution of quality

During this century, quality has evolved through several stages (which should be understood conditionally, partly due to time overlap, and partly due to uneven spread and practical acceptance of quality management methods and techniques), and it is important to note that evolution continues.

The role of standardization in the quality assurance system
Standardization involves defining and prescribing constant requirements to be met by a product, service, process and / or management system over a period of time. The term "standard" itself comes from the English word, which means norm, pattern, measure.
The main goals of standardization are:

- rational business,
- protection of human health and achieving general security of people and material goods,
- protection of consumer interests.

In the conditions of doing business on the European market, quality plays a significant role, not only in providing new markets, but also in retaining existing ones. Customers of today, not only expect a quality product, but also demand proof that the company is capable of producing quality products or providing quality service. Providing this evidence should be a first-rate goal for any company that sticks to its image and has high pretensions when it comes to new markets. For now, the only internationally recognized proof of quality is the ISO 9001: 2000 Quality Management System certificate issued by an independent international certification body.
The basic principles of international standards are as follows: Equality - every institution that is a member of the organization has the right to propose work on developing new standards, which it thinks are important for the international economy and technical cooperation, voluntariness - ISO standards are voluntary - as ISO is non-governmental organization, there is no mechanism of legal coercion for the implementation of standards, market orientation - ISO develops only those standards that relate to technologies, products and processes for which there is evident market interest, consensus - although ISO standards are voluntary, the fact that they are based on market approach , as well as being based on the consensus of stakeholders, enables their wide application, international character - ISO standards are of international character, when adopted at the international level, they are applied in national economies, and member states apply and respect them.

The goal of introducing ISO standards in any business is, above all, gaining the trust of customers through proven delivery and delivery, which only facilitates business. The basic decision of these standards can be seen in the fact that their requirements place additional requirements on the manufacturer, in order to ensure the conditions for achieving the agreed quality and complement the technical specifications of products and services. Diversity in both standardization and the

achievement of quality system standards requires harmonization to remove technical barriers to international traffic and cooperation. The goal is to achieve the uniqueness of European standards, and also to respect national standards and their specifics. Common standards focus on the essential requirements of health, safety, environmental protection and consumer protection.

Quality as a global phenomenon

Globalization of the market has affected the increase and intensification of competition. Improving the quality of business is becoming an imperative of the modern market and global trends. The built-in concept of quality is certainly one of the most important factors influencing the placement of products on the international market. In such conditions, improving the quality of business becomes a major factor in achieving competitive advantage. Business quality is based on improving labor productivity and knowledge. One of the greatest authorities in the field of quality management, Edwards Deming, noticed in the early fifties of the last century that when quality is improved, productivity is also improved. He called this interdependence of business quality and productivity a "chain reaction".

Based on this, it can be said that companies need to focus on quality and productivity in order to achieve a competitive position in the market. It is indisputable that quality and productivity go hand in hand, and this mechanism of interdependence is realized in the form of a chain reaction. Quality and productivity are inextricably linked. Improving quality reduces business costs due to fewer alterations, errors, delays, scraps, as well as better use of equipment, raw materials and supplies, in a word - due to better management of business resources. Lowering operating costs directly affects productivity. Lower costs and better productivity affect a more flexible pricing policy - selling standard quality products at lower prices than the competition. Optimization of the price-quality ratio affects the occupation of a stable market position, the achievement of development goals - it provides jobs and creates new jobs.

Quality control in the textile industry

Quality means that customer needs must be met. Therefore, if an adequate quality standard is not maintained, it can lead to failure. But maintaining an appropriate quality standard also requires effort. From the first investigation to discovering what a potential buyer really wants for a new product, through design processes, specifications, controlled production and sales. There are several factors on which the quality clothing industry is based, such as - performance, reliability, durability, visual and perceived quality of clothing. Quality should be defined in terms of a specific cost framework.

Quality is paramount in any aspect of business. Buyers demand and expect value for money. As clothing manufacturers, they must constantly strive to produce quality products. In the clothing industry, quality control is performed from the initial phase of procurement of raw materials to the phase of final production of clothing. For the textile and clothing industry, product quality is calculated in terms of quality and standards of fibers, yarns, fabric construction, color fastness, surface design and final finished clothing products.
Quality control and standards are one of the most important aspects of the content of any job and therefore a major training factor.

Complete quality control

Complete quality control covers all functions in the organization, starting from marketing and sales, through design, production and services.

The goals of complete quality control are:

- To maximize the production of goods within the specified specifications,
- To achieve a satisfactory fabric or garment design in relation to the level of choice in design, styles, colors, component suitability and product suitability for the market.

Quality characteristics

Each product has a number of properties that together describe what the user or consumer considers quality. These properties are known as quality characteristics. For example, fiber length is known to be one of the important characteristics of fiber quality.

Quality costs

Preventing, detecting and resolving damage causes costs that are called quality costs. Quality costs can be divided into four broad groups.
Prevention costs: Product / process design, process control, combustion, training, collection and analysis of quality data.
Assessment costs: Inspection and testing of received material, inspection of products and testing of products, consumed materials and services, maintenance of accuracy of test equipment.
Internal cancellation costs: Reatest, failure analysis, downtime, yield losses, humiliation, hail. External fault costs: complaint adjustment, returned product / material, liability costs, external costs.

Introduction of testing and quality control of textiles

Operational techniques and activities that maintain the quality of a product or service to meet specified requirements consist of quality planning, data collection, analysis and application of data and is applicable to all stages of the product life cycle; design, production, delivery and installation, operation and maintenance.
Quality control processes are performed:

- to produce the required product quality,
- to meet the customer's request,
- to reduce production costs,
- to make maximum profit at minimum cost.

Statistical quality control

Diagram representations such as histograms, Pareto diagrams or scatter diagrams, etc., which show the incorrect status of clothes produced in the mass production section, are called statistical quality control.

A histogram is a quality tool that, in graphical form, shows the distribution of errors, certain characteristics or activities according to the frequencies of occurrence. Each column on the graph represents one examined phenomenon (characteristic, activity, error) or interval within the data range, and the height of the column indicates the number of data in a certain interval, ie the frequency (frequency) of occurrence of the monitored phenomenon.

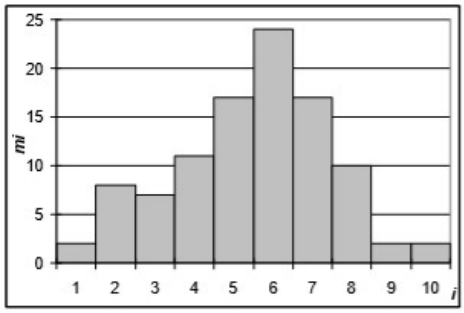


Figure 1. Histogram of the frequency (mi) of data from a statistical set arranged in i = 10 intervals

The Pareto diagram helps to identify those effects that cause the most problems. For example, out of 208 damages shown on the pareto chart, 45 or 21.6% are fabric damages, so in this case it would be most effective to solve the fabric quality because any improvement in fabric quality will significantly improve the overall product quality next defect to be addressed. the seams should be open and so on.

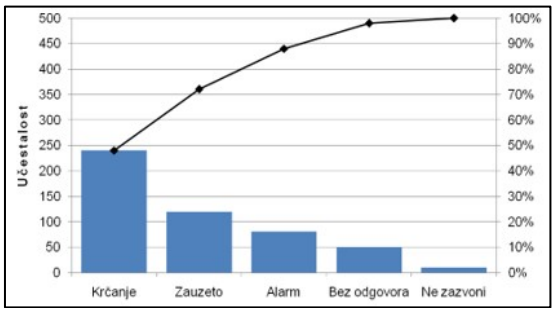


Figure 2. Example pareto diagram

This tool in the function of quality improvement is used in cases when it is possible to identify errors, their frequency and / or costs that arise and take corrective action to eliminate errors.

The Pareto diagram breaks the big problem into smaller parts and highlights the most significant influences. It indicates where we need to focus our efforts to maximize results. The Pareto diagram is guided by the fact that a small number of causes cause the largest number of problems.

Significance of textile testing - Reasons for textile testing

Testing textiles is an expensive job. The laboratory must be set up and equipped with a range of testing equipment. Trained workers must be employed whose salaries must be paid throughout the year, not just when results are sought. Moreover, all these costs are unproductive and therefore contribute to the final price of the product. It is therefore important that testing is not undertaken without adding some benefit to the final product. There are several points in the production cycle where testing can be performed to improve the product.
Importance of textile testing: The primary goal of textile testing is to assess the properties of a product and to predict its performance during use. The information obtained can be used for the following: Research and development, selection of raw materials, process development, process control, quality control, product testing, product failure analysis, comparative testing and marking at the stand, in accordance with national regulations and specifications.

Figure 3. Miscellaneous textile testing

Production technological system (PTS) in the function of quality assurance

During the years of development and application of quality systems in production organizations, it was learned that within the quality assurance system should always try five main groups of factors,

elements of the system, which should be well developed and properly integrated into the quality circle / loop. These are: materials, methods, machines (which includes the technical-technological level of development), and the working environment and human resources. It is a set of elements of crucial importance for quality and its development, which is abbreviated as 5M. The abbreviation comes from the initial letters of the listed elements in English, ie. Materials, Methods, Machines, Millieu, Man and is deeply spread in the professional literature in the field of quality management, which is probably contributed by the fact that in German words of appropriate meaning begin with the same letter Materials, Methods, Machines, Millieu, Mensch). Often the important role of this group of elements for product quality assurance is covered by the term production-technological system and will be discussed in this context in the following text.

The production-technological system defined in the manner as stated in the previous section undoubtedly has a key role in achieving the product of the desired quality as well as for achieving the overall goals of the company, ie for its business. The significance of the production-technological system for quality is also shown by the so-called Ishikava diagram. It shows the five main elements of the production-technological system (5M) and product quality in a causal relationship. The left side of the diagram, which analyzes the causes and influences that lead to a certain consequence (product quality), lists these five main elements of the system. Measures and activities have been developed within them. Such careful elaboration is the first important step for the good functioning of the production-technological system.

Materials as quality assurance factors

The term materials in textile production, which is in the foreground for us, includes raw materials and all the things that are needed to make a product of appropriate quality. The main raw material of textile production, as a rule, is fibers, however, if it is a work organization that includes only a certain higher stage of processing, then the raw material for that production is the final product from the previous stages of processing. For example, if it is a weaving mill or weaving mill as special work organizations, the basic raw materials for their production are various types of yarn, which are the final product of the spinning mill. Fabrics, knitwear and nonwovens for the clothing industry. This means that in addition to fibers, the term materials includes various other textiles of different degrees of production, depending on the need for further processing, or depending on what is the activity of a particular textile work organization. The term of course includes various auxiliary textile and other materials, as well as all chemicals, dyes and auxiliaries necessary for the smooth running of production processes and refinement in order to achieve the best possible aesthetic and usable properties. The quality of the final product depends on all usable materials, which is the reason that the quality management system should take into account everything and each material individually.

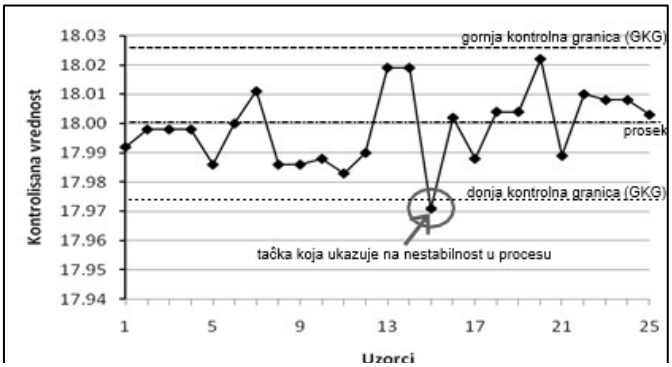
Fiber as a quality assurance factor

So, if the whole process of classical textile production is taken into account, then fibers can be considered as the basic material. Depending on the specific characteristics of the future product and the installed processing technology, it is necessary to make an optimal choice of fibers in order to achieve a specific product quality. When choosing the type of fiber, a modern textile manufacturer has a wide range of various fibers at its disposal - both in the field of natural and artificial fibers. Other high-performance fibers provide excellent comfort when wearing clothes in different climatic conditions and physical activities, and some types provide exceptional mechanical characteristics or special functional properties. Today, the textile manufacturer has at its disposal fibers of truly diverse properties, especially in the group of artificial, ecological materials - all important quality factors.

It should be noted that developed textile markets are showing increasing interest in textile products made of high quality fibers, with products with a high degree of environmental reliability being especially valued. This implies the use of environmentally friendly fibers and production processes, so that during use, the textile product is completely harmless to human health. It also assumes that after the use of textiles, they can be recycled or destroyed in an environmentally friendly way. The offer of

such materials is good, both in the field of natural and artificial fibers. All types of substances, chemicals, dyes and auxiliaries that are used in all phases of textile production - from obtaining fibers to finishing the product and its disposal after use - are also under strict environmental scrutiny. 8. Methods as an element of textile quality assurance. The word method means the way or the way in which something is done or solved, and this element of the production-technological quality management system should be understood in accordance with that meaning. It refers to the careful elaboration of the entire production in order to achieve a product of a specific quality.

The basic statistical tools used are control charts and various types of other diagrams. Control charts allow to determine the occurrence of deviations during production almost at the time of occurrence, and in the process can be responded to in time by appropriate actions that will reduce deviations and prevent errors (eg ensuring proper operation of machines, setting operating parameters of machines and materials, uniform supply material, setting environmental requirements, etc.). In this way, the causes and deviations that are sought to be eliminated by direct interventions and the work process are revealed.



Picture 9. Example of a control chart

Control charts are a suitable tool for quality control during production, as well as on the finished product. They are reliable, easy to use and an effective process control tool, especially if properly applied in the right place in the production process. As such, they can find great application in quality control, in the processes of maintaining technical systems (machines and devices), ie means of work, but also in raising the level of quality for many other activities.

Process control can be carried out continuously, by permanent measurement or observation of individual relevant physical quantities during the production process (on-line), using an appropriate measuring sensor incorporated (attached) to the production process. For example. the place where the computer-monitored and seen measuring sensor is placed may be on a machine or a general place in the process which has been determined to be critical to the occurrence of deviations. The measurement process should take place so that these values are not exceeded. In case of exceeding one limit value, an alarm signal appears, which is a sign that it is necessary to intervene in the process in order to prevent obtaining a product with an error, ie insufficient quality. Such control systems have been developed for all basic stages of textile production and processing - for spinning, including preparation, weaving, knitting and certain finishing processes. For the production control system on samples, the common name is discontinuous control. The primary task of this control is to detect deviations in the technological process as early as possible, ie the occurrence of defects in the product.

Product quality control is also an important factor in ensuring the quality of textiles. The term product is related to the final stage of processing, so the final product is a yarn spinning mill, weaving mill - fabric, clothing industry - clothing and the like. It is important that it is the final product of a work organization, intended for the market or processing in another company. This type of control examines all relevant properties of the product whose values are specified in the manufacturer's specification, ie.

compliance with the specified specifications is determined. Based on the results of this control, data are obtained that are used to prepare quality documents such as a declaration of conformity and a product declaration. On the basis of these data, sales relations and agreements are concluded. Therefore, this type of control must be very reliable.

It is always carried out discontinuously in laboratories, with the following requirements: Detailed definition of production lines, testing should be performed on statistically representative samples, standardized or agreed testing methods (if it is a known customer), instruments and apparatus on which tests must be carried out in moderation and meet the requirements for accuracy, measurement uncertainty must be monitored, laboratories with their equipment and methods should be included in periodic interlaboratory tests to check the reliability and thus the acceptability of the results. application, permanently work on the development of testing methods and procedures, especially looking at the possibilities of objective evaluation of difficult to measure subjective characteristics and complex functional usable properties.

This type of control is always used in determining the conformity of the product to the requirements (specification), or verification of its correctness, if it is a question of functional properties. It is indispensable in conducting self-assessment, internal and external verification, in determining the results of market inspection, etc.

CONCLUSION

Quality is an individual thing because everyone experiences quality in a different way, but what is the same for everyone is that quality is demanded today in every place and at all times. In order for a certain product to remain high quality or for the company to operate well in the long run, it is necessary to constantly learn and improve in order to achieve quality improvement, but also to get satisfied and loyal customers.

Quality assurance consists of various activities carried out in a quality system to meet the requirements and objectives for a particular product, service or activity. It is a systemic measure for process control and prevention of errors during the production of certain products, so it is important to perform quality control because in addition to reducing and preventing errors and shortcomings, quality is a key factor of each product but also determines its value.

REFERENCES

[1] Dr. sc. Ruzica Cunko, Professor, Quality of Textile Products, Faculty of Textile Technology, University of Zagreb, Zrinski d.d. Zagreb 2008
[2] Prof. dr Cockalo Dragan, Prof. dr Djordjević Dejan, Quality Management, University of Novi Sad, Technical Faculty "Mihajlo Pupin", 23 000 Zrenjanin, 2018.
[3]https://www.slideserve.com/studs/14-faktori-konkurentske-prednosti-organizacije
[4] Prof. dr Semsudin Plojovic, Doc. Dr. Senad Busatlić, Quality Management, University of Novi Pazar, Novi Pazar, 2012.
[5] Kljajic Zivana, Specialist paper, Topic: TQM - Total quality management and the role of employees in achieving total quality, Pan-European University, Banja Luka, 2009.
[6]https://textilelearner.blogspot.com/2013/05/an-overview-of-quality-and-quality.html
[7]https://textilelearner.blogspot.com/2011/04/introduction-of-textile-testing-and_4641.html
[8]https://www.aurostandard.org/single-post/troskovikvaliteta
[9]https://textilelearner.blogspot.com/2015/05/statistical-quality-control-in-apparel.html
[10]https://textilelearner.blogspot.com/2012/03/importance-of-textile-testing-reasons.html

HEMP FIBERS IN RELATION TO OTHER FIBERS AND THEIR APPLICATION

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ABSTRACT

All hemp products are completely biodegradable, recyclable, and are a source that can be used in any form: porridge, fiber, protein, cellulose, oil or biomass are therefore interesting for research and testing and are processed in this work in. Hemp plants only need 10-13 centimeters of water to grow to eight to twelve feet in three to four months - this is a third of the amount that cotton needs. The possibilities for hemp as a fabric have yet to be fully explored. This versatile crop has huge potential to rise as an ideal fashion choice for interiors and clothing. By choosing to grow this unusual plant with such enormous environmental benefits, the incredible, long-lasting benefits that the paper talks about are achieved.

Key words: hemp, textile production, clothing production, biodegradability.

INTRODUCTION

Today, due to current concerns about resource depletion, rising oil prices, and increasing greenhouse effects, the world is encouraged to develop new biodegradable materials produced from renewable sources. As a result, natural fibers have returned to the spotlight.

When it comes to cellulose fibers, scientific and technological development has made it possible to find more than 1000 species from which fibers could be extracted and used in several applications. Some of these natural fibers are currently under investigation worldwide. Among them are hemp fibers, a class of fibers rich in cellulose with a high potential to be used in a large number of applications (one of which is the textile industry), due to low cost, low weight, high strength, environmental friendliness and biodegradability.

Hemp

Hemp is generally known by its scientific name - Cannabis sativa, and is traditionally grown for its long and strong fibers. The term "hemp" is used to describe the plant itself, its components and all the products extracted and produced from the plant.

Figure 1. the appearance of hemp and its fiber

Hemp is one of the oldest cultivated crops in the world, sown in spring and harvested in autumn, and can reach over 3m in height. For centuries, it was grown mainly for making ropes, bark, fabric, paper and sails, which is archaeological evidence of hemp production which proves the hypothesis that the plant originated in Central Asia and was grown more than 12,000 years ago. However, the plant has been grown in a large number of geographical zones, as it can adapt to most regions and climates around the world.

However, hemp cultivation has suffered a loss in most Western countries, when it was banned for decades for several reasons, including direct competition with other raw materials (such as cotton and synthetic fibers), high production costs and the use of leaves as intoxicants. For the latter, it must be emphasized that industrial hemp has practically no 9-Δ tetrahydrocannabinol (THC), an intoxicating resin extracted from the leaves. In fact, this was one of the arguments put forward in its favor, thus enabling the lifting of the ban on growing hemp, which is now considered a legitimate crop. Currently, the European Union, together with China and Canada, covers almost two thirds of the world's hemp production, and almost 50% of the world's industrial hemp is supplied by China.

ETYMOLOGY AND HISTORY OF HEMP USE

The name hemp comes from the Sanskrit word cana, which today appears in various phonetic constructions in many languages of the world. The words of various Slavic peoples for hemp (Old Slavic: hemp, Russian: hemp, Czech: hemp, Polish: hemp) are so similar that the word certainly derives from a common Slavic homeland. Knowing the word also indicates knowledge of the plant, so the etymology can help to discover how long the Slavs have known hemp, when other, archaeological or written, sources are missing. It is believed that the Slavs brought the word hemp from the east.

Hemp is one of the oldest cultivated plants known to mankind. It is one of the first cultivated plants, and its use was multipurpose. In the beginning, it was mostly grown for its fibers, and the ancient Chinese used it to make ropes, clothes and paper. The seeds have been used for food in China for about 6000 BC. As some findings show, the recreational use of this plant was not negligible even then. The earliest mention of its psychoactive properties can be found in the Vedic scriptures - that is, the Indian scriptures four thousand years old. It is believed that the Sumerians brought it to Mesopotamia from India, in the third millennium BC. It has also been found off the coasts of Congo and the Zambezi in Africa. It is believed that hemp arrived in Europe during the great migrations of peoples.

HEMP STEM AND INTERNAL FIBER STRUCTURE

Hemp is an annual herbaceous plant from the mulberry family Moraceae whose tree contains fibers. The plant is dioecious, which means that there are male and female stems. The male plant (Cannabis sativa L.) is known as industrial hemp, due to its great use in industry, while the female plant (Cannabis indica), known as Indian hemp, is used for consumption or as a medicine for intoxicating operation. It grows up to over 3m in height, is thicker and coarser than flax.

Figure 2. The appearance of a hemp stalk

Hemp fibers are obtained from the stem of the plant, they are formed by natural synthesis in the bark of the stem. The stalk is also called a character. Lika, ie hemp fibers, consist of cellulose and non-fibrous substances (lignin, waxes, pigments, etc.). , are poorly connected, and the fibers have a thinner wall, which makes them more woody. The vegetation period of the plant (period from sowing to harvest) depends on the type of plant, climatic conditions, soil composition, etc. and amounts to 90 to 180 days. The stem of certain types of hemp can grow to a height of 3.5 m, although it is smaller on average. From 100 kg of raw stem, 8 to 15 kg of fiber were obtained.

The stem of hemp has a cylindrical shape, inside which there is an empty space - the core, which consists of a wooden core (xylem) surrounded by an outer layer of bark. On the other hand, the cortex consists of three different layers: the cambium, the cortex, and the epidermis. Each layer of hemp stem has its importance: xylem, the thickest layer (1-5 mm), provides stiffness to the stem; the cambium is like a physical barrier, separating the layers of the wooden part and the character. The cortex (thickness 100-300 μm) is composed of bundles of primary and secondary individual fibers, which are individualized in two layers. The primary fiber wall is divided into two different layers: the primary cell wall and the secondary cell wall (known as the L layer). Which is further divided into 3 more layers of lignin-bound cellulose fibers, labeled L1, L2 and L3. All the mentioned layers are made of lignocellulosic materials, although in different proportions. Layer L2 is the thickest layer, which contains about 50% of the cellulose content in the fibers and thus has the largest contribution in the properties of the fibers.

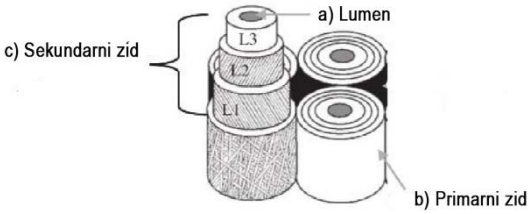

Figure 3: The inner structure of hemp fiber

Hemp fibers consist of long fibers - bark and short fibers - the core. Long bark fibers consist of a higher proportion of cellulose, a lower proportion of lignin and a varying proportion of secondary character fiber. Short hemp fibers - the core contains a higher proportion of lignin and a lower proportion of cellulose. Each bundle of fibers contains individual fibers. In hemp, we distinguish two types of fibers: long - primary fibers from 5 to 55 mm long and short - secondary fibers about 2 mm long. The woody part is more developed than with flax, as well as the bark. Quality fibers are obtained from the middle part of the stem. The cross section of hemp fiber is pentagonal and hexagonal in shape, oval and as if crushed. The longitudinal appearance is forked with transverse stripes.

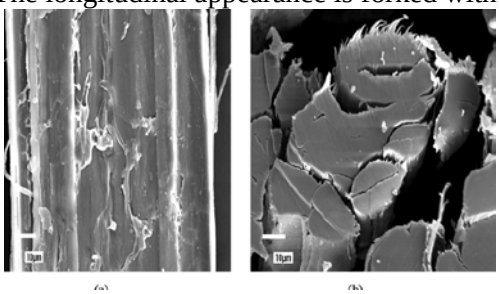

Figure 4 a) longitudinal appearance; b) cross section of hemp fiber

OBTAINING HEMP FIBERS

The hemp plant and its fiber quality largely depend on several factors, including: growing conditions (such as day length, temperature, climate and soil types) and the type of cultivar. In Europe, modern breeding programs have been established for the development of varieties of hemp for cultivation, according to the end use (hemp fiber or seed hemp) and providing low levels of THC. These cultivars are classically developed for specific environment, seasons and crops. In relation to hemp fiber cultivars, cultivation programs were able to increase the fiber content in the plant from 12-15% to 25-33%.

The process of obtaining hemp fibers consists of several stages: plucking or cutting the stems, soaking, drying, breaking and rubbing, softening the fibers, cutting, scratching the fibers. Stem harvesting is done manually or by machine. The stems are plucked or cut, and then sorted and left to dry in a loose state on the ground or tied in handles.

Figure 5 Cutting and drying hemp

Wetting is a process in which the connection between the bark and the rest of the stem is destroyed by the stem. In addition, when wetting, the bond in the multicellular fibers that are part of a single bundle weakens. Multicellular fibers are glued together with pectin, which is an excellent food for bacteria. By destroying pectin substances, the bundles of fibers are released from the stem and separated into multicellular fibers. In addition to bacteria, fungi participate in the wetting process. Favorable conditions for the reproduction of bacteria and fungi are a certain humidity and heat. Wetting can be performed on: dew, in running and standing water, and even in the sea. Wetting is done longer than with flax because hemp has coarser and thicker stems.

After soaking, the process of drying the stems is performed, and then the process of separating the fibers from the wooden part is performed - breaking and rubbing. Breaking is done on machines similar to flax, with the proviso that hemp processing machines have stronger working elements and a larger workforce. With the help of rubbing, the fibers are separated from the rest of the stem. The obtained hemp fibers are quite coarse, which is why it is necessary to soften them. Softening is done by machines whose rollers rot the fibers. It softens the hair (long fibers), and sometimes the dog (short and intricate fibers). The hangings are sometimes up to 3 m long, so they are cut on cutting machines at 600-750 mm. Scratching is performed in order to separate the long fibers from the short fibers, whereby the fibers are parallelized. After scratching, the fibers are packed in bags and sent for spinning.

Figure 6. The process of scratching hemp

Hemp fiber quality problems

The main disadvantages of using natural fibers are related to their quality problems, namely variations in fiber quality and processing limitations. Among the factors that affect the quality of hemp fibers are genotype, sex, harvest time, part of the stem, length and diameter. In addition, the geographical position together with the quality of the soil, climate and weather conditions, which also affects the growth of hemp fibers and its final properties.
After harvesting, there are other sources of variability in the end use of the fibers, including extraction methods, possible damage during processing, differences in drying procedures and further treatments, which the fibers must withstand. Therefore, variations of the previously mentioned parameters at the end of processing will contribute to undesirable changes in the morphology, structure and chemical composition of the fibers, affecting its final physical and mechanical properties.

PROPERTIES OF HEMP FIBER

Hemp is a premium fiber that holds its shape and is incredibly strong. Hemp, like bedding, becomes softer with use. It is porous and therefore absorbs water. It is a breathable fabric that can keep the consumer warm in winter and cool in summer. It is especially suitable in places with tropical climates because it resists heat decomposition and is less prone to the influence of the sun's rays. One particularly unique advantage of this fiber is that it effectively blocks UV rays. It is hypoallergenic, so it is suitable for people with sensitive skin. Hemp absorbs colors well, and also has a natural shine - it is possible to make hemp fabrics with a high shine. When it comes to fabric disposal, fiber is completely biodegradable.

Although it resists heat decomposition, hemp fibers can be attacked by fungi and bacteria under hot and humid conditions. Mold is a rotten and weak material, however this can be avoided by impregnating fabrics with chemical agents such as copper nepthenate.

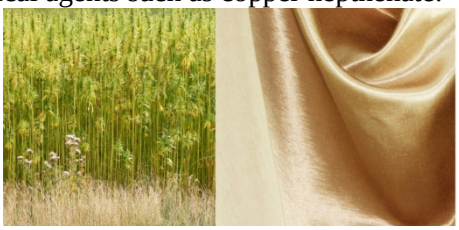

Figure 8 The possibility of producing hemp material with a very high gloss

Surface structure and external appearance of hemp fiber:

The surface of hemp fiber is not as smooth as flax. The feel and color of the fibers depends on the wetting. The color can be from light yellow, yellow-gray to greenish. The shine of the fibers depends on wetting and scratching.

Figure 9. The appearance of hemp fiber

Fiber length: The length of the fibers is from 1 to 3m, but the fibers are cut to a length of 600 to 70mm during processing. Elemental fibers are 10 to 30mm long.

Fiber Fineness: Hemp fibers are coarse. The fineness of the elemental fiber is 2-6 dtex.
Strength: Hemp fibers, along with remission, are among the strongest natural fibers. Their breaking strength is 50-90 cN / tex. In the wet state, their strength increases. Their wear resistance is similar to that of flax.

Elongation and elasticity: Intermittent elongation of fibers under normal conditions is 1-6%. Hemp fibers have low elasticity, which is why they have a tendency to wrinkle.
Density: The fiber density is 1.48-1.50 g / cm3.

Sorption properties: Hemp fibers are very hydrophilic. Humidity under normal conditions is 12%. The fibers can absorb up to 30% of moisture (in relation to their weight), without feeling moisture, which means that they are very resistant to moisture.

Thermal properties: At high temperatures, they behave similarly to cotton and linen, which means that they are resistant to the effects of high temperatures. Hemp fibers burn easily and behave like cotton and flax when burned.

Hemp fibers compared to other fibers:
Different natural fibers represent exceptional differences in chemical composition and physical properties, which makes them more or less suitable for a certain use.

Hemp and flax fibers have similar properties and are difficult to distinguish. However, hemp has several advantages over flax and other natural fibers. In the cultivation of hemp the plant blooms without the use of herbicides or pesticides. The plants are sown very close to each other to increase the production yield and therefore grow in the grape layer, which together with the dense leaves prevents the growth of weeds and other plants. In addition, growing hemp does not require a lot of chemical fertilizers and thus, it enriches the soil for crop success and helps them retain moisture. Hemp also has a deep root system, so it needs little or no irrigation. According to all these factors, hemp is considered a very economical and ecological crop. The fact that the plant does not require too much care until cutting, represents a great advantage of hemp fiber production in relation to other competitors. Hemp fibers have rounded ends, which makes them more suitable for textiles. Also for the textile industry, hemp fibers have an outstanding longevity. Therefore, textiles with a higher hemp fiber content are softer and more comfortable. Finally, when mixed with cotton, hemp fibers are twice as strong.

When it comes to chemical fibers, due to their low density, some mechanical properties of hemp fibers are comparable to glass fibers, which makes them a promising environmental alternative in the production of composites. Hemp fibers are known as one of the strongest and hardest available natural fibers, and therefore have great potential for the production of biocomposite materials. Flax, jute, ramie, also show good mechanical properties and have been tested for the same application.

USE OF HEMP FIBERS

History testifies that hemp was a widely grown commercial crop, and the use of hemp fiber is multiple. Hemp fibers have been used for centuries to make clothing, bags, shoes, paper, building materials and insulation. It is also used as food and is not the same as cannabinoids used for the purpose of intoxication. In addition to all this, hemp oil is used even in the cosmetic and medical industries. Today, the plant is associated with a wide range of products and markets, including agriculture, textiles, biocomposites, paper production, the automotive industry, construction, biofuels, food, oil, cosmetics, personal care, the pharmaceutical industry, etc.

Figure 10. Hemp products

It is one of the safest, organic and economical plants that can be used to ensure environmental sustainability. Hemp seeds have been used as a sustainable source of nutrition in a healthy diet and have been used in kitchens around the world since ancient times. When one thinks exclusively of the use of hemp fiber, it is almost dazzling how multifunctional the crop is. Therefore, we can conclude that the area of use of hemp fiber is very widespread, and some of them are:

Textile making - Hemp fibers have long been used to make textiles. It is easily accessible and easy to process. It is cheaper than most organically produced textiles and is more environmentally sustainable than those that are chemically synthesized. The fabric obtained from hemp is also good for sensitive people and does not cause allergies. We have a legacy of civilizational history that testifies to how there was a diverse craft of creating beautiful pieces of hemp textiles. Decorative designs and patterns are often added to hemp textiles to make them unique. It is a very useful fabric, so it can be used for multiple uses even in the modern world. It is also used in a mixture with cotton and linen. Hemp is used to make various clothes, bags, household textiles, etc.

Figure 11. Various hemp garments

Clothing making - Hemp fibers have long been used to make sturdy shoes that provide comfort and durability. Shoes carry most of our weight and are often easy to wear. Leather is a material that has been used for a very long time to make shoes that last a long time. However, leather footwear is very expensive, so finding a cheaper and more environmentally friendly option is very significant. Although many designers and shoemakers have tried to come up with synthetic materials like rubber or reusable polymers like plastic, hemp fibers are a far better option. They are easily accessible and grow in abundance in the wild. Even if grown as an industrial crop, the total cost of production is significantly lower and does not harm the flora and fauna of the planet. In line with this trend, hemp shoes are making a comeback on the big door.

Figure 12. Hemp sneakers

Hemp Paper Making - This is the most common and basic use of hemp fiber. Paper has historically been produced from plants. The use of trees for paper production has led to mass deforestation. This has had a negative impact on our planet and it is of the utmost importance to find an alternative raw material for making paper, hemp lumps help solve this problem. Hemp that is easy to process and versatile money culture can be easily used as a raw material for making high quality paper for our purposes. This would serve as an organic and natural resource of paper, one of the most important materials of everyday life.

Figure 13.. Hemp paper

Hemp ropes and ropes - Hemp fibers are very strong and can be used to make ropes and ropes. Ropes used to be a common commodity, and hemp was an easily available fiber for their creation. Although other fibers have been used in the past to make biodegradable ropes, such as coconut and jute fibers, nothing works as well as hemp. Ropes were not only woven to be used for tying things or hanging things, but were historically used to create decorated artifacts. Hemp ropes have also been used similarly in the past. While the modern world is looking for new organic and sustainable materials for everyday use, hemp fibers are increasingly being put into such use today.

Hemp as a filter - Hemp helps detoxify and regenerate the soil on which it is grown. In addition to the natural benefits of falling leaves that replenish the soil with nutrients, nitrogen and oxygen, hemp plants absorb and disperse the energy of rain and waste, which protects the fertilizer, soil and keeps the seeds in place. More surprisingly, it can also extract nuclear toxins from the country. It was even planted around the site of the Chernobyl nuclear disaster, to help clean up contaminated sites. This process is called phyto-remediation. Phyto-remediation can be used to remove nuclear elements and to clean metals, pesticides, solvents, crude oil and other toxins from landfills. Hemp breaks down pollutants and stabilizes metal pollutants by acting as a filter. Hemp has proven to be one of the best plants that contain phytoremediation.

Hemp in medicine and cosmetics industry - The oil extracted from the plant is used in medicine and cosmetics industry due to its anti-inflammatory properties. It is also an effective painkiller and helps reduce acne. Cannabinoids lead to relaxation and dilation of blood vessels, which results in lowering blood pressure and improving circulation, thereby reducing the risk of heart disease, it is also a good herbal remedy for the early stages of diabetes.
In cosmetics, it is used as a means of caring for dry skin, against eczema and burns. Many skin and face creams contain hemp oil as one of the main ingredients. This oil is rich in fatty acids that are good for the skin, and the oil itself is plant-based, so there are almost no side effects. Hemp oil is good for hair care, and in addition to care, it solves the problem of dandruff.

Figure 14. Hemp cosmetics

Hemp for raw material and energy recovery - Among the best potential applications for hemp production are the use of hemp biomass as a renewable raw material for energy production or second generation biofuels, as well as the use of fibers as reinforcement for biocomposite materials and concrete. phases are known as composite materials. This class of materials includes fiber-reinforced composites that are. They are currently used in the car market, aviation, construction, infrastructure, etc.

Natural fiber composites (NFCs) or biocomposites are composite materials in which the least reinforcing fibers are derived from renewable and neutralizing carbon dioxide resources, such as wood or plants. The possibility of using biopolymers, based on basic examples of epoxidized vegetable oils, to replace oil-based matrices, was also considered. Thus, most of the NFCs produced are the result of a combination of natural fibers (mainly flax, hemp, jute) with petrochemical matrices.

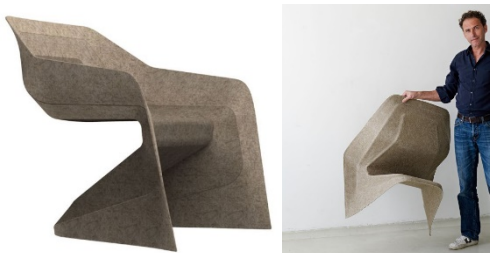

Figure 15. A chair made of hemp

CONCLUSION

Today, this plant is almost never grown, although Serbia has favorable climatic conditions and quality land for cultivation.

Hemp can grow in any agronomic system, in any climate. All hemp products are completely biodegradable, recyclable, and a source that can be used in any form: porridge, fiber, protein, cellulose, oil or biomass. In addition to this, there is no need for herbicides, pesticides, fungicides or insecticides for the crop to thrive, because it is its own fertilizer, its own herbicide and its own pesticide - because it is a technical weed. Hemp plants only need 10-13 centimeters of water to grow to eight to twelve feet in three to four months - this is a third of the amount that cotton needs. This is just a part of the use of hemp in the environment. The possibilities for hemp as a fabric have yet to be fully explored. This versatile crop has huge potential to rise as an ideal fashion choice for interiors and clothing. By choosing to grow this unusual plant with such huge environmental benefits, incredible, long-lasting benefits are achieved.

REFERENCES

[1] Skundric P., Kostic M., Medovic A., Mihailovic A., Asanovic K., Sretkovic Lj., Textile materials, University of Belgrade, Belgrade, 2008.
[2] Marina Tesic, Textile fibers, Department of Textbooks, 2007.
[3] Diogo Alexandre Santos Silva, Technical University of Lisbon, Lisbon 2015
[4] Pierre Bouloc, Hemp - Industrial Production and Uses, CABI - UK, 2013
[5] https://recreator.org/blogs/hemp-101/hemp-101-a-traditional-method-of-hemp-textile-production
[6] https://www.the-sustainable-fashion-collective.com/2014/12/02/hemp-fibre-fabric-eco-benefit/

TELLING A STORY THROUGH CLOTHES AND CREATING AN UNIQUE FASHION CLOTHES

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ABSTRACT

Fashion has always been a way of expressing attitudes, emotions or thoughts; when it is darkness and mystery - it is a weapon of rebellion, courage or silent disapproval; when it is light, it is a form of escapism that improves life, a piece of (almost) tangible happiness. ž want to send with the clothes. Humans are visual beings and like to give meaning to the things they see. We will always have a natural tendency to rely on symbols to understand the world around us, and even the people we meet. The idea is to present a collection that is inspired by Serbian folk patterns of modern cut and thus show that despite the fact that the costume is not so common today in everyday wear, some of its parts, ornaments and patterns can be used in modern industry, and still look beautiful and unique.

Key words: motifs, unique clothes, Serbian folk patterns, costumes.

INTRODUCTION

Everyone tells stories. Stories as powerful as ancient Greek myths and the Bible have taught us how to relate to certain values and how the influence of stories shapes our lives. When fashion designers and brands use stories, they become storytellers and bring stories to life with professional stories.
Fashion designers and brands are engaged in the art of creating impressive content and retelling impressive stories that immediately connect people. When they apologize properly, it opens up a whole world of creativity.

Fashion has always been a way of expressing attitudes, emotions or thoughts; when it is darkness and mystery - it is a weapon of rebellion, courage or silent disapproval; when it is light, it is a form of escapism that improves life, a piece of (almost) tangible happiness. However, often as a target of criticism that usually comes from the intellectual elite (or those who believe that it is so), fashion has never been easy. The moment she gained respect, fashion jumped into the role of constant self-defense, with the goal of proving its value, significance and greatness.

The artists behind the clothes are prophets, literary geniuses who convey stories and feelings by manipulating fabrics, colors, methods and techniques to create stories that will encourage various stylistic individuals to enjoy the art they live in by understanding it.

By creating original and interesting stories, unique, unusual and unique fashion collections are created.

Telling a story through clothes

What we wear can say a lot about who we are. It is a powerful experience when we wear clothes that tell a story or make a statement.
Unfortunately, the meaning is not clear to everyone who sees the clothes. . This cannot be changed permanently if people are not willing to learn to understand each other and not to rely on pre-created ideas.

Adding symbolic pieces to clothes can make it easier to make a clear statement about what we want to send with the clothes. Humans are visual beings and like to give meaning to the things they see. We

will always have a natural tendency to rely on symbols to understand the world around us, and even the people we meet.

If you use symbolism, whether it is a picture, colors or written words (yes, language has a symbolic meaning), clothes can become more readable. The way Richard Nordquist presents in his article Symbol in Language and Literature is very interesting: "A symbol is a person, place, action, word or thing that (by association, similarity or rules) represents something other than itself." Symbolic clothing and accessories make up great pieces to talk about and it is in these conversations that you can best help people understand you.

If what you are wearing means something to you, it is the first and most important step towards forming a unique style and showing yourself through the clothes we wear while telling our story.

Creating inspiration for unique clothes

Designers often get similar ideas at the same time. This suggests that they are mutually agreeing on what they will do next season. But actually, they are very mysterious and no one says anything until the show is over.

They have similar ideas because they seek inspiration at the same time and are exposed to the same influences. The fashion world is not that big, no matter if the fashion designer lives in New York, Milan, Paris or London, he will be exposed to the same sources of inspiration.

After the show, they are already looking for sources of inspiration for the next season. They will visit the same galleries, exhibitions, books, watch interesting movies. Some creators will travel abroad or will bring inspiration from a trip. Events around them affect the way they "feel" trends and determine the direction in which their collection will go.

My idea was to show a collection that is inspired by Serbian folk patterns of modern cut and thus show that despite the fact that the costume is not so common today in everyday wear, some of its parts, ornaments and patterns can be used in modern industry, and that at the same time they look beautiful and unique.

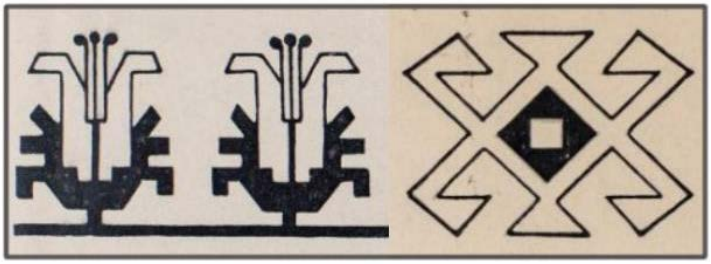

Figure 1. Serbian folk patterns as inspiration for the collection

I modified, incorporated and incorporated the selected patterns shown in Figure 1 into my collection as inspiration, so that they look more modern, but again in the spirit of Serbian tradition. I got a number of different combinations that I will use for direct printing.

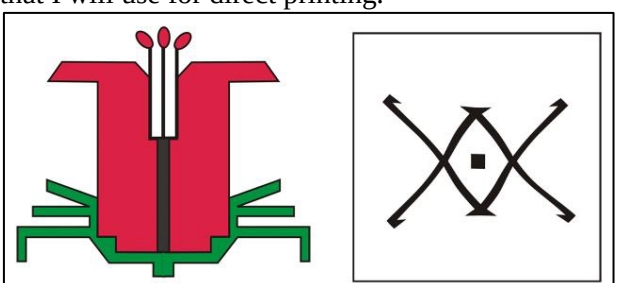

Figure 2. Modified Serbian folk patterns

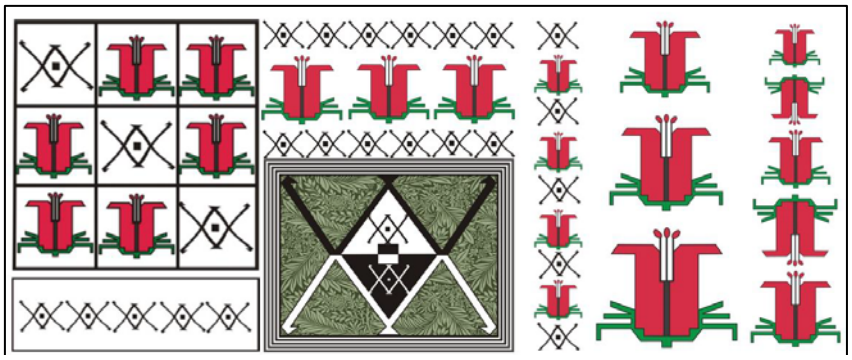

Figure 3. A combination of modified Serbian folk patterns

Description of inspiration

Through a simple skirt cut mixed with today's popular wide T-shirts (so-called "oversize" T-shirts), the author comes up with new solutions. Seemingly simple clothing items stand out with the help of selected Serbian folk patterns that give uniqueness and originality to clothing items. Combining traditional elements with current trends and cuts, the author created clothing items that depict the Serbian tradition, reminiscent of Serbian folk patterns and the place they occupy in the Serbian tradition, which the author thus revives and keeps from oblivion.

Technical and fashion sketches for five models

The pictures below will show five fashion sketches consisting of three clothing items each T-shirts, skirts and cegers, on which there are motifs of Serbian folk patterns.

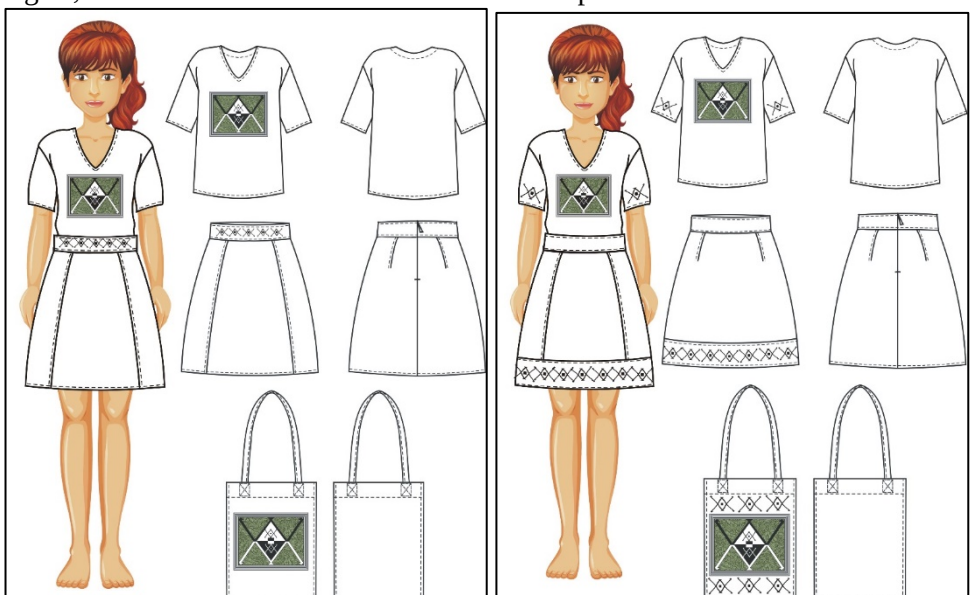

Figure 4. Technical and fashion sketch for Model 1. Photo 5. Technical and fashion sketch for Model 2.

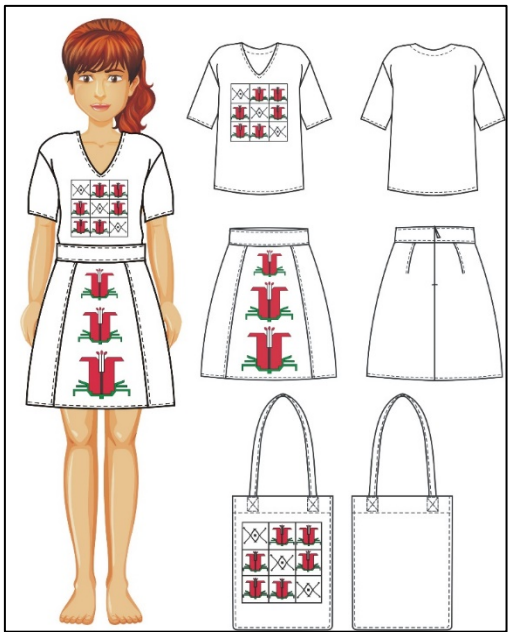

Figure 6. Technical and fashion sketch for Model 3.

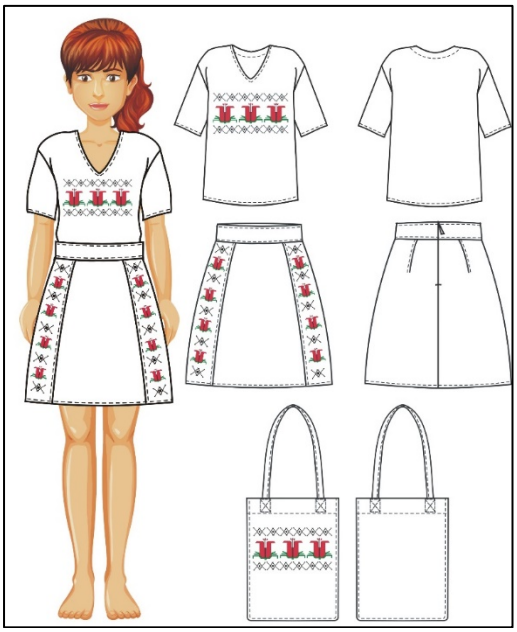

Figure 7. Technical and fashion sketch for Model 4.

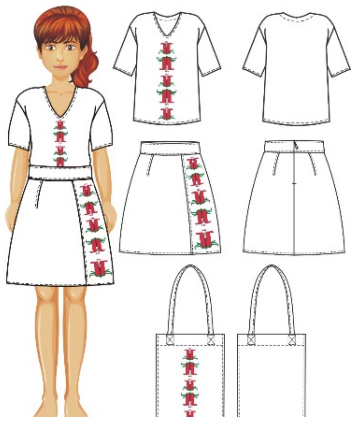

Figure 8. Technical and fashion sketch for Model 5.

Components

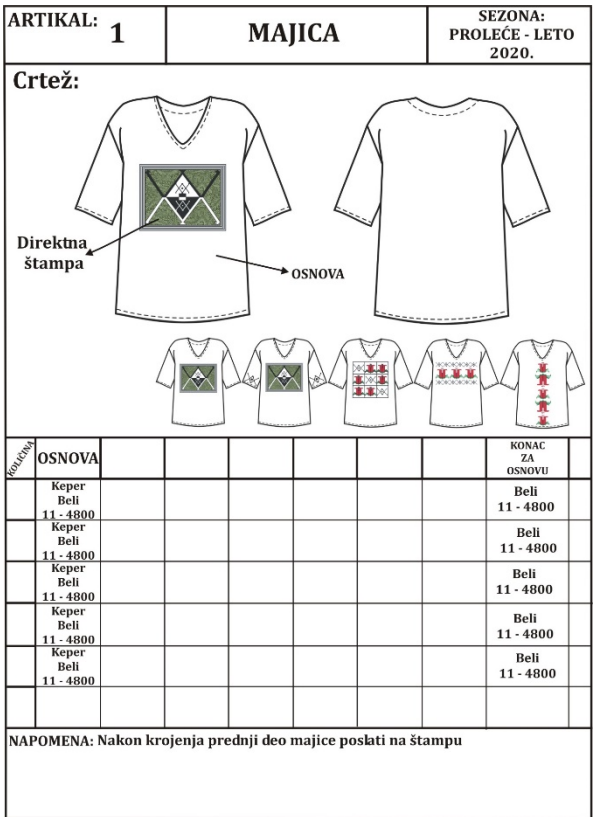

Figure *9. Component for a T-shirt - item 1*

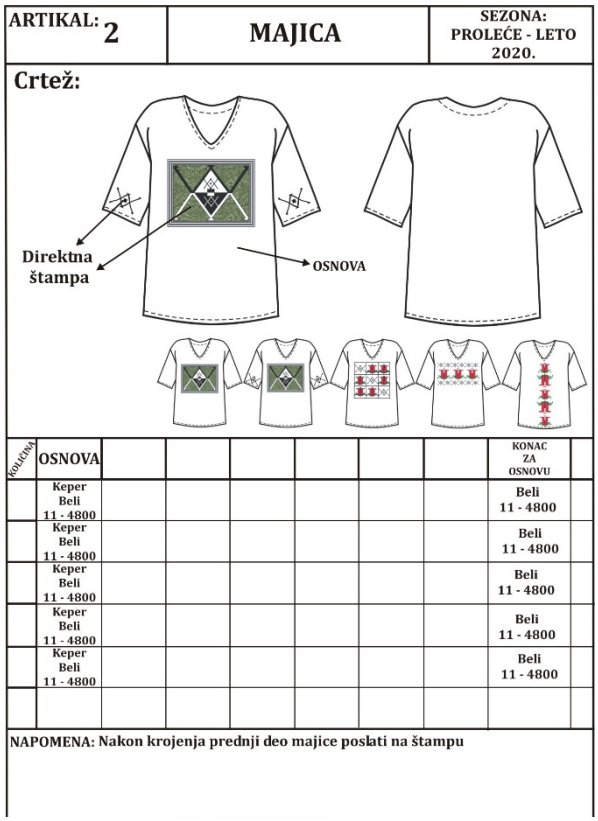

Figure *10. Component for a T-shirt - item 2*

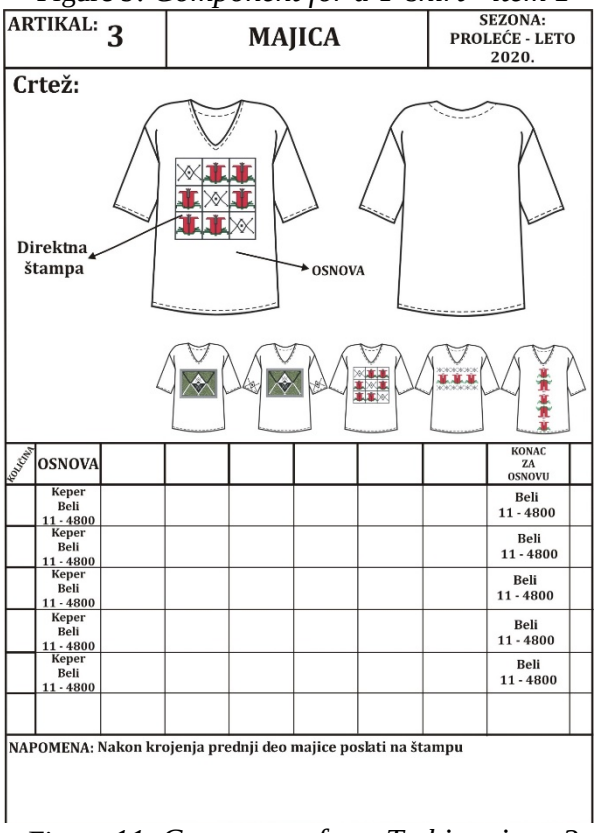

Figure *11. Component for a T-shirt - item 3*

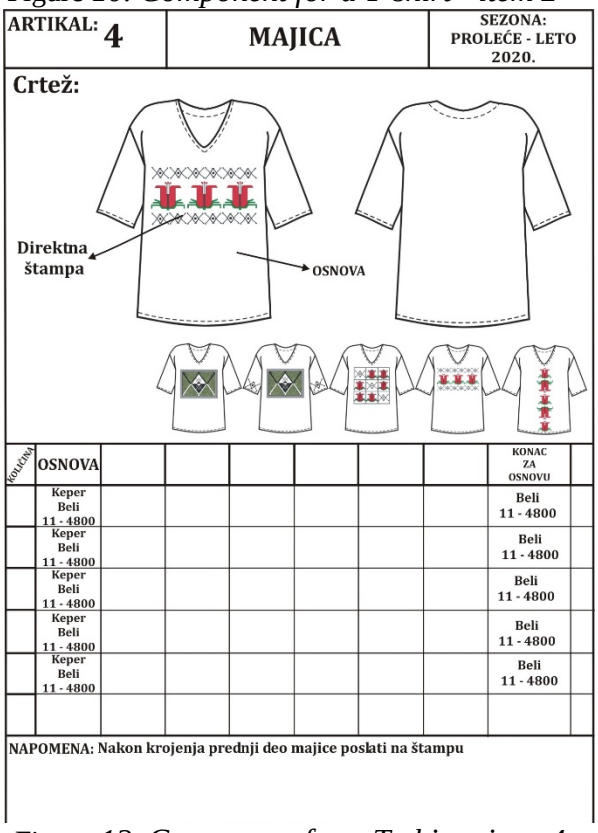

Figure *12. Component for a T-shirt - item 4*

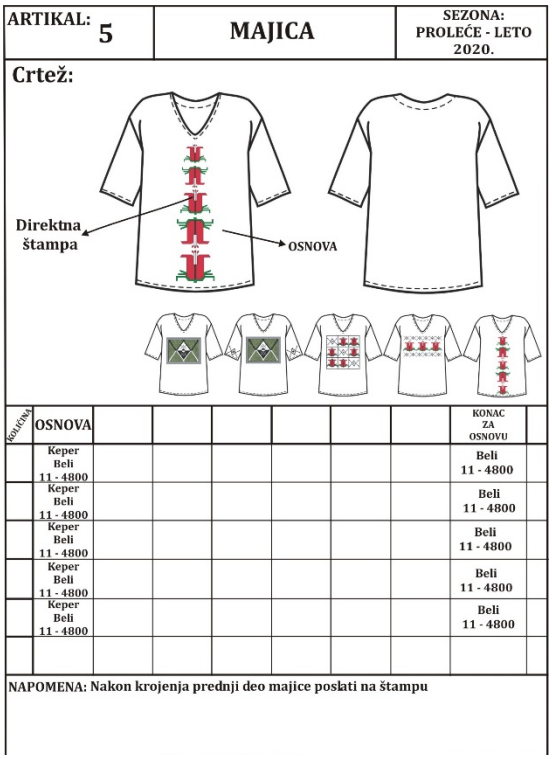

Figure *13. Component for a T-shirt - item 5*

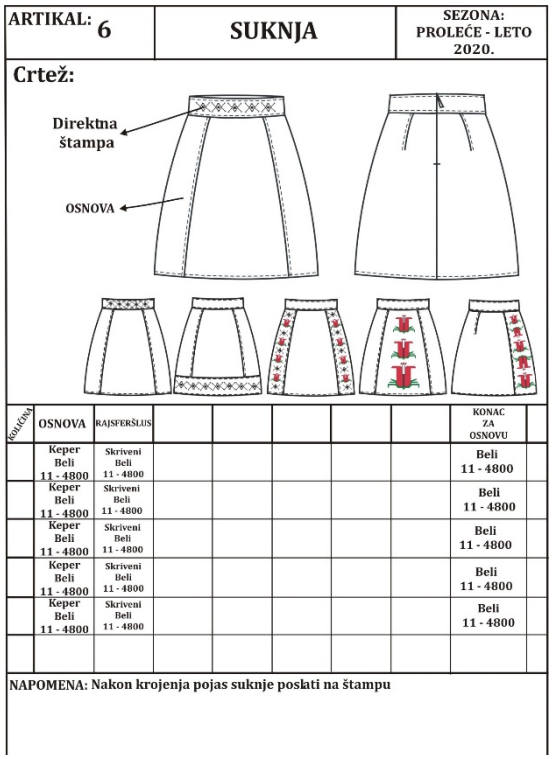

Figure *14. Component for a skirt - item 6*

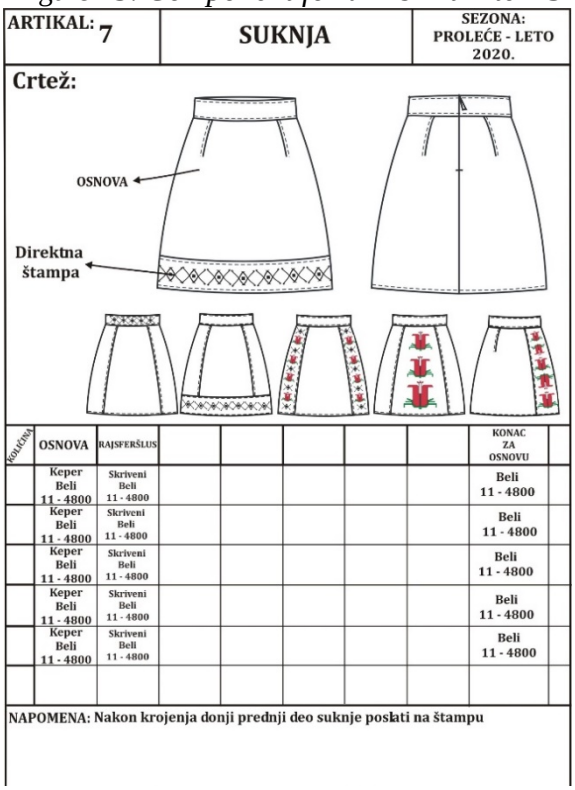

Figure *15. Component for a skirt - item 7*

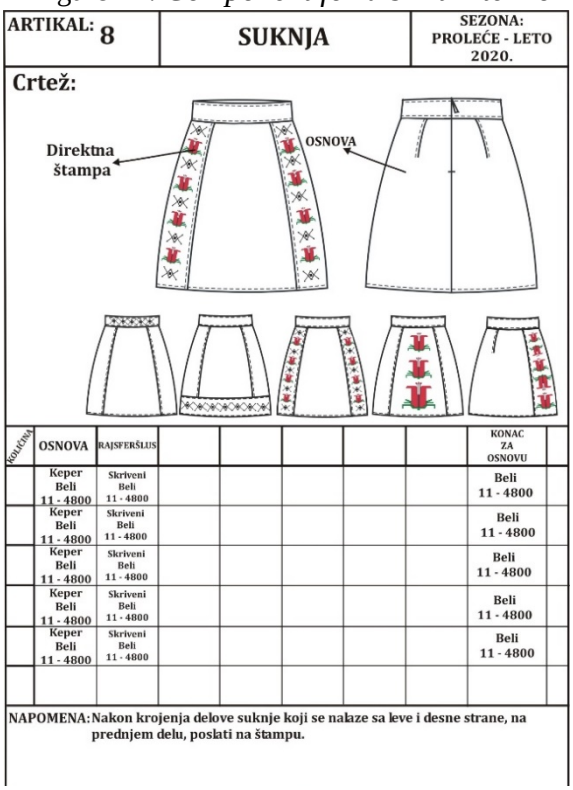

Figure *16. Component for a skirt - item 8*

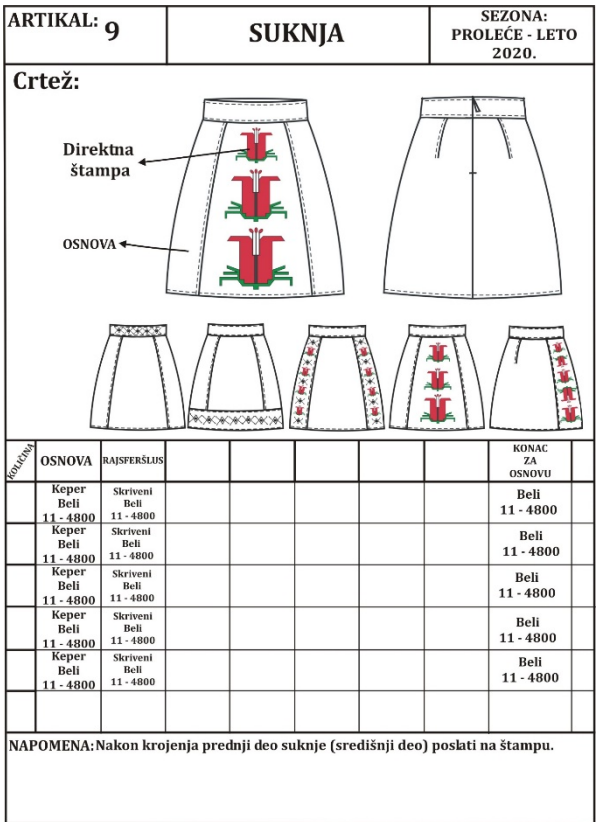

Figure *17. Component for a skirt - item 9*

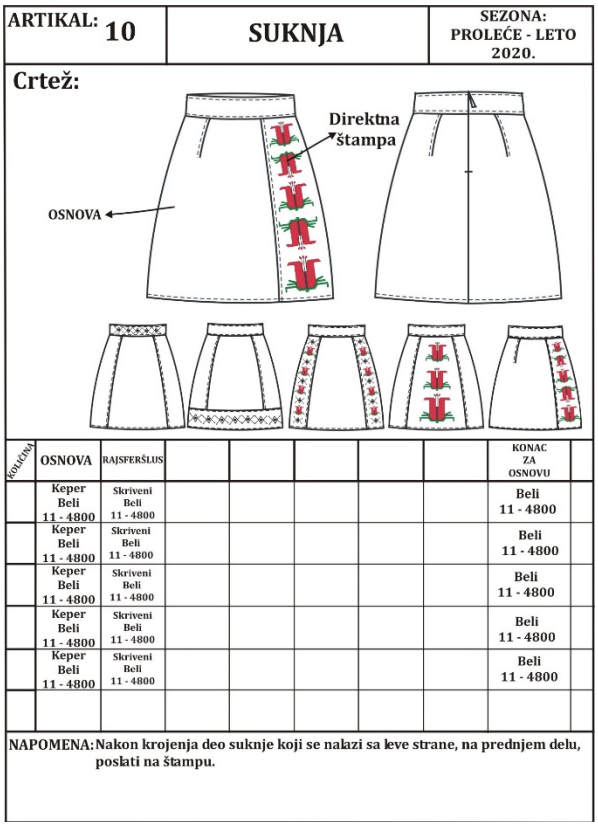

Figure *18. Component for a skirt - item 8*

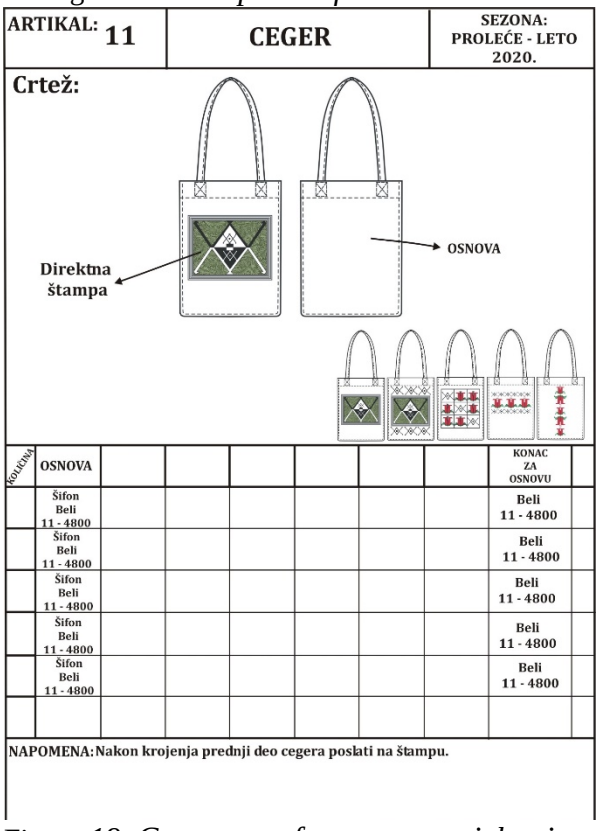

Figure *19. Component for ceger - article - item 7*

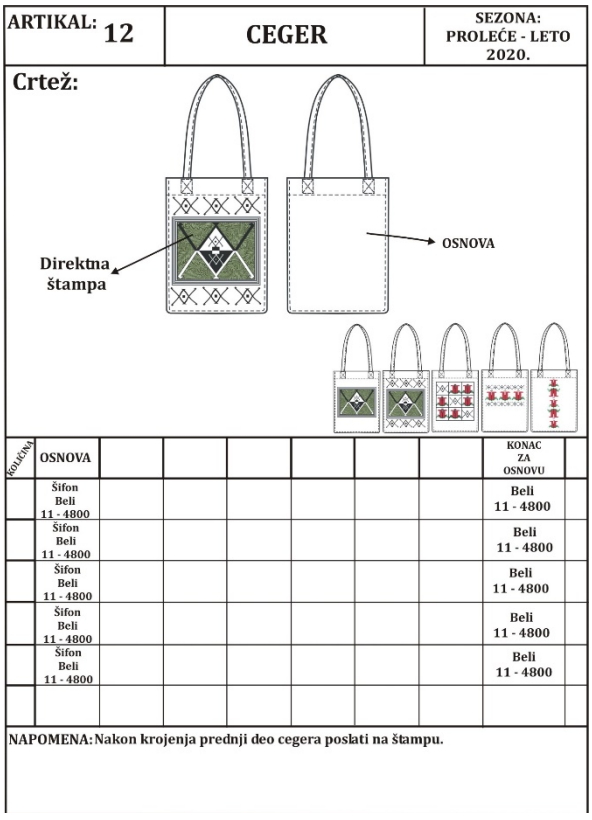

Figure *20. Component for ceger - article - item 8*

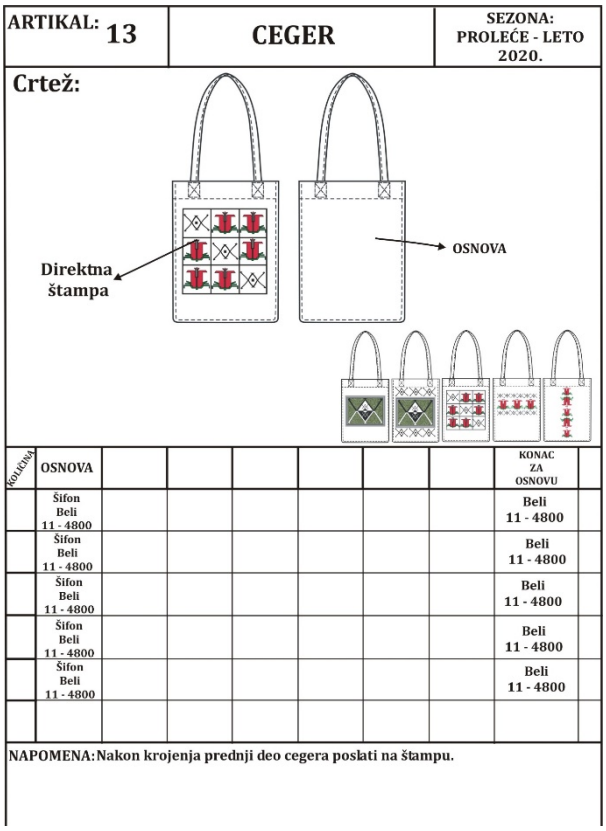

Figure *21. Component for ceger - article - item 7*

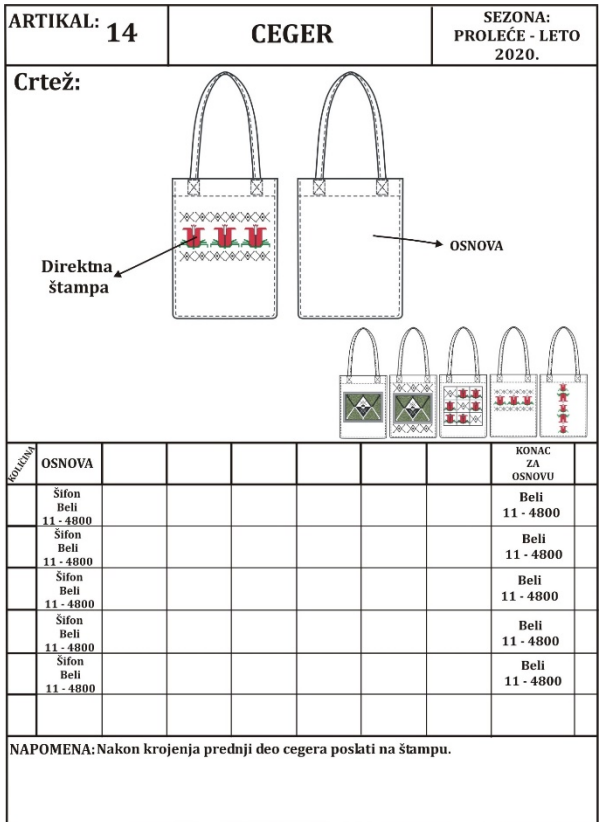

Figure *22. Component for ceger - article - item 8*

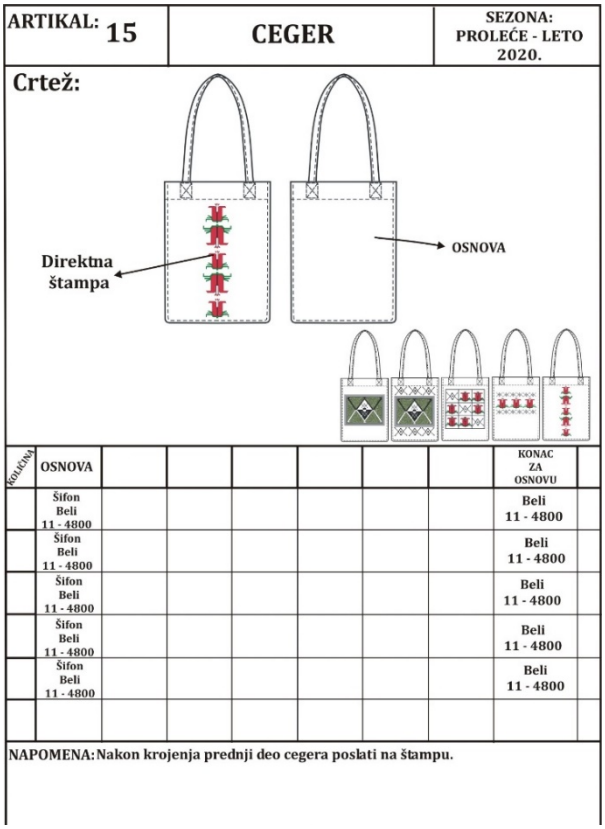

Figure *23. Component for ceger - article - item 8*

CONCLUSION

Increasingly, designers are taking ethno motifs as inspiration for their collections. Modern tailors draw these motives in creating something new. The purpose is to make this new look unique, different and modern. The ethno motif refreshes today's fashion and sets it apart with its unusualness. Ethno culture is being revived in this way, which is also very important to use on the world's catwalks.

Serbia is a country rich in tradition and ethno culture, and it would be a shame to forget and not use it. Reviving tradition by inserting motifs is not just a repetition of national motifs, but an opportunity to express and show imagination and good taste.

REFERENCES

[1]https://social.shorthand.com/alexander_coste/3gblKLldYi/the-art-of-fashion-storytelling
[2]https://highstylife.com/the-best-examples-of-storytelling-through-fashion/
[3]https://storybehindthecloth.com/fashion-storytelling-symbolism/
[4] https://wannabemagazine.com/kako-nastaju-modni-trendovi/
[5]http://digital.bms.rs/ebiblioteka/pageFlip/reader/index.php?type=publications&id=2770&m=2#page/1/mode/2up
[6] Dr. sc. Ružica Čunko, full professor, Quality of textile products, Faculty of Textile Technology, University of Zagreb, Zrinski d.d. Zagreb 2008
[7] Kljajić Živana, Specialist paper, Topic: TQM - Total quality management and the role of employees in achieving total quality, Pan-European University, Banja Luka, 2009.

THREE DIMENSIONAL KNITTED MATERIALS

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ABSTRACT

The three dimensional knitted fabrics, indifferently of the technology used, are characterised by a specific 3D geometry, with reinforcement yarns, characterized of a multiaxial directions. There are different knitting techniques to produce 3-D knitted fabric on an electronic flat-bed knitting machine: incomplete rows, the use of patterns with 3D effects, multilayer structure (sandwich), and fullyfashion. This research targets the optimization of the knitting process based on adjustments of technological parameters: stitch length, fabric take-down, carriage speed, to obtain a tight structure and a better dimensional stability of the knitted fabric.

Key words: weft knits, 3D effects, technical application.

INTRODUCTION

Development of three-dimensional knitted fabrics dates from the 19thcentury, but their engineering applications began in the late 1960s. The threedimensional technical textile products have been used in various fields, such as protective clothing, transportation, geo-textiles, buildings, packing materials, military equipment, medicine and sports, etc. Preforms made of knitted fabrics with complex shapes represent a group of three-dimensional materials with great applicability, mainly due to the advantage of eliminating the process of assembling before composite processing. The elimination of this operation significantly reduces the production time and allows for automation, improving whole process. Also it ensures and improves the overall quality of the finished product, by being able to control the characteristics and properties of textile performs from its design phase.
Development of three-dimensional fabrics was stimulated by the new software design and performance modelling, and new generations of textile machines, capable of producing complex structures.

Characterisation of 3D Knitted Fabrics

The concept of three-dimensional of the textile materials is not related to the intrinsic value of dimensions found on the three axes (x, y, z), but to the relationship between them. This relation characterises the importance of the dimensions in the geometry of the material. The concepts of one, bi and three-dimensional materials are directly related to the construction of a particular fabric. Thus, a one-dimensional material shows negligible dimensions compared to its length, while for a two-dimensional material thickness is considered negligible. The textiles included in one-dimensional materials are fibres and filaments. Textile materials produced by different technologies are considered to be two or three dimensions. A three-dimensional fabric, regardless of the process used, is “a continuous ensemble, with fully integrated fibre, characterised by multiaxial spatial orientation”. Three-dimensional knitted fabrics can be obtained with different technologies and their specific techniques. Thus, as shown in Fig. 1, creating a three-dimensional effect on knits is based on the following techniques: I. Insertion of additional yarns along multiple directions; II. Knitting and linking independent layers in different ways; III. Spatial shaping.

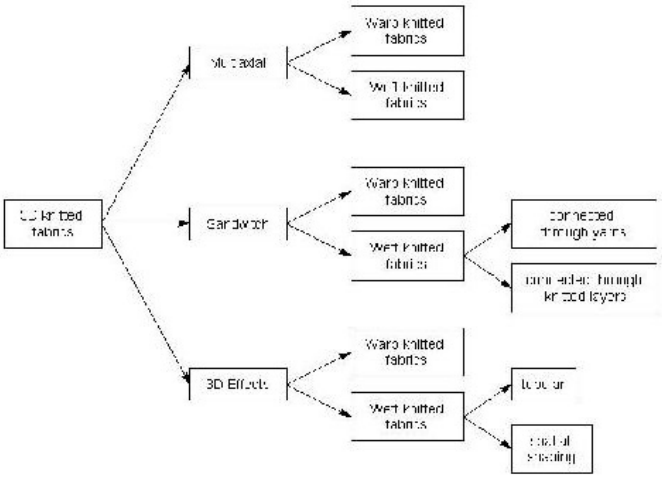

Figure 1. Classification of three-dimensional knitted fabrics

Spatial shaping technique is based on three methods. First method involves using a combination of different structures or different evolution, which presents a different arrangement. Limitations of these fabrics refer
to the lack of homogeneity of all the material properties and reduced diversity of forms. A second method involves the use of dynamic density, the areas with different stitch lengths presenting different geometry. Both methods are restrictive and limiting. For this reason, spatially shaped preforms are produced with the third method. This method is known as incomplete rows knitting technique; this technique implies a process of knitting by holding temporary the stitches on the selected needles which don't participate to the knitting, until those are reintroduced in work-consecutive or simultaneous. The basic structures used are: single jersey structure and rib structure, the most used is single jersey structure.

Principles for Obtaining Three-Dimensional Knitted Fabrics

To produce three-dimensional fabrics, the knitted material can be formed by the technique called spatial fashioning technique (also known as flechage). Three-dimensional structures can be created also by knitting stitches and loops combined with the lateral movement of the needle bed. By increasing or decreasing the number of working needles it is possible to create threedimensional knitted items on intarsia knits. The paper approaches four different methods of producing three-dimensional articles on flat needle knitting machines. The methods of making three-dimensional items on flat knitting machines are: 1. Incomplete knitted rows technique (spatial fashioning); 2. The use of patterns with 3D effects – egg. Knitting tuck stitches patterns combined with racking; 3. Knitting separate fabrics connected in between – sandwich/spacer fabrics; 4. Integral knitting /wholegarment.

Incomplete Rows Knitting Technique

Incomplete rows knitting technique is a technique used by designers of knits to create three-dimensional knitted items or tubular knits.

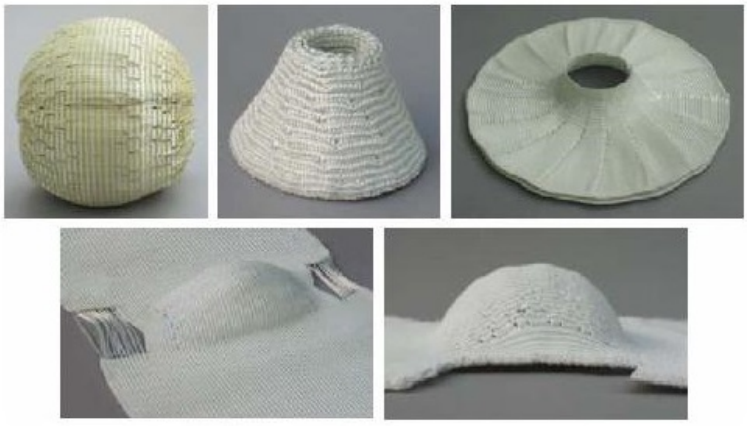

Figure 2. Knitted fabrics with spatial geometry.

Use of Patterned Structures with 3D Effects

Three-dimensional knitted fabrics can also be created using structure patterns with 3D effects. The most known example is the so called egg nest fabric, created by Shima Seiki [1]. The pattern is based on cardigan evolutions combined with successive racking in opposite directions. Fig. 3 exemplifies the aspect of such a fabric. Another example is a jersey fabric with a zone with miss stitches while the carriers produce stitches on the opposite bed. When the missing stitches are discharges, the stitches produced on the opposite bed are transferred to the working bed. The effect in the fabric is illustrated in Fig. 4.

Figure 3. Knitted fabric with 3D effects.

Figure 4. Knitted fabric with wave effect

Sandwich Fabrics

A knitted layered item (sandwich) is a three-dimensional structure, composed from two outer layers knitted together independent, connected by yarns or other knitted layers, definition illustrated in.

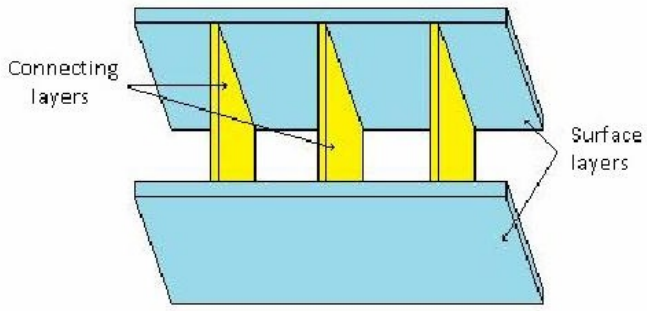

Figure 5. Principle of sandwich fabrics.

Figure 6. Sandwich fabrics.

Sandwich fabrics with connection through knitted layers present a large range of development possibilities:

- increase in the fabric thickness based on the length of the connection layers; modification of the geometry of external fabrics due to the use of connecting layers with different length;
- modification of the cross section geometry due to connecting layers with modified geometry.

Integral Knitting Technique

Integral knitting technique is an improved stage in the development of technologies for machine flat knitting machines. So far it is the most advanced knitting technology through which a garment is completely assembled on a knitting machine without the need of sewing. Seamless knitting technology is a method that cuts off waste and reduces costs. The seamless garment is very comfortable and resistant to wear.

Figure 7. Seamless product – integral knitting

CONCLUSION

Sandwich fabrics are three dimensional structures suitable for the production of 3D knitted preforms used for technical purposes. If high performance yarns are used, these composites provide improved mechanical properties compared to traditional materials. The use of flat knitting machines offers great possibilities of shaping for knitted preforms. The dimensional sandwich fabrics provide for air, heat and moisture transfer.

These characteristics make them The structural design of the sandwich structures is essential for the engineering of fabric properties. Especially the cross section of the fabric is responsible for the channel shape and orientation, thus for the type of resulted cells. The properties of the fabric depend on the cross-section geometry, which is determined by joint point position between layers. recommendable to use for medical purposes, pillows, matrices, shoes, tables for operations.

Technical solutions for fabric diversification are summarised below: Variations of the number of layers; Combinations between the outer fabrics, connecting layers on vertical and horizontal position; Engineering the thickness by modifying the length of connection layers; Developing different structure and opacity independently on each side; Using different materials for the two fabric sides and spacer threads.

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REFERENCES

1. Gelev, S. & Geleva, I. (2013). "Intelligent clothing and computer equipment as a fashion detail". Faculty of Electrical Engineering Radoviš
2. Lam J., Zhou J.Y., Principle and Development on 3D Knitted Fabrics - A Knitter`s Perspective. the First Word Conference on 3D Fabrics and Their Applications, Manchester (2008).
3. Blaga M., Unconventional technologies of knitting. Note de Curs, “Gheorghe Asachi” Technical University of Iaşi (2009).
4. Albo - personal protective equipment.
5. https://albo.biz/product-category/lzo/lzo-odeca/lzo-odeca-odeca-visoke-vidljivosti/
6. Vasilije M. Petrović: (2006), Modern technologies in the clothing industry, II Scientific Conference of the Textile Industry of Western Serbia, Regional Chamber of Commerce of Užice, September 2006, Ivanjica.
7. D. Rogale, D. Ujević, S. Firšt Rogale, M. Hrastinski: Technology of clothing production with a study of work, Universi

3D TECHNOLOGY IN THE TEXTILE INDUSTRY

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APSTRAKT

This paper primarily describes a possible change in human consciousness. It talks about the introduction of new technology in the textile industry. These are modern 3D scanners that can contribute to making a wardrobe tailored to the consumer. In order for this technology to be applied, consumers are the ones who need to accept it.

Keywords: *3D scanner, custom, human, clothes*

INTRODUCTION

In the very beginning, the world had a problem with ergonomically adjusting certain objects (car seats, chairs ...) to fit a person ergonomically. However, with the advent of the 3D scanner, everything has changed. Initially, this type of scanner was used only by the military, mostly to adapt seats and other machines to the soldier. For the first time outside the military, a 3D scanner was used in the film industry for the filming of "Terminator." The film industry had major problems making certain costumes and things and adapting them to humans. At some point, they went to me to replace certain actors with virtual ones. Computer graphics had a large share in this, but like everything, it has its limits. Therefore, they are a way to do a scan of the human body via a 3d scanner and thus make the necessary models for the film.

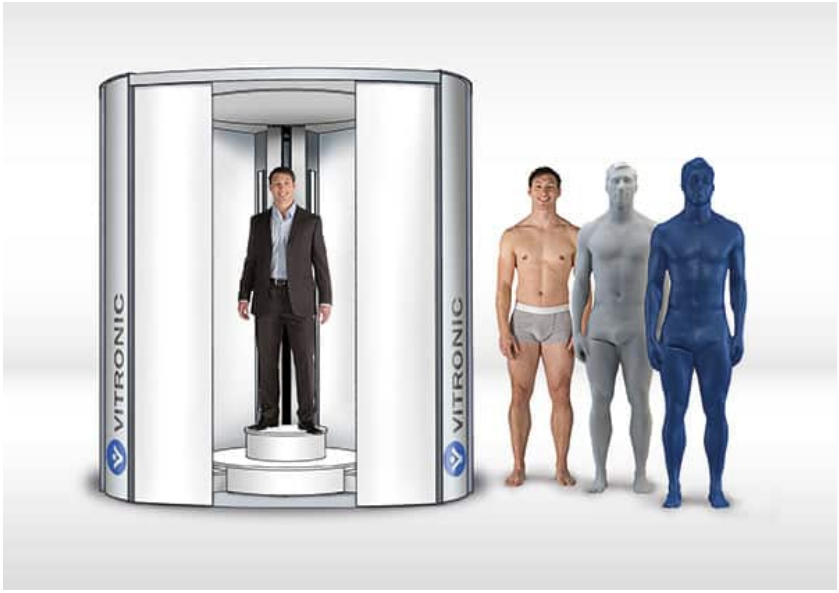

Figure 1: **3D body Scanner review**

3D scanning technology has found application in many industries ranging from medicine, agro industry, architecture, all the way to fashion and textile industry. The possibilities that this technology offers to the textile industry are great, but at the same time very complex.

How 3D technology works

3D body scanning works by keeping the model standing, with sensors and cameras capturing it and creating an image of its body. Body scanning is done all 360 degrees. The scanner makes photos with the help of light lasers and at the same time the system assembles them into one 3D shape. Three-

dimensional body measurement or scanning in the textile industry is used by the manufacturer to ergonomically adjust the clothes that the customer will wear.

3D body measurement is used in various fields in the textile industry. One of the most commonly used fields is custom tailoring. It is known that people are of different sizes and shapes and that there is no standard that can cover all people in the world. Wardrobe manufacturers have a problem with fitting, so they need precise information and measures about the human body. Customizing clothes to the customer actually depends on the amount of available measures that the manufacturer has. The advent of 3D technology has helped both the manufacturer and the customer to more easily obtain size information. 3D technology contains standardization of sizes and on that basis, during the measurement, it classifies people according to the industrial sizes of clothes. This technology is widely used in the textile industry.

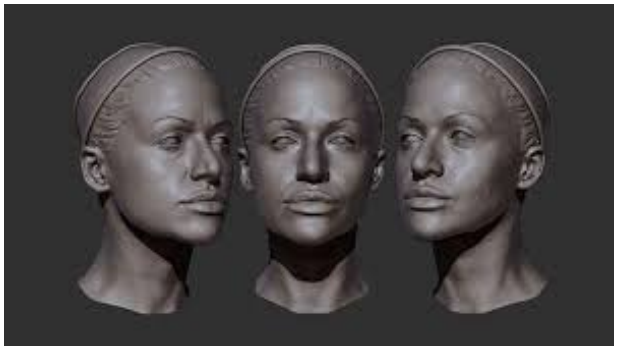

Figure2: 3D scanned head

3D scanning is an accurate, fast and easy process. It contains a scanner and a measurement extraction process. The scanner takes a lot of photos of the individual, while the process measures the customer. In the end, a virtual twin is created that roughly coincides with the consumer's measures.

It is a fast, accurate and easy process. It includes a scanner and measurement extraction software. The scanner extracts hundreds of images of the individual and the software automatically extracts thousands of measurements. The consumers measurements are taken through the scanner digitally and a digital twin is created by the computer on the screen. Based on this image on screen, the computer confines all the measurements that match almost with the consumers actual, individual measurements.
A 3D model is created by digitizing the surface of the individual. The scanner generates number of 3D images of the consumer. Each image is a partial 3D model exhibiting a single view of the consumers structure. To create a 360 degree image of the consumer number of images are taken and all images are aligned in a proper format and one final 3D image is created. Once the image is created, the measurement extraction software installed in the computer takes hundreds of individual measurements from head to toe. This data is then forwarded to the manufacturer who uses his creativeness and creates the garment in a very short time with the exact measurements that matches the consumer.

While body scanning technology has great potential to benefit the fashion industry and aid consumers in obtaining clothing that fits, there are also a number of issues that might be considered disadvantages when compared with traditional physical measurement methods. Some of the disadvantages are related to the type of technology (light, laser, or microwave) and how the image is actually collected.

There are several different 3D scanning technologies, but those used commercially to measure the human body can be divided into 5 groups:
Laser scanning
Projection of white light patterns
Combination modeling and image processing
Digital manual measurement
Technologies based on other active sensors

Different scanning systems work differently, so the following section will briefly describe how they work.

Laser scanning

Laser scanning technology consists of the use of a laser to project one or more thin and sharp stripes onto the human body. At the same time, light sensors acquire a scene and apply simple geometric rules to the surface of the human body is measured. To ensure the non-offensive nature of the light beam, only eye-safe lasers are used. Special optical systems and mirrors are used to create a strip of a single laser beam of light. Laser scanner unit, consisting of the laser, the optical system, and the light sensor move around the human body to digitize the surface. The mode of movement and the number of laser units measured at a given moment depend on the part of the body being measured.

The process of making a laser for measuring the human body is very expensive and can therefore be considered a disadvantage. In addition to the lasers and light sensors themselves, there must be precision electric motors used to move the measuring units. The complete measuring system can be calibrated so that each unit used for measuring in this system can be precisely adjusted.

Another major problem with laser measurement is the measurement of large areas. When measuring small areas such as the arm or leg, it is possible to keep them motionless for a few seconds, but when the whole body is measured, the lasers capture even the slightest movement, and this includes breathing and a certain movement of the muscles. Things like this can create measurement errors.

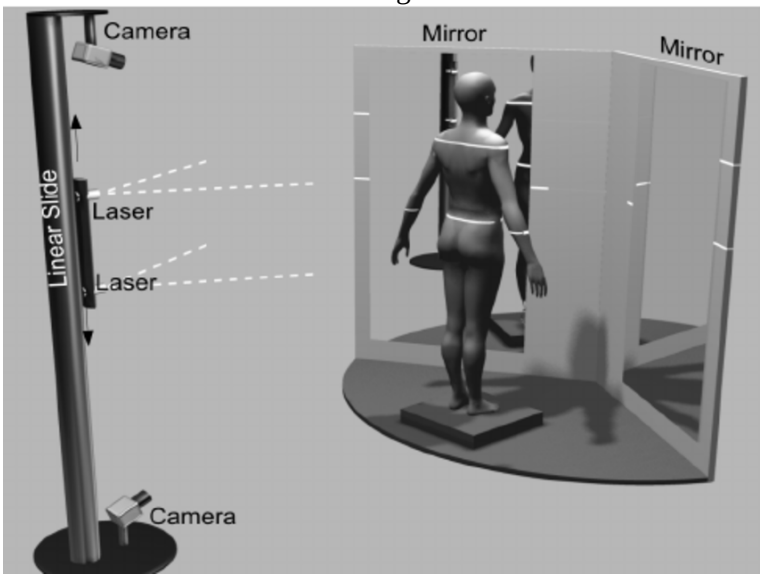

Figure 3: Laser 3D body scanning

Projection of white light patterns

This system uses a white measurement scanner. So he makes hundreds of pictures and through the extraction of measurements he takes pictures and extracts the exact dimensions of the body.

A series of light edges are projected onto the individual. Based on the irregularities created by the rays, the system analyzes and defines the 3D virtual twin of an individual. Projection and image formation are obtained in just a few seconds.

This technology is better than laser technology because the image and measurements of an individual are obtained in just a few seconds. Also with this method it is easier to make a 3D measurement of the whole body.

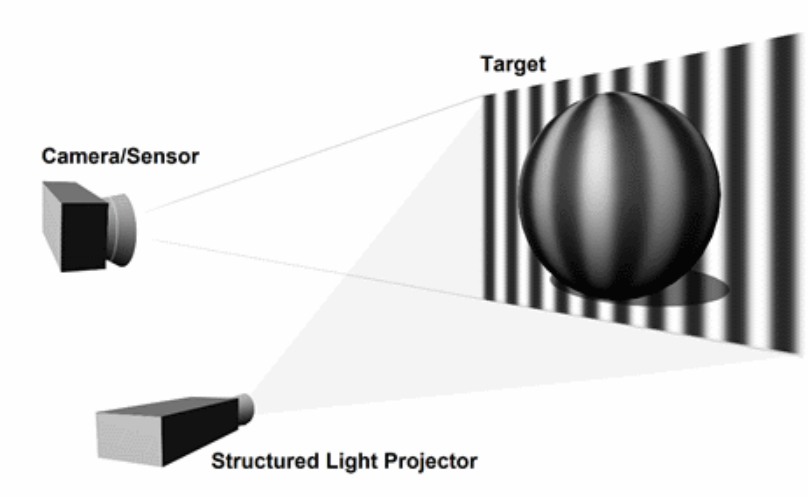

Figure 4: **Projection of white light patterns**

Image processing and modeling

This technology, unlike the previous ones, does not use 3D scanning. It measures the human body's calculations from 2D images. Using the symmetry of the body, the most important quantities are calculated from the silhouette of the body itself. This uses sizes taken out of the body, such as when sewing a custom-made dress.

The 3D model of the computer is generated manually with the help of user-friendly software tools. However, a 3D computer was produced models are extremely photorealistic and completely adequate for applications such as, for example, animation and computer games. Great advantage of combining image processing and modeling techniques are extremely low cost compared to actual 3D measurements.This way of measuring makes three pictures. Two from the front and one from the side, and in that way it calculates the necessary measures of the human body.

Digital tape measurements

As one of the technologies for measuring the human body, the method is used: Electronic tape measurement. This method combines classical measurement of the human body and digital technology.

This measurement process is similar to measuring the human body with a tailor's meter. The system works by measuring certain key elements of the human body (height, waist, sleeve ...). This device electronically measures a person and records the obtained measures in a computer. This method is the same as measuring with a tailor's meter, only it is faster to apply.

Figure 1: *Digital tape measurements*

Other active sensors

In recent years, new technologies based on active sensors have also been used to measure the human body. A very interesting product created by applying cylindrical holographic imaging technology to the human body, allowing a full body scan while the person remains fully clothed. In this case, the computer uses harmless radio waves to obtain accurate measurements of the individual.
Radiation penetrates through clothing, bounces off the human body, and the transceiver collects data on body dimensions. The scanning process works as follows: a man steps into the Intellifit cabin without undressing, "L" the millimeter-wave transceiver oscillates around and over the person to obtain the necessary data. The entire scanning process takes about 10 seconds, and the collected data consists of about 200,000 dots on the surface of the human body. From the measurements, the algorithms determine about 200 points on the human body using an accuracy of about 6 mm.

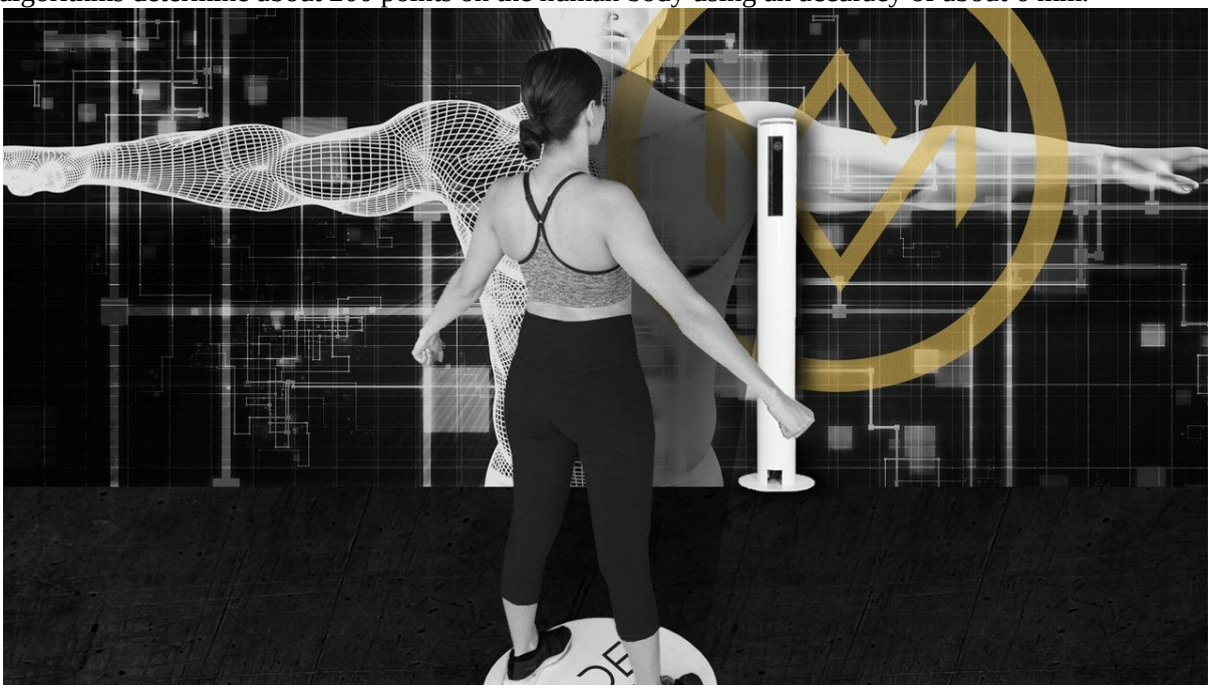

Photo 2: 3D body Scanner Guide

Other technology based on other active sensors is also used to measure the outer surface Human body. In this case, 3D cameras use special CMOS sensors where each pixel measures the distance to painted surface part. These the cameras are based on the principle of phase measurement of flight time (TOF). Light source (in this case through emitting diodes) emits near an intensity-modulated infrared wavefront. Light is reflected by the scene and captured by an optical lens on a dedicated 3D sensor. Depending on the distance of the target, the recorded is recorded delayed in phase compared to the originally emitted light wave. Measurement of phase delay, set distance a scene can be determined. The result of the acquisition is a map of the depth of the scene. The core of such cameras is a CMOS sensor.

3-D Body Scanning in the Apparel Industry Linking Tradition with Technology

The shapes of the human body are different. They depend on age, poly, height, size ... In today's industrial production, the trend is mass production and marketing. Manufacturers do not have enough measurements of customers, so it can happen that the clothes fit nicely on the shoulders, but they are wide at the waist. Currently, about 50% of women in the world have a problem buying clothes in a certain size. The clothes are adjusted to the standard figures.

Three-dimensional technology allows sellers to create custom-made clothes. They attach data about the dimensions of their consumer and thus allow them to create their own cuts and designs.

Once a consumer's personal information is created on a computer, it is then transmitted to the manufacturer online. This speeds up the tailoring process, and by eliminating intermediaries and their costs, it also becomes economical. Acquired measurements can be archived by the seller with the permission of the consumer, so that the consumer can order a whole range of clothes at any time. The data collected by this technology provides the garment industry with real-time information, with garments being produced with attached labels mentioning bust, waist and hip sizes, leading consumers to choose garments with perfect fittings.

Tailored clothes and economical price could not go together. Mostly custom clothes are made only for the rich. This system is being introduced precisely because middle-class people would also have customized clothing at the cost of mass production. 3D scanners help manufacturers to approach their customer more easily and thus allow him to create his own personal design.

Figure 7: Clothes in 3d program and in reality

Precise measurements made during 3D scanning help mass product customization. This process provides the customer with a virtual image of how he or she will look in a particular garment. General information about the consumer like, small waist, narrow shoulders, long hair etc is entered in the computer. The software in the computer develops an image of the consumer based on these descriptions and displays it on the screen. The consumer can make modifications on the displayed virtual image so as to match it with himself. The computer then displays various types of garments on the screen. The consumer chooses different types of clothing and tries them on his virtual image available on the computer screen.

The computer applies this clothing image on the virtual image of the consumer created and displays the picture on the screen. The image is also rotated in 360 degrees so that the consumer can get a perfect idea of the fitting. The computer highlights areas of good and bad fit, and guides the consumer to select the most appropriate apparel.

The future of technology

The main goal of this innovation is to guide the customer to choose clothes that will suit him. 3D scanning is still under development, and awareness of its existence among retailers and manufacturers in the apparel industry is very low. The cost of scanning the body in a 3D model is too expensive, so it

is not affordable for consumers with average salaries to take measurements. Currently, 3D scanners are not the best connected to the network, so consumers cannot choose their design, but have to rely on designers who design for consumers according to the dimensions and shape of the body.
This makes this production even more expensive. Therefore, an affordable and simple scan of the consumer's body is needed. 3D technology in the textile industry can create a real industrial revolution. It can also create drastic changes in how clothes will be bought. The goal of this technology is for manufacturers to attract and retain customers of their product and thus adapt each product to the customer as much as possible. The ultimate success of this technology primarily depends on the customer, whether he will accept or not and whether he is aware of the progress of technology and applications, as well as whether he is interested in buying 3D custom-made clothes.

Figure 3: Custom made dress

CONCLUSION

The notion of new technology implies certain changes in society. The willingness of society to accept or reject change is a matter for them. However, if it is proven that the new technology is in fact a relief for people, then it will be easier for society to accept it. Starting to think about this technology can actually lead to a revolution in the textile industry. Measuring human bodies from different areas helps to create one great global standard for the production of clothing. 3D scanners will enable humanity to take such a big step.

The program that will accompany the scanner and the whole story will actually allow each individual to design a wardrobe for themselves. This may not seem like a cheap investment at the moment, but in time it would pay off in full. Adapting the wardrobe to each individual, in fact, makes each of us special, unique and so we can stand out from the crowd. Technology is what is advancing, but it is also what makes our lives easier.

Whether this scanner will make life easier or not depends on how we look at it. There will always be those who will say that we are not better, but in essence in today's world, what we feel will always be what we feel about a change.

Figure 4: 3D clothes - professional outfits

REFERENCES

[1] https://www.fibre2fashion.com/industry-article/2980/a-glimpse-of-3-d-body-scanning-technology-in-the-apparel-industry
[2]https://www.spiedigitallibrary.org/conference-proceedings-of-spie/6491/64910O/3D-body-scanning-technology-for-fashion-and-apparel-industry/10.1117/12.703785.full?SSO=1
[3] https://www.sciencedirect.com/topics/engineering/body-scanning-technology
[4] https://www.morganstanley.com/ideas/3d-scanning-apparel

STUDENTS PAPERS

HEMPAGE FASHION

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ABSTRACT

Hemp, or industrial hemp, is a variety of the Cannabis sativa plant species that is grown specifically for industrial use. It can be used to make a wide range of products. Along with bamboo, hemp is one of the fastest growing plants on Earth. The origin of hemp is Asia. It was also one of the first plants to be spun into usable fiber 50,000 years ago. It can be refined into a variety of commercial items, including paper, rope, textiles, clothing, biodegradable plastics, paint, insulation, biofuel, food, and animal feed. Thus, hemp has a huge potential to become the main natural resource in the world that can be used in the economy and the environment.

Key words: Hemp, HempAge fashion, HempAge company.

INTRODUCTION

In addition to flax, hemp is one of the oldest plants grown by man for fiber. It was cultivated and used in China 2800 BC. Hemp is an annual herbaceous plant whose fiber contains fiber. The plant is dioecious, which means that there are male and female stems. It grows over 3 m in height and is thicker and coarser than a flax stalk.

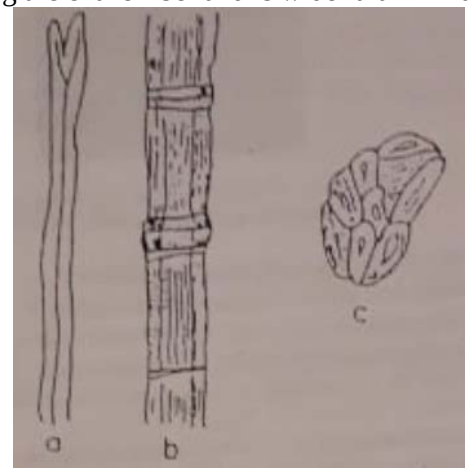
Figure 1: *Hemp stalk*

Today, hemp is grown all over the world for both fiber and seed. The largest producers of hemp are Russia and Italy. Serbia used to be the third largest producer of hemp in the world, but after the Second World War, hemp cultivation was significantly reduced. Today, it is grown a little in Vojvodina, in the Morava basin and in southeastern Serbia.

The process of obtaining hemp fibers consists of different phases: cutting the stems, sorting and drying, wetting the stems, drying, breaking and rubbing, softening the fibers, cutting and scratching the fibers. The growing season depends on the type of hemp and climatic conditions. The stems are plucked or cut, mostly by machine, and then sorted and dried and then tied. The fibers are up to 3m long, so they are cut 600-750mm on cutting machines.

Properties of hemp

If we look at the cross section of hemp fibers, they are pentagonal and hexagonal and oval. In the longitudinal appearance, the top of the fibers is blunt or branched, with thickened transverse stripes and a channel that extends along the entire fiber and is wider than in flax.



Picture 2: *Microscopic appearance of hemp fibers*

The surface of the conical fibers is not as smooth as that of flax. The feel of the fibers depends on the wetting and is not coarser than with flax. The color of the fibers also depends on the wetting and can range from light yellow, yellow-gray to green. The shine of the fibers depends on soaking and scratching, but is always less than with flax.

The length of multicellular fibers is 1-3m, and they are cut to 600-750mm in length. Elemental fibers are 10-30mm long. Hemp fibers are coarser than flax fibers. The fineness of the fibers is 2-6 dtex. Hemp fibers, along with ramie, are among the strongest natural fibers. Their breaking strength is 50-90 cN/tex. In the wet state their strength increases.

Intermittent elongation of fibers under normal conditions 1-6%. fibers have low elasticity and therefore a high tendency to crease. The fiber density is 1.48-1.50 g/cm^3.

Hemp fibers are very hydrophilic. Humidity under normal conditions is 12%. The fibers can absorb up to 30% of moisture (in relation to their weight), without feeling wet. They are very resistant to moisture.

They are resistant to the effects of high temperatures. They burn easily, and when burned they behave like cotton and linen. Hemp fibers have very good resistance to light. However, if they are exposed to light for a long period of time, they first lose their strength and then decompose.

Hemp fibers contain the most cellulose and are therefore more sensitive to the action of acids than alkalis. Pectic substances and lignin in hemp fibers slow down the action of chemical agents. The purity of hemp fibers depends on the degree of scratching. The longer the fibers are combed, the cleaner they will be.

Microorganisms attack the fibers in the wet state. The higher content of lignin makes them more sensitive to the action of microorganisms.

Hemp uses

The fibers can be used to make textiles that are 100% hemp, but they are commonly blended with other fibers, such as flax, cotton or silk, as well as recycled polyester, to make woven fabrics for apparel and furnishings. The inner two fibers of the plant are woodier and typically have industrial applications, such as mulch, animal bedding, and litter. When oxidized (often erroneously referred to as "drying"), hemp oil from the seeds becomes solid and can be used in the manufacture of oil-based paints, in creams as a moisturizing agent, for cooking, and in plastics. Hemp seeds have been used in bird feed mix as well.

Figure 3: *Hemp fiber*

Hemp fiber has been used extensively throughout history, with production climaxing soon after being introduced to the New World. For centuries, items ranging from rope, to fabrics, to industrial materials were made from hemp fiber. Hemp was also commonly used to make sail canvas. Pure hemp has a texture similar to linen. Because of its versatility for use in a variety of products, today hemp is used in a number of consumer goods, including clothing, shoes, accessories, dog collars, and home wares. For clothing, in some instances, hemp is mixed with lyocell.

Figure 4: *Hemp fabric*

Figure 5: *Hemp dress*

HEMPAGE COMPANY

History

The company Colour Connection, originally active as a fair-trade company, merged with the company Hanfzeit in 1999 to form HempAge AG. Ecological textiles, fairly produced and distributed, became the basic message. Above all there was a desire to regain the standing of Hemp material, which had been neglected in the past decades.

A long path began starting with hand woven and plant-dyed Hemp from Thailand, through industrial production in Romania, to the excellent quality they have reached today with Chinese partners.
Commitment is not only limited to the development and marketing of textiles, but also includes research work in the areas of extraction and refinement of fibers. In addition company work together with European committees dedicated to disseminating Hemp into other fields such as insulation material or fiber composites. In 2012, HempAge founded a research organization to establish a concrete remedy for the technological shortage in the processing of Hemp.

Picture 6: *HempAge logo*

Vision

It is HempAge's long-term goal to help the natural resource hemp getting back the reputation it deserves. Regarding a variety of possible fields of application it offers a real alternative to polluting materials. Indeed manufacturing hemp fabric is much more expensive compared with material made of cotton, but its life cycle assessment is much better.

Furthermore, research and development department is working on a cost reduction of hemp fabrics with the result that hopefully everyone can afford hemp clothing in the future. To make goods even now affordable company consciously create timeless collections and forgo cost-intensive promotion as well as sales agents.

Ecology

As with many people and campaign groups the ecological responsibility was recognized by HempAge as one of the big and serious challenges of modern times. In this sense company mounted the Global Organic Textile Standard (GOTS) and consider it as an ecologically sensible guideline in all aspects of production. Because of practical and political motivation there are no GOTS- certified HempAge products by now.

Besides wearing comfort of hemp clothing this admirable plant shows an ecological balance, which is the best in its field. So the plant does not need either pesticides or herbicides. Furthermore it loosens compacted soil with its deep roots and the water consumption of a hemp crop is significantly less compared to cotton.

Therefore HempAge creates not only colorful and up-to-date fashion, but is also committed to increase the efficiency regarding usability of hemp. For that reason a research and development company was founded in 2011.

Shows

HempAge company is a participiant in the INNATEX fair. INNATEX is the only natural textiles fair in the world to feature not only fashion, but also other textile product categories such as accessories, home textiles, fabrics, etc.

Organised under the auspices of the IVN (International Association of the Natural Textile Industry) and providing exhibitors with information about product certification, INNATEX stresses the importance not only of ecological factors in the supply chain, but also social aspects.
Green fashions are a growth market. Consumers are becoming increasingly inquisitive and critical. They want to know from which materials and under what conditions their clothing is made – the right time for a professional trade fair which presents contemporary eco-friendly and socially responsible fashion.

Neonyt is based on a visionary concept tailored to innovative street fashion and casual wear brands, for which ecology and ethics are a matter of course, and which are positioned in the heart of the fashion market.

INNATEX

Figure 7: *INNATEX fair logo*

New collection

In the new autumn/winter 20/21 collection, because of its sustainable and timeless design the blouses are easy to combine with the new denim culottes. The cape is not only a warming companion, as part of HempAge recycles series it supports the sensible using of cut overs and makes a contribution to improve our environment. New pullovers are inspired by well-tried classics like shawl collars or remarkable waffle pattern. The use of stone nut- or nickel free metal buttons enables the vegan feature of chino pants.

Figure 8: *Part of a new collection and color palette*

CONCLUSION

Hemp is an extremely fast-growing crop, producing more fiber yield per acre than any other source. Hemp can produce 250% more fiber than cotton and 600% more fiber than flax using the same amount of land. The amount of land needed for obtaining equal yields of fiber place hemp at an advantage over other fibers.

Hemp leaves the soil in excellent condition for any succeeding crop, especially when weeds may otherwise be troublesome. Where the ground permits, hemp's strong roots descend for three feet or more. The roots anchor and protect the soil from runoff, building and preserving topsoil and subsoil structures similar to those of forests. Moreover, hemp does not exhaust the soil. Hemp plants shed their leaves all through the growing season, adding rich organic matter to the topsoil and helping it retain moisture. Farmers have reported excellent hemp growth on land that had been cultivated steadily for nearly 100 years.

As a fabric, hemp provides all the warmth and softness of a natural textile but with a superior durability seldom found in other materials. Apparel made from hemp incorporates all the beneficial qualities and will likely last longer and withstand harsh conditions. Hemp blended with other fibers easily incorporates the desirable qualities of both textiles. The soft elasticity of cotton or the smooth texture of silk combined with the natural strength of hemp creates a whole new genre of fashion design.

The possibilities for hemp fabrics are immense. It is likely that they will eventually supersede cotton, linen, and polyester in numerous areas. With so many uses and the potential to be produced cheaply, hemp textiles are the wave of the future!

REFERENCES

[1] Tešić Marina, Textile Fibers, Institute for textbooks, Belgrade, 2007.
[2] Đorić B., Radeka M., Textile materials, Institute for textbooks, Belgrade, 2012.
[3] https://hempage.com/, accessed 08.10.2020.
[4] https://www.hemptraders.com/Hemp-Textile-Properties-s/1881.htm, accessed 09.10.2020.
[5] https://en.wikipedia.org/wiki/Hemp, accessed 10.10.2020.

APPLICATION OF TEXTILE MATERIALS IN THE AUTOMOTIVE INDUSTRY

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ABSTRACT

The paper presents the application of textile materials in the automotive idustry, new materials encourage different approaches of manufacturing various types of vehicles. It is estimated that the average family car contains about 12-14 kg of textile. The largest region for car production is Western Europe, which annually spends 1,50.000 of textile for the automotive industry. The second and third largest automotive textile markets are the United States and Japan. Two thirds of textiles are used for interior coverings, seat covers, roofs, door coverings and carpets. The rest goes into other parts of the cars. The world's largest producer of nonwovens estimates that 42% of overall sales are tied to the automotive sector.

Keywords: *Car, Fibers, Technical textiles, Textile materials.*

INTRODUCTION

Mankind has known textile for generations. From a broad perspective, textile seems to have no other purpose than making clothes. In fact, there are uses for textiles that do not apply to clothing, such as technical applications. Industrial textiles are widely used in transportation vehicles and systems, including cars, trains, buses, airplanes and marine vehicles. Around 50 square meters of textile material is spent on the interior trim of the average car, such as: seat backs, side panels, carpets and trunk, trim, tires, filters, belt hoses, airbags.

According to the research, 2 percent of the total weight of the car can be attributed to the textile itself. In addition, visible textile components, removing hidden components such as rubber and composites, hoses and filters; amount to 10-11 kg per vehicle in absolute amount.

Figure 1: *Application of textiles in the car*

TECHNICAL TEXTILE

Technical textile is defined as textile material and is produced primarily because of its technical performance and functional properties instead of its aesthetic or decorative characteristics.

Categories of technical textiles depending on characteristics of the product, functional requirements and final use applications, a very diverse range of technical textile products can be grouped into following categories:

1. Agro textiles (agriculture, horticulture and forestry)
2. Geo textile (construction)
3. Textile clothing (footwear and clothing components)
4. Industrial textile (filtering and cleaning)
5. Medical textile (hygiene)
6. Mobile textile products (cars, boats, railways)
7. Eco textile (environmental protection)
8. Aerospace textile (aerospace textiles)

Figure 2: Car textiles

Figure 3: Honeycomb geo-textiles

SAFETY DEVICES

Thanks to the pressure from the government and legislations, safety devices have become a growing market in the automotive textile. Seat belts and airbags are often used for safety in cars.

Seat belts are used to control the movement of the user during a sudden stop of the vehicle. About 1 kg of textile fiber is used in seat belts per car. Airbags are automatic safety systems that have gained importance in the last decade. The airbag isn't an alternative to the seat belts but an extra layer of safety. The seat belt provides protection regardless of the direction of the collision, while airbags provide protection against head collision.

Initially, the pillows were made for a frontal collision, but now there are many other safety devices such as knee supports, side curtains, and more.

Since frontal collisions are the main cause of accidental deaths, airbags are presented by law as a standard product in vehicles, which has enabled the rapid growth of airbags in the last decade.

NHTSA and HHS report that airbag systems have played an important role in saving thousands of lives since 1985. Just in 2002, due to the airbag system, we observed a 20 percent reduction in deaths due to fatal collisions.

***Figure 4**: Appearance of airbags*

About 1.42 m2 of fabric was needed for the production of airbags in light trucks. This assessment gives the idea that the airbag market is of great importance for the use of technical textiles. Airbags are usually made of coated or uncoated fabrics made of PA 6,6 with lower air permeability.

Generally, the bag is woven from nylon 6, 6 filament yarns, which are required in huge quantities due to the high ratio of strength and weight, favorable elongation, adequate thermal properties and relatively low production costs.

Other required properties are high tear strength, controlled air permeability and the ability to be placed in confined spaces for over ten years without suffering any damage. The airbags are mainly made of the most tension nylons 6, 6 in high-quality yarn fineness from 210, 420 to 840 den.

INTERIOR DESIGN

A major concern for designers has always been the importance of interior design for the potential car sales. However, despite the fact that textiles played a major role in car production for a long time, it was not until the early and mid 1970s that the companies began to understand the role that well designed textile fabrics can play in the design of attractive interiors.

The reasons why the interior design was not the best at the beginning are: the cars were mostly designed by engineers, who although talented were not usually textile technologists, so they relied on suppliers when it came to choosing the correct materials.

Second reason was that up until recently the textile industry had not considered the automotive industry to be the main market for aesthetically designed fabrics. This was due to performance problems due to which existing technologies struggled to produce products that could withstand the critical requirements for abrasive wear and high light resistance. Products that could meet the criteria were usually uninteresting fabrics, probably dyed in pieces, that offered little potential for design.

The special requirements to be met for the interior of the vehicle are as follows:

- Good looks and aesthetics
- Good comfort
- Ease of maintenance

- Retaining good properties even after prolonged usage
- Good durability
- Wear resistance
- Water and stain resistance
- No emission or it is minimal, which can interfere with driving in fog or contamination of the internal atmosphere
- Flame resistance for safety reasons
- Low cost

***Figure 5**: Car interior*

Table 1: Raw materials used for the production of car interiors

Application	Fibre used	Properties
Seat covers	Nylon, polyester, polypropylene, wool	Abrasion and UV resistance, attractive design and texture
Seat belts	Polyester	Tensile strength, extension(unto 25-30%), abrasion and UV resistance
Carpets	Nylon, polyester, polypropylene	Light fastness, mouldability
Airbags	Nylon 6,6 and nylon 4,6	Resistance to high temperature inflation gases, durability to storage over many years, tear strength
Seat fire barriers	Panox (UCF), Aramid(Nomex,Kevlar-DuPont), Inidex(Courtaulds)PBI(Hoechst)	Very high FR including restrictions of heat release, toxicity and opacity of fumes
Door trim	Polypropylene, nylon polyester	
Trunk liners	Polyester blends	

POLYESTER AND POLYPROPYLENE

The merits of polyester and polypropylene are discussed below:

- These two fibers are comparable in tensile strength, even though polyester fibers have much higher strength
- Elongation is higher with polypropylene. This has some advantages in terms of reduced cracking during molding
- The density of polypropylene is much lower than the density of polyester
- Polypropylene is drug-colored and is available in a wide range of colors and shades. Therefore, it is much easier to achieve matching colors and shades by mixing a minimum

number of fiber shades. On the other hand, doped colored polyester is only available in a limited number of colors and shades.

- The melting point of polypropylene (165˚C) is much lower than the melting point of polyester (260˚C). Heating time, temperature and pressing time are therefore more critical for the formation of polypropylene
- Stopping the flame at the rate of combustion is inferior in polypropylene than in polyester. A slower burning compouund must be added to the binder to meet the flammability requirements in polypropylene exports. This also increases the costs.
- Resistance to UV light is inferior in polypropylene compared to polyester. During the production of polypropylene, a UV stabilizer must be added to improve its resistance to UV light.

More than 90% of all car seat fabric in the world is polyester, because only polyester has the required standard of high abrasion, resistance combined with UV and light resistance. The laminate provides a soft touch, prevents creasing or bagging over many years of use and also gives deep attractive sew lines. The scrim backing helps control ability to stretch of knitted fabrics, helps seam strength and acts as a slide aid during sewing and making up. Leather and man-made leather are also foam backed with a scrim slide aid. Exact specification of cover components depends on where in the car the laminate will be used, that is, seat center panel, bolster, or back.

JUTE

Advantages of jute nonwovens:

- Fuel saving:

The decrease of a car weight by 1kg allows decreasing the fuel consumption 0.05 to 0.1litre per 100km. So the replacement of metallic parts by plastic based on natural fibre has an additional advantage of fuel saving.

- Low thermal conductivity:

The natural fibres also show low thermal conductivity and therefore considered a good heat barrier.

- Competitive specific strength:

The mechanical parameters of natural fibres can compete with glass in respect of specific strength.

ENGINE SECTION

Hoses, filters and belts are important parts of a car engine that are reinforced with textile materials. Car filters are usually made of textiles. Few examples of filters are air and oil filters. The function of these filters is to filter the liquid before it enters the engine, because a delicate component of the machine can be destroyed if dust particles enter the engine.

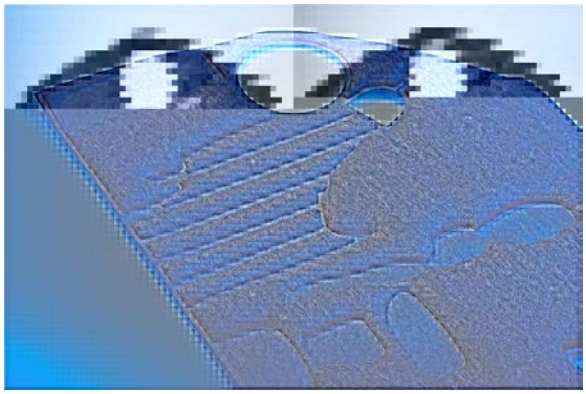
Figure 6: Apearance of polyester oil filter

The average automotive industry has around 12 to 14 different types of filters and vents. Locations include crankcase, fuel tank, fuel filter, engine air intake, transmission, air bag inflating system, as well as front and rear lights and electric motor exhaust vents.

CONCLUSION

Textile materials are used in cars for interior trim and to provide comfort such as: seat covers, carpets, roof and door trims, as well as to strengthen tires and filters. Textiles also can reduce the weight, which can result in saving of fuel. Airbags help in saving lives, but can sometimes be a result of serious injuries. There is currently a search for a new smart airbag that can detect the size of the passenger or whether the seat is empty and react in such way. This "smart" airbag has built-in sensors that assess the weight, size and location of car passengers, and thus the appropriate layout.

In addition, built-in safety devices connected to the seat belt, together with other safety elements, especially for child passengers, are under construction.



Picture 7:Aplication of textiles in car parts

REFERENCES

[1]https://www.fibre2fashion.com/industry-article/80/textiles-applications-in-automotive-industry
[2] https://www.technicaltextile.net/articles/application-of-technical-textiles-6548
[3]https://nileshtharval.wordpress.com/2010/05/19/application-of-textiles-in-car-interiors/
[4]https://technicaltextile.net/articles/upholstery-in-automobiles-3100

CHANEL

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ABSTRACT

Chanel is a French fashion house that focuses on women's high fashion and ready-to-wear clothes, luxury goods and accessories. The company is owned by Alain Wertheimer and Gérard Wertheimer, grandsons of Pierre Wertheimer, who was an early business partner of Coco Chanel. As a fashion designer, Coco Chanel catered to women's taste for elegance in dress, with blouses, suits, trousers, dresses, and jewellery (gemstone and bijouterie) of simple design, that replaced the opulent, over-designed, and constrictive clothes and accessories of 19th-century fashion.

Keywords: Coco Chanel, haute couture, company, history.

INTRODUCTION

Deserving of many new fashion trends, from a tanned complexion to the famous little black dress, Coco Chanel was one of the first designers to create an informal women's wardrobe. She was a significant fashion figure who expertly sensed the mood of consumers after the First World War, introduced the modern woman and gave a stamp to many future trends. The women's clothing she created in the 1920s and 1930s was simple and in keeping with the sober functionalism of the clothes worn during the war. The women embraced her relaxed jersey and tweed suits, a little black dress, jewelry, pants with wide legs and authorially prescribed fashion details. Coco Chanel used a casual approach, designing clothes that were comfortable and easy to wear. Her appearance and lifestyle were the embodiment of modern ideals and provided her with a powerful and lasting status of a fashion icon.

COCO CHANEL – BIOGRAPHY

Gabrielle Chanel, as her real name is, was born on August 19, 1883 in Saumur, a small French town. She was the illegitimate child of a street vendor and a housewife, who had five other children next to her. Despite the fact that the children were born out of wedlock, which was unacceptable at the time, the mother still managed to baptize Gabriel with her father's surname Chasnell. By mistake of the church official, who wrote Chanel in the baptismal certificate instead of Chasnell, Gabriela got the surname by which she will become famous.

Figure 1: *Gabrielle Coco Chanel*

When she was 11, her mother died, and her father did not want to take care of the children. She ended up in an orphanage and was cared for by nuns. It was a sharp, frugal life, which required strict discipline. Despite this tragedy, being placed in an orphanage was perhaps the best thing for Gabriela's future, because she learned tailoring there. It was the tailoring skill, thread and needle that marked her life forever, bringing her to the paths of luxury, power and unforgettability.

Figure 2: *Coco Chanel as a child*

At the age of 16, Gabriela left the orphanage and started working as a seamstress. Shortly afterwards, she moved to Paris where she started working in nightclubs as a singer. She got the nickname Coco, which she will later start using as a name, by singing the song "Qui qu a vu Coco dans le Trocadero", in the cafe "La Rotonda" on Montparnasse. Her great wish, by the way, was to deal with the design and making of hats, which at that time were an indispensable fashion detail of every lady. Thanks to the financial help of a military officer and the rich heir of Etienne Balzan, Coco opened her first boutique in 1909, which made her dream come true. The business started great and Gabriela not only created hats, but after a short time she started offering her customers simple creations that were characterized by practicality and comfort, which actually represented the beginning of her "new fashion".

Figure 3: *Portrait of Coco Chanel wearing one of her hats*

Despite the initial acceptance, her clothes were difficult to break through, but with the help of the industrialist Arthur Capello, who believed in her visions, Coco opened new boutiques in Deauville and Biarritz. As early as 1920, Chanel was a respectable fashion house that employed over 300 workers. In the early 1920s, Coco expanded the scope of her creative work to high fashion design, creating comfortable and elegant costumes, dresses, women's pants, jewelry and perfumes. Relaxed creations, short skirts and comfortable clothing items strongly oppose the hitherto very widespread fashion of strict, conservative lines. Men's style of dress is her frequent inspiration. That is how the famous Chanel costume was created, by which it will be remembered. The elegant set, which is characterized by a knee-length skirt and a short, waisted jacket, traditionally made of wool and decorated with gold-

colored buttons, has become a permanent feature of the style and a favorite item of clothing for women, especially members of the upper classes.

Figure 4: *Coco Chanel completes her new model*

Just before World War II, at the height of fame, creativity and creative energy, Coco Chanel closed her boutiques, with a modest explanation that there is no time for fashion anymore. It was during those war years that a big stain was cast on her life, reputation and career. She actively and publicly maintained contact with the German officer, which led to the suspicion that he was a Nazi spy, their sympathizer and collaborator, as well as an anti-Semite, and all that resulted in her arrest. With the intervention of the English royal family, she was acquitted of the accusations, but she was forced to move to neutral Switzerland.

She returned to France ten years later, already in her seventies, determined to make a boom on the fashion scene again. Her new collection, however, was not warmly welcomed, because the French, despite her earlier merits, were not ready to forgive her for a kind of "betrayal" and potential cooperation with the occupiers. Unshakable, self-conscious and persistent, Coco, as expected, did not give up, but sought success and praise outside the European continent, which was successful: America began to adore Chanel.

The woman who was listed by "Time" among the 100 most influential people of the 20th century died at the age of 88 in the Paris hotel "Ritz", where she lived for 30 years. The hotel was located right across from her first boutique. She died while preparing the farewell collection, which was a huge success.

CHANEL- COMPANY

Chanel revolutionized fashion – both high fashion (haute couture) and everyday fashion (prêt-à-porter) – by replacing structured-silhouettes, based upon the corset and the bodice, with garments that were functional and at the same time flattering to the woman's figure. Chanel used colors traditionally associated with masculinity in Europe, such as grey and navy blue, to denote feminine boldness of character. The complementary accessories were two-tone pump shoes and jewellery, usually a necklace of pearls, and a leather handbag.

History

The Coco Chanel

The House of Chanel (Chanel S.A.) originated in 1909 when Gabrielle Chanel opened a shop at 160 Boulevard Malesherbes, the ground floor of the Parisian flat of the socialite and textile businessman

Étienne Balsan. Because the Balsan flat also was a salon for the French hunting and sporting élite, Chanel had the opportunity to meet some of the most important women of France and Coco Chanel thus could sell to them the hats she designed and made in the course of those salons.
Coco Chanel befriended Arthur "Boy" Capel and he perceived the businesswoman innate to Coco Chanel and, in 1910, financed her first independent millinery shop, Chanel Modes, at 21 rue Cambon in Paris. Two years later, in 1913, the Deauville and Biarritz couture shops of Coco Chanel offered for sale prêt-à-porter sports clothes for women, the practical designs of which allowed the wearer to play sports. In Biarritz Coco Chanel opens her first Couture House and she employs 300 workers there and designs her first Haute Couture collection.

Figure 5: *Coco Chanel in front of her boutique in Deauville, 1913*

Figure 6: *The Couture House in Biarritz*

The First World War (1914–18) affected European fashion through scarcity of materials, and the mobilisation of women. By that time, Gabrielle Chanel purchases the building at 31 rue Cambon, near Hôtel Ritz and sets up her Couture House there. The "31" building housed a boutique, salons and workshops; a layout that remains the same today. Among the clothes for sale were flannel blazers, straight-line skirts of linen, sailor blouses, long sweaters made of jersey fabric, and skirt-and-jacket suits.

In 1915 and in 1917, Harper's Bazaar magazine reported that the garments of La Maison Chanel were "on the list of every buyer" for the clothing factories of Europe. The Chanel dress shop at 31 rue Cambon presented day-wear dress-and-coat ensembles of simple design, and black evening dresses trimmed with lace; and tulle-fabric dresses decorated with jet, a minor gemstone material.

Figure 7: *The Chanel boutique, 31 rue Cambon*

After the First World War, La Maison Chanel, following the fashion trends of the 1920s, produced beaded dresses, made especially popular by the Flapper woman. By 1920, Chanel had designed and presented a woman's suit of clothes – composed either of two garments or of three garments – which allowed a woman to have a modern, feminine appearance, whilst being comfortable and practical to maintain; advocated as the "new uniform for afternoon and evening", it became known as the Chanel Suit.

In 1921, to complement the suit of clothes, Coco Chanel commissioned the perfumer Ernest Beaux to create a perfume for La Maison Chanel. His perfumes included the perfume No.5, named after the number of the sample Chanel liked best. Originally, a bottle of No. 5 de Chanel was a gift to clients of Chanel. The popularity of the perfume prompted La Maison Chanel to offer it for retail sale in 1922.

Figure 8: *First known representation of Chanel N°5 perfume by famous sketch artist of the era, Sem, 1921.*

In 1923, to explain the success of her clothes, Coco Chanel told Harper's Bazaar magazine that design "simplicity is the keynote of all true elegance."

The "Société des Parfums CHANEL" company is created in 1924 to produce and sell perfumes and cosmetics. Ernest Beaux then became the House's first in-house perfume designer. The first collections of powders and lipsticks were created in the same year. Gabrielle Chanel creates Gardénia with Ernest Beaux. A white flower like the camellia, Chanel’s iconic flower with a scent that cannot be extracted, the Gardénia has a more distinctive olfactory signature. Reproduced in 1983, it has formed part of Les Exclusifs collection since 2007.

The success of the No. 5 encouraged Coco Chanel to expand perfume sales beyond France and Europe and to develop other perfumes – for which she required investment capital, business acumen, and access to the North American market. To that end, the businessman Théophile Bader (founder of Galeries Lafayette) introduced the venture capitalist Pierre Wertheimer to Coco Chanel. Their business deal established the Parfums Chanel company, a parfumerie of which Wertheimer owned 70 per cent, Bader owned 20 per cent, and Chanel owned 10 per cent; commercial success of the joint enterprise was assured by the Chanel name, and by the cachet of la "Maison Chanel", which remained the sole business province of Coco Chanel.

Nonetheless, despite the success of the Chanel couture and parfumerie, the personal relations between Coco and her capitalist partner deteriorated, because, Coco said that Pierre Wertheimer was exploiting her talents as a fashion designer and as a businesswoman.

Unsatisfied, the businesswoman Gabrielle Chanel hired the attorney René de Chambrun to renegotiate the 10-per-cent partnership she entered, in 1924, with the Parfums Chanel company; the lawyer-to-lawyer negotiations failed, and the partnership-percentages remained as established in the original business deal among Wertheimer, Badel, and Chanel.

Upon the request of American producer Samuel Goldwyn, Gabrielle Chanel leaves for Hollywood in February 1931 to dress the actresses of the United Artists studio. She then designed costumes for the following films: Tonight or Never (1931) and The Greeks Had a Word for Them (1932).

Figure 9: *Actress Ina Clarie and Coco Chanel in Hollywood, 1931.*

In 1932, Chanel presented an exhibition of jewelry dedicated to the diamond as a fashion accessory, more than 45 jewelry pieces are presented.; it featured the Comet and Fountain necklaces of diamonds, which were of such original design, that Chanel S.A. re-presented them in 1993.

During World War II, Chanel closes its Couture House. Of the five rue Cambon buildings, only the "31" boutique remained open, where perfumes and accessories continued to be sold.

The House of Chanel also presented leather handbags with either gold-colour chains or metal-and-leather chains, which allowed carrying the handbag from the shoulder or in hand. The quilted-leather handbag was presented to the public in February 1955. In-house, the numeric version of the launching date "2.55" for that line of handbags became the internal "appellation" for that model of the quilted-leather handbag.

Chanel and her spring collection received the Fashion Oscar at the 1957 Fashion Awards in Dallas. Later, in 1965, Pierre's son, Jacques Wertheimer, assumed his father's management of the parfumerie.
In 1957, Gabrielle Chanel creates the two-tone pumps with black tips: the beige leather helps elongate the legs, and the black tip makes the foot look smaller. Shoemaker Massaro added the elastic strap around the heel for more comfort, marking a revolution.

Figure 10: *Italian actress Gina Lollobrigida, surrounded by CHANEL models, wearing a suit and two-tone pumps, October 25th 1954*

Alain Wertheimer, son of Jacques Wertheimer, assumed control of Chanel S.A. in 1974. In the U.S., No. 5 de Chanel was not selling well. He used famous people to endorse the perfume – from Marilyn

Monroe to Audrey Tautou. Looking for a designer who could bring the label to new heights, he persuaded Karl Lagerfeld to end his contract with fashion house Chloé.

The post-Coco era

In 1983 Karl Lagerfeld took over as chief designer for Chanel. He brought life back into the Cruise collections, introduced the Métiers d'art and pre-collections, restored Haute Couture to its former glory, and created the Chanel Ready-to-Wear collection as we know it today. Like Chanel, he looked into the past as inspiration for his designs. He incorporated the Chanel fabrics and detailing such as tweed, gold accents, and chains. Lagerfeld kept what was signature for Chanel but also helped bring the brand into today. In later collections Lagerfeld chose to break away from the ladylike look of Chanel and began to experiment with fabrics and styles. During the 1980s, more than 40 Chanel boutiques opened worldwide. In 1986, the House of Chanel struck a deal with watchmakers and in 1987, the first Chanel watch debuted.

In 1994, Chanel had a net profit equivalent to €67 million on the sale of €570 million in ready-to-wear clothes and was the most profitable French fashion house.

The House of Chanel launched its first skin care line, Précision, in 1999. That same year, Chanel launched a travel collection, and under a license contract with Luxottica, introduced a line of sunglasses and eyeglass frames.

In 2018, Chanel announced that it would be moving its global headquarters to London. In December 2018, Chanel announced that it would ban fur and exotic skins from its collections. In February 2019, Lagerfeld died at age 85. Virginie Viard, who had worked with Lagerfeld at the fashion house for over 30 years, was named the new Creative Director.

Logotype

The Chanel logotype comprises two interlocked, opposed letters-C, one faced left, one faced right. The logotype was given to Chanel by the Château de Crémat, Nice, and was not registered as a trademark until the first Chanel shops were established. Beginning in the 1990s, all authentic Chanel handbags were numbered.

Figure 11: *Chanel logotype*

Stores

Worldwide, Chanel S.A. operates around 310 Chanel boutiques; 94 in Asia, 70 in Europe, 10 in the Middle East, 128 in North America, 1 in Central America, 2 in South America, and 6 in Oceania. The shops are located in wealthy communities, usually in department stores like Harrods and Selfridges, high streets, shopping districts, and inside airports.

DESIGNER LEGACY

Chanel removed tight corsets from the fashion scene forever. Crinolines and zippers, everything that prevented a woman from moving freely, were now a thing of the past, a new era began, "baroque buns, long hair, long skirts" disappeared. Her refined taste redefined the fashionable woman in the post-World War I era. The Chanel brand was an association of lightness and comfort. Her own inclination

towards sports life led to the design of comfortable clothes. She designed clothes inspired by nautical, due to frequent yacht trips: a T-shirt on the navy stripes, bell towers, sweaters around the neck and espadrilles - which were traditionally worn by sailors and fishermen.

Jersey fabric

Chanel triumphed by using jersey fabric, a machine knitted material produced for her by the Rodier company. Jersey is considered too "ordinary" to be used in fashion. Her introduction of jersey in high fashion was good for two reasons. First, the war caused a lack of other materials, and second, women wanted simpler and more practical clothes that were comfortable and that they could wear without anyone's help.

Little black dress

After the jersey suit, a little black dress was created and it is marked as Chanel's contribution to the fashion lexicon, and that is the style that is still worn today. Chanel told herself that in 1920, watching the audience at the opera, she would dress all women in black. In 1926, a picture of a Chanel black dress with long sleeves was published in the American edition of Vogue magazine. Vogue predicted that such a simple but elegant design would become a kind of uniform for women of style. The popularity of the little black dress can be partly attributed to the time of its creation. The 1930s were a time of great depression, when women needed affordable fashion. Chanel boasted that she allowed the less wealthy to "walk like millionaires". Chanel started making little black dresses from wool for the day, and satin or velvet for the evening.

Chanel suit

Chanel created a tweed suit for comfort and convenience. It consists of a jacket and skirt sewn with flexible and light wool or tweed material. As well as blouses lined with jersey or silk material. Chanel did not use straps or solid material, as was usual in modern fashion. She designed a neckline around the neck to comfortably release the neck, and added functional pockets designed to hold things. For greater comfort, the skirt had an elastic band around the waist, instead of a belt. More importantly, great attention is paid to details when sewing. The client's measurements were taken in a standing position with arms outstretched at shoulder height. Chanel tested the models, walking them, singing them on the platform as if they were climbing the steps of an imaginary bus, and they were bending as if they were sitting in a low sports car. Chanel wanted to make sure that women could do all these things while wearing her suit, without accidentally exposing the body parts they wanted to cover. She would repair each client again, until their suits were comfortable enough to perform daily activities comfortably and easily.

Figure 12: *Variations on Chanel's little black dress*

Figure 13: *Chanel suit*

Jewelry

Chanel presented a line of jewelry that was a conceptual innovation, because the design and materials simulated precious stones. This was revolutionary at a time when jewelry was strictly categorized into jewelry or costume jewelry. Her inspirations were global, often inspired by the design tradition of the Orient and Egypt. Wealthy clients who did not want to show their valuable jewelry in public could

wear Chanel creations to impress others. In 1933, designer Paul Irib collaborated with Chanel in creating extravagant pieces of jewelry commissioned by the International Union of Diamond Dealers.

Camellia
The camellia was inspired by the literary work of Alexander Dima, The Lady with the Camellias. The flower was associated with the main character, who wore a camellia to signify her freedom. The camellia was identified with the Chanel House, the designer first used it in 1933 as a decorative element on a black and white suit.

Perfume
Chanel did not create Chanel no. 5, the author of the perfume already suggested it to her and asked her to brand his perfume. She chose the fifth pattern he had, and so Chanel no. 5. Not wanting to enter the cosmetics industry, she demanded only 10% profit. When Chanel no. 5 became an international hit, she demanded that her wealth be returned to her.

Chanel bag
In 1929, Chanel presented a bag inspired by military bags. Its thin strap on the shoulder allowed the user's hands to be free. After returning to the world of fashion, Chanel renewed the design in February 1955, creating "2.55"; a bag, named after the date of its creation. The details on the classic bag were redesigned only in the 1980s. Karl Lagerfeld redesigned the bag buckle to fit the crossed C-logo. A leather strap was also introduced, which was intertwined through a metal belt on the shoulder, and the rest of the bag kept its basic shape.

In 2005, the company Chanel released an identical copy of the original bag from 1955 to mark the 50th anniversary of its creation. The design of the bag is inspired by the period of Chanel's life in the orphanage, and her love for the world of sports. The chain he used for the belt was reminiscent of the shuttles worn by the guards of the orphanage where Chanel grew up, while the inner burgundy lining resembled the uniforms worn at the orphanage.

Figure 14: *Chanel diamond camellia*

Figure 15: *Chanel No.5 Perfume*

Figure 16: *Chanel 2.55 bag*

CONCLUSION

The story of Coco Chanel is the story of 20th century fashion. Avant-garde, different, bold, in the 20s, it launched a new fashion style that was in complete contradiction with the previous fashion standards. She considered simplicity the key to true elegance, and accordingly changed women's fashion by removing uncomfortable clothes and freeing a woman's body. She drew inspiration for her new fashion approach from materials and clean lines of men's clothing.

Coco Chanel supervised her collections until her death. After her death, her fashion house continued to operate. The new main creator, Karl Lagerfeld, launched the brand on the world market. The fact that he managed to find many new ways to promote her fashion concepts proves that Coco Chanel's work is timeless.

Coco Chanel was a revolutionary, a fighter for women's rights and the one who changed the course of fashion forever. She made black and white inviolable colors, and pearls and perfume inevitable details that every woman of style must possess.

However, the lessons that Coco left as an eternal trace in the history of women's fashion are much more significant, but also the lessons about independence, elegance and courage are also given to women. She was innovative and different which enabled her to survive for many years after her death.

REFERENCES

[1] Franklin K. (2015). Fashion
[2] https://www.chanel.com/us/about-chanel/the-history/
[3] https://inside.chanel.com/
[4] http://www.mycupoftea.rs/koko-sanel/
[5] https://branka992.wordpress.com/istorijat/
[6] https://en.wikipedia.org/wiki/Chanel

CREATIONS OF THE TRADITIONAL CULTURE OF THE SERBIAN PEOPLE - Serbian folk costume

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ABSTRACT:

Serbian folk costume, once everyday clothing, was the main sign of ethnicity by which Serbs differed from foreigners and powerful conquerors, and occupies a prominent place in the culture and tradition of the Serbian people. Folk imagination and a sense of beauty were an inexhaustible source of ideas for women who created the most beautiful examples of folk costumes. Clothes and footwear were very diverse in the former Serbia. Each end has something of its own, recognizable. And that very diversity, richness of embroidery, jewelry and ornaments made the Serbian folk costume unique. Once upon a time, the pattern on a skirt or apron, the shape of an opanak, the color of a braid cut and other details made it possible to recognize from which region the costume came. The age of the wearer (especially for women), the economic situation, as well as the position in the family and society could be deduced from the costume.

Keywords: *Serbian folk costume, Serbia, culture, tradition, history*

INTRODUCTION

Among the creations of the traditional culture of the Serbian people - in terms of their role in everyday life and the meaning of ethnic identity, as well as in terms of artistic and aesthetic values - one of the most important places belongs to folk costumes. They are known mostly on the basis of preserved clothing items from the 19th and the first decades of the 20th century, which are characterized by a great variety of shapes and decorations. This diversity and richness are present in both women's and men's costumes. Each area was characterized by a special costume. By the way of dressing, it was recognized not only where one came from, but especially in mixed ethnic environments, and to which ethnic or national community he belonged. In their historical development, various folk costumes, as independent creations, with multiple meanings in the life of the people, have been exposed to many influences. Therefore, in addition to the hallmarks of the time in which they were handcrafted and worn, they also contain other clothing elements from past times. The formation of clothing characteristics, in addition to cultural and historical factors, was significantly influenced by the nature of the soil and climatic conditions that provided certain benefits for the development of one or more ways of doing business, whose products formed the basis of life and all accompanying elements.

According to the established division of labor, apart from certain clothing forms and jewelry that were the product of craftsmen, the clothes were almost entirely handmade by women for their household. Their work included work on the cultivation and processing of textile raw materials, dyeing, weaving of linen and woolen fabrics, knitting, tailoring, sewing, embroidering, lace and other applied ornaments. Experience and skills were passed on from older to younger, from generation to generation, and folk costumes became a trademark of Serbian tradition over time.

SERBIAN FOLK COSTUME

Folk costumes, once everyday clothing, are the main sign of ethnicity by which Serbs differed from foreigners and powerful conquerors.

The most common parts of the folk costume among Serbs were: *vest, gunj, fermen, anterija, zubun, dolaktenik, tkanica, čakšire, dolama, dizluk, ječerma, džemadan, mintane, jelek, džube, fistan, šalvare and opanci.*

In the great variety of clothing forms, apart from the special forms of costumes from one rural area to another, there are also distinct differences in clothing between the urban and rural population. Civic clothing in most of the Serbian ethnic space developed under the Turkish-Oriental, and later, as in the cities of the Pannonian region and the Adriatic coast, primarily under European influences. The Balkan-Oriental style civic costume, made of precious fabrics and with rich gold and silver embroidery, was of high-quality handicrafts. Rural costumes, on the contrary, until the beginning of the 20th century, both in materials and design, were mostly the product of domestic and rural handicrafts. They were handcrafted by women, with some parts also made by village craftsmen. Experience and tradition were passed on from generation to generation, from generation to generation.

Figure 1: *Serbian folk costume*

Even the first look at various rural costumes reveals certain peculiarities in combining the functional, artistic and aesthetic features of clothing in a wider area. The same or similar way of doing business, conditioned by the geographical environment, then historical, social and cultural development influenced the creation of certain clothing contents within larger cultural-geographical areas, such as the Dinaric, coastal, Central Balkan and Pannonian. In each area, considering the material for making and decorating the clothes provided by the environment, the cutting shapes and the way of decorating, as well as the clothing tradition and cultural layers, the basic type of costume is characteristic, which occurs in many clothing and decorative variants.

Pieces of clothing that were worn in the 19th century in Serbia today are mostly part of folklore games and performances.

'Opanak', which over time has become one of the symbols of Serbia and a frequent souvenir that tourists bring with them from here, is a traditional footwear used in medieval Serbia.
It is made of leather, without many laces or laces, it lasts a long time, it is pointed in shape, which ends on the fingers. The shape of the pointed end of the opanka means the part of Serbia from which it originates, and the name dates from the Romanian word "apinci".

Figure 2: *Opanak, one of the symbols of Serbia*

According to the role in everyday life and the meaning of ethnic identity, as well as artistic and aesthetic values, folk costumes and all its variants are known mainly on the basis of preserved clothing items from the 19th and early 20th century.

Clothing also showed the difference between urban and rural population, so civic clothing developed under Turkish-Oriental, but also under European influences, while rural costumes were mostly the product of domestic, domestic and rural handicrafts.

COSTUMES BY REGIONS AND GENDERS

Dinaric area

The costumes of the Dinaric mountain area cover the areas of the Serbian Krajina - Kordun, Lika and northern Dalmatia, then a large part of Bosnia and Herzegovina, the continental areas of Montenegro and the southwestern parts of Serbia. In this vast mountainous area, cattle breeding, namely, sheep breeding, was the basic branch of business, to which the whole way of life was adapted. Folk costumes were mostly made of wool. After weaving, woolen home-made fabric was carried in special pillars, *'valjevica'*, which used to be many on smaller rivers. That finished fabric, namely, the cloth, in some areas it was naturally white and brown, and in other areas it was dyed black, navy blue, or red. In addition to many pieces of clothing made of domestic woolen fabrics and cloths, in whose strict form traces of ancient Balkan and Turkish-Oriental clothing culture can be seen, the basis of both women's and men's clothing was a hemp or linen shirt in the form of a tunic with sleeves, richly decorated with woolen embroidery.

In women's clothing, woolen belts and aprons, harmoniously composed motifs and colors, were indispensable parts over a long shirt. Of the cloth gowns, the most widespread was *'zubun', 'sadak'* or *'koret'* - a type of long vest, as well as a dress with sleeves, decorated with embroidery and color choke applications. The girl's head was adorned with a red cap, over which married women laid a scarf pressed in various ways. In men's costumes, narrow *'čakšire'* are characteristic, and in some regions, spacious *'pelengiri'* with wider legs, very old parts of the costume. They were accompanied by vests with flat and folded poles (*gunjić, zubun, ječerma, džemadan*) and shorter coats with sleeves (*gunj, gunja, koporan, aljina*). A woven belt of various colors was obligatory, and a shallow red cap on the head, around which a woolen scarf was wrapped in many parts in winter.

Figure 3: *An example of women's costumes*

The decorations, richly applied on men's and especially women's costumes, are characterized by an extraordinary range of ornaments and colors. The nuanced harmony was greatly contributed by the refined coloring of the materials for fabrics and ornaments achieved by the traditional process of dyeing with vegetable dyes. In the ornamentation of polychrome abundant embroidery and in the applications of choke and other decorations, which cover almost all visible surfaces of the robes, equally in the weaving, geometric and geometrized vegetable motifs predominate. In the realization of the decorative and aesthetic values of woolen Dinaric clothing, a variety of silver jewelry played a significant role, which further enhances its heavy and monumental overall form. One of the most prominent forms were men's "tokes" for the chest, composed of several silver plates or shots, often gilded. They were a symbol of heroism and they were accompanied by weapons of high quality craftsmanship, tucked into the partitions of a wide leather belt.

Women's clothing - in addition to a long shirt - inevitably included a woven woolen belt and pregaču (apron), with beautifully composed motifs and colors. Serbian housewives wore long vests, as well as gowns or dresses - always with long sleeves. The men's costume was characterized by narrow trousers – '*čakšire'* or, in some places, spacious diapers - trousers with wide, slightly shorter legs. The fabric - a woven belt of various colors - was obligatory with the Serbian hosts as well. Each end had its own characteristic cut of the vest, which differed in patterns, embroidery, shape, material and other details. '*Jelek'* (the vest) male and female, was worn around the chest, and was usually made of plush, cloth or leather, with various embroideries and decorations - braids, which also indicated the wealth of the family. From the end of the 19th century, changes took place in the older clothing layer under the influence of urban areas and military clothing. Factory-made fabrics are increasingly being replaced by cloth, long skirts with modern fashion features are being adopted in women's clothing, and military men's hats and trousers are being adopted in men's clothing, which will become a distinctive feature of men's ethnic clothing throughout Serbia in the middle of the 20th century.

Figure 4: *Dinaric Folklore Costume*

Pannonian area

The ethnic clothing of the cultural-geographical Pannonian zone is spread in the northern part of Serbia. In the southern border zone with several areas, among which the central place is occupied by Šumadija and Kolubara, the clothes are permeated with Central Balkan and Dinaric content, and the influences of 19th century Serbian civilian clothes and military uniforms are present. In the rest of the Pannonian noon - Vojvodina, clothes were exposed to Central European influences and styles, especially baroque and until the end of the 19th century to the bourgeois fashion of the European framework. Of importance are the Old Slavic elements, which are best preserved on South Slavic soil in the Pannonian region.

Figure 5: *Pannonian Folklore Costume*

In the predominantly lowland area, with complex cultural permeations, the fertility of the soil, with an abundance of cereals and other fruits, gave economic security to the population, which was reflected in all areas of life and which contributed to the rich variety and playfulness of shapes, decorations and colors. Richly pleated linen clothes that were worn in summer and winter, seem easy and lively. Cloth and fur garments are spacious with tailoring features. Vegetable motifs are common, as well as geometric shapes in colorful, white and gold expressions of woven and embroidered objects, mostly light colors.

In women's clothing, whose earlier layer of clothing was dominated by a long pleated shirt, as early as the beginning of the 19th century, under the influence of European clothing, two-piece linen clothing appeared - a short shirt and skirt cut from more a polo canvas. The short shirt, with occasional fashion transformations in cut details, was sewn for festive occasions from transparent cotton cloth and decorated, especially the sleeves of rich width, with white or gold woven and embroidered ornaments, often with lace inserts. The lower part of the linen clothes is a skirt, large width with light embroidery and white lace decor - worn in several layers. The linen silhouette of the pronounced waist is completed by a woolen apron of geometric ornamentation or an apron made of velvet, satin, silk and appears on the vest. Along with gold or silver embroidery, necklaces, strung with gold or silver coins, glass beads and pearls, suited. To cover the head with braided hair in braids wrapped in a wreath around the head or in the back of the bun, the most widespread were: Old Slavic horses (padded with a towel), scarves reshaped into caps whose calotte was laid on a bun, and the lower end fell down the neck and back, with prominent gold-embroidered ornament. In everyday occasions, a headscarf was worn, and the bride wore lavishly wreaths, hats and crowns.

Figure 6: *Pannonian Folklore Costume*

Men's linen clothing consists of a shirt and *"čakšire"*, with the Pannonian way of dressing - the shirt was always worn over the *"čakšire",* in most environments with a belted woven belt. Both the shirt and the *"čakšire"* are large in width, achieved by stacking more than polo a canvas. As on women's shirts the embellishment was distinct. Among the plant ornaments on men's shirts, the symbol of fertility stood out, the motif of a ripe wheat ear. Summer clothes were complemented by a vest made of tea, silk, brocade, often with silver oval buttons. The conical head is characterized by a conical black hat made of lambskin, a hat made of black desert, in the summer made of straw and in the southern border zone, a widespread military hat.

Central Balkan area

The costumes of the Central Balkan area, except in the southern and central parts of Serbia, with the communication core of the Moravian Valley, spread in the Kosovo-Metohija area and in the areas of

Raška. In this wide area, lowland and hilly landscapes alternate, and the costumes represent a combination of agricultural and livestock elements, with preserved traces of Greek, Old Balkan Byzantine, Serbian medieval and Turkish-Oriental clothing culture.

Anterija is a type of old dress up to the legs, with a deep neckline on the chest and with long, open sleeves in the front. The look of this dress from the waist down is bell-shaped. It was made of various materials - cotton, silk, velvet and brocade - and gold embroidery on silk or velvet was considered lavish. The craftsmen who produced the *anterije* were called *terzije*.

FIgure 7: *Serbian 'Anterija'*

In many variants of the basic clothing type, with a special variety in women's suits, men were characterized by cloth-white and then brown *'haljeci'*. The specific decoration was applications made of black or dark blue woolen cord. In women's costumes, with numerous features of elongated visual form, there is an exceptional richness of shapes, fabrics, embroidery, application of various decorations, as well as the use of red in combination with other colors, as well as gold and silver threads, contributed to the great vividness of this textile. The basic part of the clothes was a shirt, straight cut, with a very rich embroidery on the sleeves, chest and along the lower edge. The embroidery is made of wool, cotton and silk thread on a hemp, linen or cotton base. Another characteristic part of the clothing was a woolen or cotton skirt open the entire length, which differed from one end to the other in length, decoration, color and name.

'Tkanica' was a type of belt that was obtained by weaving, usually from wool, with various ornaments and color details. In Montenegro, the belt was called a *'kanica'*, and men had a strong leather belt under it, intended for carrying weapons.

Elegant Kosovo one-color *'bojče'* with a subtle embroidery, as well as a fine variety of *'futa'*, *'bokča'* and *'zaprega'* from other parts, with striped and finely geometric patterns obtained by weaving, fit very harmoniously with the whiteness of embroidered long linen shirts. All other parts, and especially the *'zubun'*, a long cloth vest with embroidered flowers, represent exceptional achievements of folk

handicraft in terms of artistic expression. To these features should be added the special equipment of the head for women, with the addition of inserts in the hair and covering with ornaments and some cutting features, and in various jewelry - earrings, hairpins, beads, bras, rings, reflections of Serbian medieval costumes and jewelry.

Figure 8: *Central Balkan Folklore costume*

CONCLUSION

Folk costume occupies a prominent place in the culture and tradition of the Serbian people. Throughout history, it was not only a symbol of ethnic identity, but stood out in terms of both artistic and aesthetic values. Each area in Serbia was characterized by a special costume, so the way of dressing could be recognized not only where someone is from, but also to which ethnic group he belongs (especially in mixed environments).

In their historical development, folk costumes have been exposed to numerous influences of different peoples, so, in addition to the features of the time in which they were made, they also had other clothing elements from past times.

Figure 9: *Serbian Performance - Folklore*

Today, costumes from the 19th and early 20th centuries are mostly preserved and are used only for folklore. The costume intended for folklore depends on the performance, areas and music. With its rich history, costumes and traditions, Serbia has something to be proud of.

REFERENCES

[1] Folk culture of Serbs in the XIX and XX century, Guide through the permanent exhibition, Ethnographic Museum, Belgrade 2003
[2]https://starizanatisrbije.rs/srpska-narodna-nosnja/
[3]http://www.panacomp.net/narodne-nosnje-srbije/
[4]https://www.opanak.rs/sumadijska-narodna-nosnja-delovi-narodne-nosnje/
[5]http://www.serbia.com/srpski/o-srbiji/kultura/etno-naslede/34075-2/

APPLICATION OF ORIGAMI TEHNIQUE IN FASHION DESIGN

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ABSTRACT

Fashion represents what is currently popular, ie. fashion refers to styles, clothes, fashion details and more. The word itself comes from the Latin language and means way, rule, rhythm. Fashion and the way of dressing is constantly changing over time, depending on the wishes of consumers and what is currently popular. When we talk about clothes, the clothing industry is very expanded and developed today. Textile is significant and permeated through all spheres of our lives. In order for those who manipulate textiles and clothes, ie fashion designers and engineers, to succeed in their business and break into the market, it is necessary for their ideas to be innovative, creative and original. Inspiration can be found in anything around us. Many designers have found it in the origami technique. Origami is paper bending technique which give various shapes and forms of dominant and interesting appearance. This technique has been very successfully applied to textile materials and products, ie clothing.

Keywords: fashion, textile, fashion designers, inspiration, origami

INTRODUCTION

Fashion is a term that denotes popular styles in various spheres of human activities and thinking. Styles can change quickly, and today the term fashion refers to the latest version of a style. Fashion changes in various fields can also lead to a change in culture as a whole.

Fashion is a popular style or practice, especially in the areas of clothing, footwear, fashion details, cosmetics, or the body. Fashion is a special and often constant trend in the style in which a person dresses. It consists of prevalent behavioral styles and the latest creations of textile designers. Since the more technical term costume is regularly associated with the term "fashion", the use of that term has been suppressed until used in special circumstances such as masquerade or masquerade clothing, while "fashion" generally refers to clothing. Although fashion aspects can be female or male, some trends are androgenic.

Clothes as a product

Clothing items can be viewed in several ways. Clothes usually represent works of art for designers, but we must not forget that every garment is actually a product intended for consumers. Designers need to take into account trends, styles and in general what is popular and what consumers currently want. Designers have to create new products that will attract the attention of, something totally different from what the market is offering at the moment. Creativity is a tool for success. Creativity sells the product and with the help of original ideas we fight the competition. That is why it is necessary to find inspiration that leads us to innovative ideas. Many designers have found it in the origami technique and applied it quite successfully to clothes, creating totally original and interesting creations, ie products.

Origami tehnique

Origami is the art of paper folding, which is often associated with Japanese culture. In modern usage, the word "origami" is used as an inclusive term for all folding practices, regardless of their culture of origin. The goal is to transform a flat square sheet of paper into a finished sculpture through folding and sculpting techniques. Modern origami practitioners generally discourage the use of cuts, glue, or markings on the paper. Origami folders often use the Japanese word kirigami to refer to designs which use cuts.

Figure 1. *The best-known origami model-Paper crane*

History of origami

There is no precise data on when origami originated. It is most often associated with the discovery of paper in China around the 2nd century AD. e. Although it most likely originated there, origami experienced a real boom in Japan, where it is treated as a national art. In addition to Japan, this skill has appeared in other parts of the world, for example, in Spain, where it is known as Papyroflexion.
Already in the 8th century, origami became an integral part of various ceremonies in Japan. The samurai exchanged gifts that were decorated with "costumes" - folded strips of paper. During Shinto wedding ceremonies, origami butterflies were used to symbolize the newlyweds.

Origami paper

Almost any laminar (flat) material can be used for folding; the only requirement is that it should hold a crease.

Origami paper, often referred to as "kami" (Japanese for paper), is sold in prepackaged squares of various sizes ranging from 2.5 cm (1 in) to 25 cm (10 in) or more. It is commonly colored on one side and white on the other; however, dual coloured and patterned versions exist and can be used effectively for color-changed models. Origami paper weighs slightly less than copy paper, making it suitable for a wider range of models.

Washi (**和紙**) is the traditional origami paper used in Japan. Washi is generally tougher than ordinary paper made from wood pulp, and is used in many traditional arts. Washi is commonly made using fibres from the bark of the gampi tree, the mitsumata shrub (Edgeworthia papyrifera), or the paper mulberry but can also be made using bamboo, hemp, rice, and wheat.

Artisan papers such as unryu, lokta, hanji[citation needed], gampi, kozo, saa, and abaca have long fibers and are often extremely strong. As these papers are floppy to start with, they are often backcoated or resized with methylcellulose or wheat paste before folding. Also, these papers are extremely thin and compressible, allowing for thin, narrowed limbs as in the case of insect models.
Paper money from various countries is also popular to create origami with; this is known variously as Dollar Origami, Orikane, and Money Origami.

Figure 2: *Dollar origami*

ORIGAMI TYPES

Action origami

In addition to the more common still-life origami, there are also moving object designs; origami can move in clever ways. Action origami includes origami that flies, requires inflation to complete, or, when complete, uses the kinetic energy of a person's hands, applied at a certain region on the model, to move another flap or limb. Some argue that, strictly speaking, only the latter is really "recognized" as action origami. Action origami, first appearing with the traditional Japanese flapping bird, is quite common. One example is Robert Lang's instrumentalists; when the figures' heads are pulled away from their bodies, their hands will move, resembling the playing of music.

Modular origami

Modular origami consists of putting a number of identical pieces together to form a complete model. Often the individual pieces are simple, but the final assembly may be more difficult. Many modular origami models are decorative folding balls such as kusudama, which differ from classical origami in that the pieces may be held together using thread or glue.

Chinese paper folding, a cousin of origami, includes a similar style called golden venture folding where large numbers of pieces are put together to create elaborate models. This style is most commonly known as "3D origami". However, that name did not appear until Joie Staff published a series of books titled 3D Origami, More 3D Origami, and More and More 3D Origami. This style originated from some Chinese refugees while they were detained in America and is also called Golden Venture folding from the ship they came on.

Figure 3: *A stellated icosahedron made from custom papers*

Wet-folding

Wet-folding is an origami technique for producing models with gentle curves rather than geometric straight folds and flat surfaces. The paper is dampened so it can be moulded easily, the final model keeps its shape when it dries. It can be used, for instance, to produce very natural looking animal models. Size, an adhesive that is crisp and hard when dry, but dissolves in water when wet and becoming soft and flexible, is often applied to the paper either at the pulp stage while the paper is being formed, or on the surface of a ready sheet of paper. The latter method is called external sizing and most commonly uses Methylcellulose, or MC, paste, or various plant starches.

Figure 4: *Paper figure of a horse obtained by the technique of wet folding*

Figure 5: *Paper butterfly figure obtained by wet folding technique*

Figure 6: *Paper lion figure obtained by wet folding technique*

Pureland origami

Pureland origami adds the restrictions that only simple mountain/valley folds may be used, and all folds must have straightforward locations. It was developed by John Smith in the 1970s to help inexperienced folders or those with limited motor skills. Some designers also like the challenge of creating within the very strict constraints.

Origami tessellations

Origami tessellation is a branch that has grown in popularity after 2000. A tessellation is a collection of figures filling a plane with no gaps or overlaps. In origami tessellations, pleats are used to connect molecules such as twist folds together in a repeating fashion.

Kirigami

Kirigami is a Japanese term for paper cutting. Cutting was often used in traditional Japanese origami, but modern innovations in technique have made the use of cuts unnecessary. Most origami designers no longer consider models with cuts to be origami, instead using the term Kirigami to describe them. This change in attitude occurred during the 1960s and 70s, so early origami books often use cuts, but for the most part they have disappeared from the modern origami repertoire; most modern books don't even mention cutting.

Figure 7: *Paper castle made with kirigami*

Strip folding

Strip folding is a combination of paper folding and paper weaving. A common example of strip folding is called the Lucky Star, also called Chinese lucky star, dream star, wishing star, or simply origami star. Another common fold is the Moravian Star which is made by strip folding in 3-dimensional design to include 16 spikes.

ORIGAMI AND FASHION DESIGN

Fabrics for origami

In order for the fabric to be used for the origami technique, it is usually necessary to prepare it for this process. This means that the fabric will be coarser and stiffer. This is achieved by using a fabric stiffener which, after application, makes the fabric stiffer and perfect for shaping.

In Selecting a fabric: 100% cotton broadcloth is the fabric of choice. It will always produce a crisp crease when stiffened. Fabrics with synthetic blends do not absorb a stiffening agent very well. Taffeta and silk will lose their iridescence but retain a unique beauty of their own. Metallic threads also perform well if they are woven into a natural fiber. This stiffener can be used to stiffen various fabrics: cotton eyelet, pin striped worsted wool, English lawn, metallic madras, taffeta, batik, kimono silk, cotton upholstery and brocade.

A twill or heavy woven fabric will make a larger item than a thin one. Coarse weaves make structurally stronger pieces. Fine weaves suit smaller pieces and produce crisp finishes. The size of print should reflect the proportions of the finished piece.

After applying stiffener on fabric, we should wait for the fabric to dry. Then we iron fabric and fold the fabric to make the finished piece.

Figure 8: *Fabric stiffener*

Application of origami on clothes

When people heard of origami fashion, they may think that the garment is made by folding without any cutting or stitching. However, origami fashion also refers to the fashion inspired by origami ideas such as quilting and pleating.

Figure 9: Origami hat- Lock Man Yee

Figure 10: Bag-Digest Design Workshop

Contemporary fashion designers have been always inspired by origami ideas and its sculptural forms; they realize that Origami art is a valuable opportunity to explore very futuristic interesting ideas in fashion design.

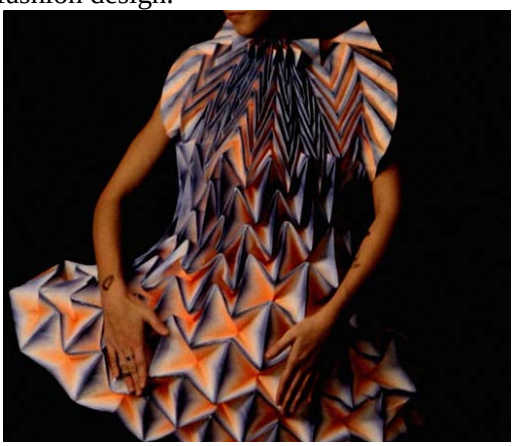

Figure 11: *Dress- designed by Jule Weibel*

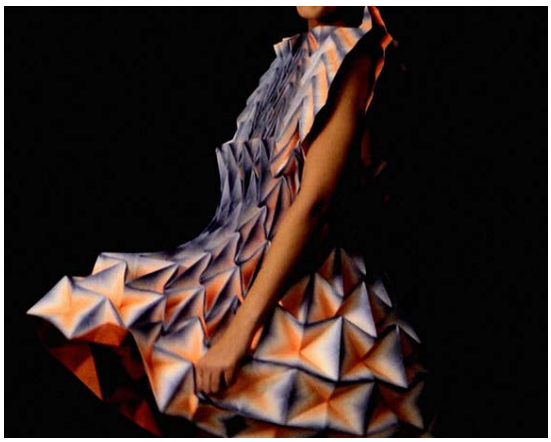

Figure 12: *Dress- designed by Jule Weibel*

Figure 13: *Dress- designed by Lucia Benitez*

Figure 14: *Shirt- designed by Jung Wong*

The origami art is the main idea to implement the 3D Geometric Dresses, so this research is focused on how we can benefit from the incorporation of origami art as three-dimensional sculptural forms into the garments designs, and how we can use origami techniques in Computer software to create Futuristic Geometric fashion collections, while still maintaining the functional and beauty purpose of the designs. The research aims to activate the role of the art of origami techniques in the field of fashion design, and identify the most important technical characteristics used in this creative art in fashion field, different shapes including square, triangle, hexagon, semi-circle and waves can be with different cutting and folding techniques to create very intricate designs. We can use the aspects of origami techniques such as folding, creasing and building of the structures out of rectangles and patterns to create an eye-catching three dimensional appearance.

PROCESS OF MAKING CLOTHES USING ORIGAMIC TECHNIQUE

The following pictures will show the process of making some pieces of clothing or clothing items in their entirety using the origami technique. We can see how demanding and complicated this process is, but the results it brings are worth the effort.

It is necessary to change the cut of the garment or piece and adjust it to the shape we want to achieve. This requires great knowledge in the field of geometry, mathematics and of course the construction and modeling of clothes.

Application of origami technique in making sleeves

***FIgure 15**:Origami-sleeve-designed by Jenneth Alegre*

***Figure 16:** Origami-sleeve-designed by Jenneth Alegre*

***FIgure 17**: Origami-sleeve-designed by Jenneth Alegre*

Figure 18: Origami-sleeve-designed by Jenneth Alegre

***FIgure 19**: Origami-sleeve-designed by Jenneth Alegre*

Figure 20: Origami dress- designed by Jenneth Alegre

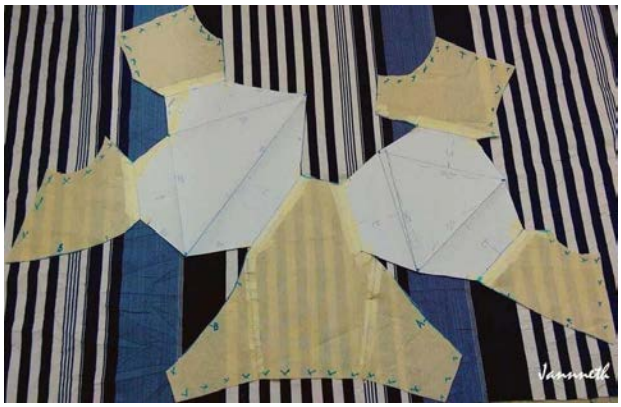

Figure 21: The upper part of the dress-designed by Jenneth Alegre

Figure 22: The upper part of the dress-designed by Jenneth Alegre

Figure 23: The upper part of the dress-designed by Jenneth Alegre

Figure 24: The upper part of the dress-designed by Jenneth Alegre

CONCLUSION

Fashion is very widespread and designers are very careful about what is currently popular as well as what could become popular as a style, and thus can create something new that will become popular. That is why creativity is a very important feature for the fashion, design and clothing industry. It achieves success. Designers around the world today find inspiration all around them, and one part of them found it in origami technique. By applying this technique, phenomenal creations of striking shapes and designs have been created.

REFERENCES

[1]https://www.researchgate.net/publication/281202554_ORIGAMI_FASHION_THE_MIX_BETWEEN_FUTURISTIC_GEOMETRIC_DRESSES_AND_COMPLEX_ORIGAMI_COUTURE
[2] http://www.make-origami.com/FabricOrigami/process.php
[3] https://en.wikipedia.org/wiki/Origami
[4] https://sh.wikipedia.org/wiki/Origami

MICROPLASTIC AND THE TEXTILE INDUSTRY

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APSTRAKT

Planet earth is poisoned without return. About 20% of pollution is the fault of the textile industry. The problem is that this industry pollutes without returning. The textile industry should actually be one of the safest industries in the world. With the advent of synthetic materials, designers and business owners began to use them en masse for the production of clothing. There is a lot of talk at the moment about the problems caused by synthetic materials. They pose a great threat to the world's water systems, and thus to both animals and humans. In recent research, microplastics from which synthetic fibers are produced have also been found in the human body.

Keywords*:* Poliester, Microplastic, pollution

INTRODUCTION

Plastic is a word that originally meant “pliable and easily shaped.” Only recently in the world have plastics started to be classified into a category of words called "Polymer". Polymer means "Of many parts". Let's assume that in nature there is a polymer called Cellulose and it is an integral part of plants. Thus, plastic also consists of different polymers.

Over time, people have learned to make plastics sometimes from natural polymers such as cellulose, but mostly from carbon obtained from oil and other fossil fuels. Synthetic polymers are much longer than natural polymers and this makes them much more flexible, stronger and more flexible. These polymers actually allow us to shape the plastic as we need it. The very development of plastics has changed the world, and that is a lot compared to the past.

At the very beginning of its development, plastic found application in everyday life, for the production of the most classic objects necessary for life. However, in the recent past, with the expansion of knowledge about plastic molding, it began to be applied in the textile industry as well. The use of these polymers in the textile industry has led to a certain revolution in production, but with time and the saturation of the world with plastics, problems have arisen that may change both the textile and all other industries.

History of synthetic textile materials

Many plastic textile materials have become our everyday life. Somewhere since the end of the Second World War, they have become part of everyday life. Many of the materials known today are under 100 years old.

A brief historical overview of the origin of synthetic textile materials:

- Parkesine

Invented in 1862 by Alexander Parkes, Parkesine was first made public at the Great International Exhibition in London. Parkes made this material from the cellulose found in the cell walls of plants. Initially promoted as an inexpensive replacement for rubber, Parkesine was moldable, transparent and maintained its shape after cooling.

- Celluloid

Invented by John Wesley Hyatt in 1865, celluloid was used initially in billiard balls. By the 1890s, manufacturers were using celluloid to create combs and bowls to imitate tortoiseshell, ivory and other expensive natural materials.

- Rayon

Rayon is modified cellulose created by purifying wood pulp into cellulose fibers that are woven into a fabric. First invented in 1891 Paris by Louis Marie Hilaire Berniguat, rayon was promoted as a replacement for silk because of its shiny, filmy quality. Incidentally, early rayon was highly flammable!

- Bakelite

Considered the first completely synthetic plastic material, Bakelite was invented in 1907. Bakelite amazed consumers and manufacturers alike by retaining its form and shape despite high temperatures and stress. By the 1930s, Bakelite clocks, jewelry and telephones gained in popularity due to the unique appearance.

- Cellophane

A Swiss chemist invented cellophane in 1912 as a waterproof table cloth. Later, Whitman's used the product to wrap its candies. Cellophane food packaging gained a place in every home after DuPont introduced a truly moisture resistant version in 1927.

- Polyvinyl Chloride (PVC, Vinyl)

Originally synthesized in 1872 but not commercially viable until 1926, PVC was initially developed as a substitute for rubber and quickly became popular because of its high versatility. "Vinyl" records get their name from this material. Today, PVC is popular in the medical and construction industries.

***Figure 1**: Examples of the use of synthetic fibers*

- Polyethylene

First discovered accidentally in 1898 by the German chemist Hans von Pechmann, polyethylene became widely commercially available in 1944. Polyethylene is the most popular plastic today with a global production of approximately 80 million tons per year. It is available in a variety of different densities and grades.

- Polyvinylidene Chloride

Accidently discovered by a lab worker at Dow Chemical in 1933, polyvinylidene chloride was initially used by the military as a coating on fighter planes because of the material's resistance to saltwater corrosion. Because of the product's clingy nature, polyvinylidene chloride became popular as Saran Wrap, first released in 1953.

- Nylon

Nylon stockings, developed by DuPont, were unveiled at the New York's World Fair in 1939. Soon, nylon replaced expensive silk in military applications and clothing during World War II. Nylon is one of the most popular and inexpensive materials for plastic components today.

- Polyester

Made famous by the crazy fashion of the 80's, the group of polymers known as polyester actually became commercially available in the 1950s. It gained fame as "Dacron," marketed by DuPont as a new fabric and the first synthetic fabric that was washable.
Synthetic materials have mostly been developed as a cheap replacement for expensive and sophisticated materials. However, with their appearance, the production of natural materials decreases. Nowadays, synthetic materials create problems of an ecological nature and scientists are trying to solve those problems

Danger of synthetic materials

Unlike other industries, the textile industry is the one that harms the most with its production and its existence. About 10% of carbon emissions are emitted by textile factories. The textile industry should actually be one of the safest industries in the world. With the advent of synthetic materials, designers and business owners began to use them en masse for the production of clothing. There are several reasons for this. One of the main reasons is economy, it is cheaper to buy synthetic material than natural. The second reason is that synthetic materials are much more resistant and elastic and thus make it easier for designers to make models. Today, the industry is much more dangerous than 50 years ago. Synthetic materials may be more cost-effective to use now, but they are causing enormous damage that will show consequences in the future.

In the very beginning, the production of clothes was simple, but painstaking. Simple because the clothes were made only from natural materials, but laborious because the people who made them had to pull wool and cotton by hand to get a certain style of clothes. With the increase in the demand for clothes, industries appeared that mass-produced clothes. Initially, clothing was produced in these industries in simple ways, then production progressed. They started adding dyes to the fibers, and over time they included various chemicals to keep the wardrobe from crumpling, as if it weren't burning. Today, this leads to a time when synthetic materials are produced that harm the environment in which we live.

Health risks from synthetic materials and problems that arise in the environment

And if synthetic fibers are cheaper than natural ones, they have a very big harmful impact on the health and the environment in which we find ourselves. Nowadays, when we are surrounded by fabrics, it is almost impossible that we are not surrounded by synthetic materials.

These synthetic fibers are mainly made of Polyester, but also of other synthetic materials, which is a by-product of petroleum. Thus, it is directly related to hormones and may be responsible for the development of breast cancer.

Synthetic materials are not only harmful to the people who wear them, but also to the workers who produce them. The process of converting oil into polyester is long and toxic. Working conditions are exhausting and cause some health problems.

Planet earth is poisoned without return. About 20% of pollution is the fault of the textile industry. The problem is that this industry pollutes without returning. Water polluted by the discharge of waste products is permanent pollution. The substances released into them are not degradable and have no way to be removed and cleaned from the water. Those waters into which these substances are poured are permanently polluted. Plastic is also another by-product of polyester production from oil. Some of the potholes are clogged with plastic bottles. Parts of nylon were found in the intestinal system in both fish and some other marine species.

Figure 2: *Synthetic threads*

Many seabirds have been found dead, and the reason for this is that they have swallowed the nylon found in the water.

Fabrics and chemicals have a different impact on health depending on what they are made of.

- Polyester and Nylon: These two by-products of petroleum are very hazardous to the environment. They are non-biodegradable and unsustainable to the environment. The production of nylon emits nitrous oxide, a greenhouse gas 300 times more dangerous to the ozone layer than carbon dioxide. The production of polyester requires much water, the contaminated water after usage is flushed back into the waterways.
- Rayon: This organic fiber is made from wood pulp. Wood might look unharmful and non-toxic, but the clearing of large forests to get wood for rayon has an adverse effect on the environment, this we all know.
- Dye: Dye is another material used mostly for the production of garments. The unused dyes are then washed into rivers and waterways, polluting the environment.

Figure 3: *Clothes made of synthetic fibers*

Synthetic materials which are by-products of petroleum are non-biodegradable, synthetic products take a long time to decompose, creating long-term pollution.

Nylon is hard to recycle, making them hard to decompose, accumulate landfills more. Polyesters are easy to recycle, which makes them less harmful to the society. Recycled polyesters are used to make eco-fashion, which is fashion that is more eco-friendly. Synthetic fibers also taint the water bodies, from a waste product derived from textile factories to dyes, they are all flushed into our waterways and sewers, making the environment more harmful and dangerous.

Are there solutions to the problem with synthetic materials?

There is a lot of talk at the moment about the problems caused by synthetic materials. They pose a great threat to the world's water systems, and thus to both animals and humans. In recent research, microplastics from which synthetic fibers are produced have also been found in the human body. This has led to great confusion and general concern among the people.

Despite all the research, there is currently no precise information on how many factories actually emit waste chemicals. It is also not known how much microplastic is found in these wastewaters, but it is known that the chemicals used to wash the materials are very large producers of microplastics. There are currently two possible ways to reduce microplastic production. The first is to produce better quality materials and thus to stay in use with users longer and the more they are washed, the less microplastics these materials have on them. Another way is that factories that produce materials try to meet the standard of material care and thus reduce the formation of microplastics below the limit. Also to monitor when new studies appear and adhere to them.

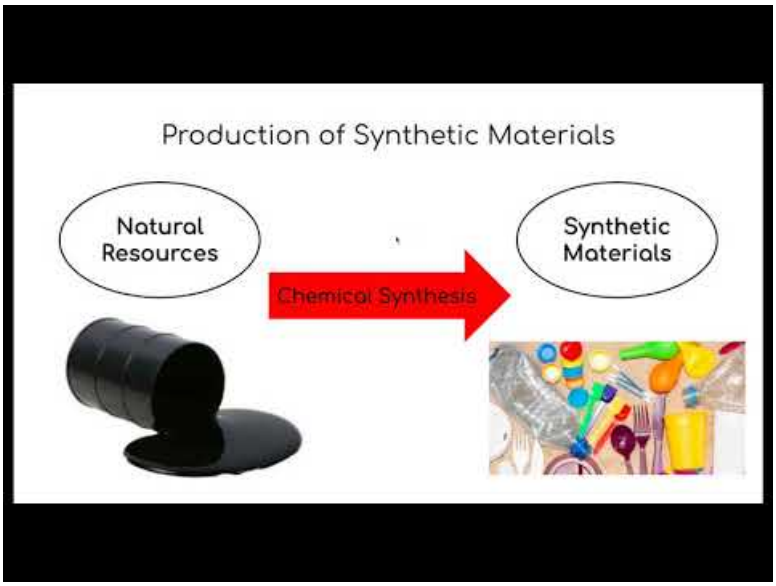

Figure 4: *Production of Synthetic Materials*

Plastic is an important raw material which, however, poses a serious threat to the world's water systems due to its prevalence and longevity. Microplastics refer to plastic particles with a diameter of less than 5 mm. Primary microplastics are particles that are manufactured for a specific purpose such as cosmetics and toiletries or as raw material for the plastics industry. Many EU countries have banned, or are about to ban, the deliberate addition of microplastics into products.

Secondary microplastics, then again, are released from other products during use. These products include plastic products, car tires and roads as well as synthetic textiles. When discussing clothes containing microplastics, fleece garments are often brought up. It is a positive phenomenon that

clothes containing plastic fibres are being discussed because consumer awareness of the issue is increasing.

According to the Finnish Environment Institute, there is currently no detailed information about the microplastic emissions of various operators and production sectors. According to the European Textile Service Association (ETSA), current information suggests that textile services are not very significant sources of microplastics. However, the issue is constantly being studied and ETSA is also promoting research to increase knowledge.

It should also be noticed that microplastics are also created when washing and drying laundry at home. The advantage of industrial washing is that it is energy efficient, which means that the quantity of water, energy and detergents can be accurately optimised and the limit values for the solids in wastewater can be closely monitored.

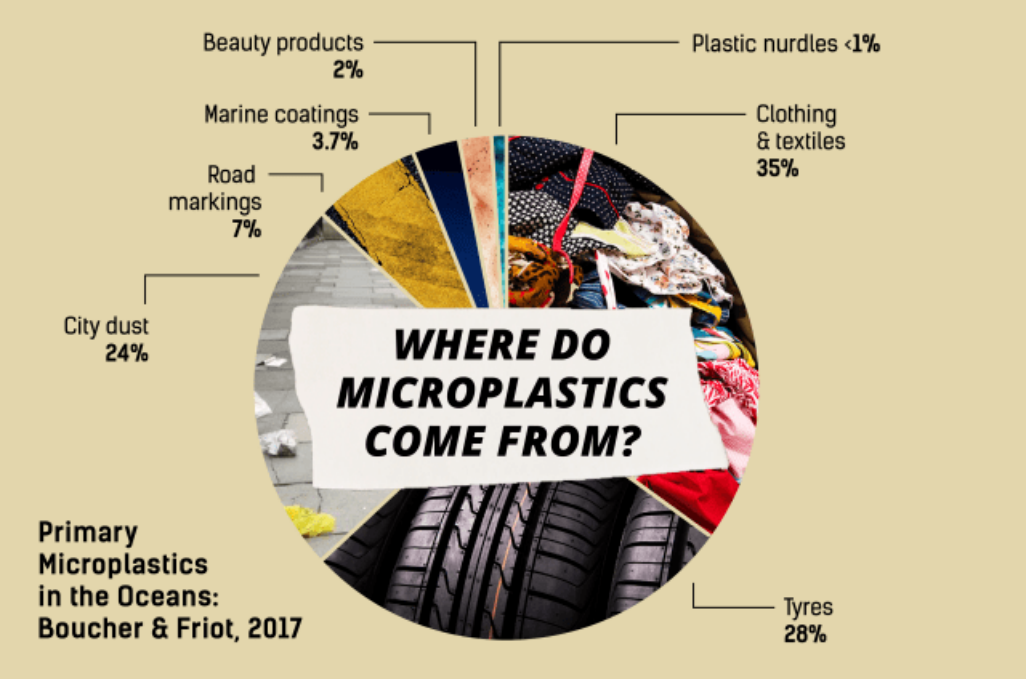

Figure 5: *Where the microplastics come from*

CONCLUSION

The general problem of the planet at the moment lies in pollution. If every branch of industry decides to participate in certain changes and standards, pollution can be reduced. Any industry that is powerful enough to create a certain problem is even more powerful to solve it. The textile industry is one of the largest industries in the world, which is why it creates so much pollution. If all products were made of natural materials, we would run into problems. One of the biggest problems would be the lack of raw materials for the production of clothing, which is why sitetinka mostly exists, to supplement natural materials.

However, because of the society in which we live today and the time in which we find ourselves, earnings come first and this has led to everyone switching to artificial materials en masse. The solution lies in the people. It's called the border. If everyone would use as much as they really need and would not overdo it, we would get rid of the excessive production of all goods and thus get rid of pollution in the long run.

Since textile materials in production itself produce a lot of microplastics, perhaps the textile industry should at some point focus on producing special nets that will collect microplastics from wastewater. In today's world, nothing is impossible. It is all a matter of will to achieve certain results.

REFERENCES

[1] https://lindstromgroup.com/article/microplastics-from-textiles-cause-worry-this-is-what-we-can-do/
[2] https://www.sciencedirect.com/science/article/pii/S004896971834049X
[3]https://www.craftechind.com/the-invention-of-plastic-materials-from-parkesine-to-polyester/
[4]https://superegoworld.com/blogs/the-world/the-dangers-of-synthetic-fibers-and-fabrics-on-the-environment

WORLD'S FASHION CAPITALS

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ABSTRACT

Clothing has always been a reflection of the personal identity of the person wearing it, but also a true picture of social circumstances and cultural norms of the period in which it was created. Each generation recreates fashion. Modern society perceives fashion trends through media events. This paper analyzes the main fashion capitals of the world and places of fashion promotion.

Key words: fashion capitals, Paris, London, New York, Milan.

INTRODUCTION

The most prominent fashion shows are held in the centers of global fashion -"the big four" New York, Paris, Milan and London. Each of these cities has its own identity and occupies a specific symbolic and economic position in the fashion industry. Major shows in these cities are often covered in television news, newspapers and magazines.

Historically, the number of fashion capitals is changing. Fashion capitals appear, develop and disappear. Before the Second World War, only London and Paris had the title of fashion capital - London for men's clothing, and Paris for women's clothing.

Cities that are becoming more and more famous in the world of fashion every year are Los Angeles, Berlin, Tokyo, Rome, Miami, Hong Kong, Sao Paulo, Sydney, Barcelona, Madrid, Montreal, Vienna, Moscow, New Delhi and Dubai.

PARIS

The rule of Paris is rooted in history, especially because several major fashion innovations have emerged in Paris. If we go back to the reign of Louis XIV and the concentration of French political power in Versailles, the influence of French fashion suppressed the influence of Spanish, Italian and English style. The importance of fashion is testified by the sentence of Louis XIV: "Fashion is a mirror of history". During the reign of Louis royal courts had access only to luxury goods. The creation of the fashion press in the early 1670s made it possible for fashion to be mass-produced for the public. Later, the position of Paris was strengthened thanks to Queen Marie Antoinette.
There are numerous reasons why Paris is the capital of fashion, which mostly dates from the 18th century, although it can be argued that Parisian fashion hegemony began even before that. In the 18th century, Rose Bertin was appointed Minister of Fashion, and the position was still maintained in the Napoleonic era. The first fashion magazine, *Le Mercure de France*, which was considered to be the most influential magazine in pre-revolutionary France, also appeared in France.

Figure 1: *Le Mercure de France, the first fashion magazine*

At the beginning, rich and powerful people told designers what they wanted to wear, but in the 19th century that changed. An increasing number of tailors became actively involved in the production of garments for the court at Versailles, for the rich of Paris, but also for the increasing number of foreign visitors and those from the provinces. The Paris haute was born then, thanks to Charles Frederick Worth, an English - born tailor who came to Paris in 1858. Charles became the father of high fashion when put his name on his clothing labels. He went a step further, creating designs based on his own ideas and showing them on live models so that clients could approve them or not. The novelty succeeded and the designers then began to dictate what is modern. Since then, it has been understood that every designer who wanted to achieve success must be in Paris and become part of a fashion house or form his own. Paris was home to fashion shows and all fashion magazines either had headquarters or sought information from Paris.

Figure 2: *Charles Frederick Worth*

Until the 1960s, the creation of fashionable clothing styles was a centralized process in which, with rare exceptions, styles originating in Paris predominated. Other fashion centers were not nearly as influential as Paris and generally followed trends from Paris. Paris as a global fashion center was supported by the mass media.

Haute couture in Paris had a strong impact when many houses such as Vionnet, Chanel and Balenciaga opened their doors at the turn of the 20th century. At the beginning of the 20th century, the ideal of female beauty was a slender figure and youthful appearance. The leading role in the design was played by Paul Poiret and Coco Chanel - who are launching pants in women's fashion. However, World War II led to the closure of many fashion houses, redirecting fashion lights to America, which was not much affected by the war. At the end of the war, Chanel was still popular, but Dior became one of the most influential designers in the middle of the century. Dior announced its new look, which changed the view of women's fashion, emphasizing femininity, as opposed to fashion during the war. Couture remained a modern style until the 1960s when Yves Saint Laurent introduced the idea of *pret-a-porter* or *ready-to-wear*.

In the mid-1970s, after the death of Coco Chanel, Japanese designers - Kenzo, Issey Miyake, Johji Jamamoto and Rei Kawakubo - appeared at Paris fashion shows. Paris has strengthened its status as the capital of fashion by nurturing the styles of old masters, but also a significant influx of designers from other countries. So, for example, Karl Lagerfeld, a native of Germany, is the chief designer of the creative director at Chanel, and in the following years other fashion houses flourished with the arrival of young talents like Stella McCartney in Chloé and Marc Jacobs in Louis Vuitton.

Paris is still the capital because little has changed, despite the decline in the number of fashion houses. The most important fashion shows are still held in Paris, and more ambitious designers come to Paris, rather than to London, Milan and New York to educate and present their works. Although there are certainly those who try to claim otherwise, Paris is still the fashion capital of the world. While it is true

that fashion magazines and designers do not have the absolute power they once had, the ability to be flexible and understand tastes and trends is what makes Paris a magnet for the fashion world.

To better understand why Paris is the capital of fashion, you should consider the Golden Triangle - a shopping district in Paris dedicated exclusively to high fashion clothing and accessories. The triangle lives between Avenue Marceau, Champs Elysees and Avenue Montaigne. It houses the homes of Vuitton, Givenchy, Rochas, Dior, Celine, Chanel, Donna Karan and Hermes.

LONDON

Home to some of Britain's most successful top fashion designers, including Alexandra McQueen and Stella McCartney, London is a major player in the fashion industry and has rightly gained its place as one of the most important iconic fashion capitals in the world.

The London fashion scene is known for setting trends and the latest fashion style and has been influencing trends around the world for decades. The streets of London, one of the most creative cities in the world, are surrounded by unusual boutiques, successful markets and top shops that offer collections of sought-after items with unique designs.

The fascinating history of London's fashion industry has helped shape the city as it is today and contributed to its exceptional reputation as a central hub of innovative style. Although trends come and go, and fashion is constantly changing, one thing that has remained the same over the years is that London famously wears a higher class style, influenced by the English royal family and excels in smart sharp tailoring, shoe making and fine handicrafts.

The fashion industry of London is now recognized as one of the most exciting and innovative in the world, but in medieval British things they were not always like that. Despite a thriving trade economy, which London was considered a central member of trade and culture, the city struggled to compete with Paris and Rome in a fashion role.

Yet he played a key role in the international fashion system. London dominated the export of unfinished products and materials such as wool and silk, while at the same time importing top luxury items such as embroidery and embroidery. Life in London during medieval times was completely different depending on whether you were rich or poor. The rich could afford these luxury items. The royal palaces of Henry VIII, Elizabeth I and Charles I were in London and this influenced the true English style, as London sought the structural production of quality products such as leather goods.

In the 18th century were worn beautiful silk embroidery, exaggerated wigs, intricate full dresses and skirts for women and ceremonial knee-length coats for men. The London fashion scene flourished during this period, as they stood out in sharp tailoring, dresses to enhance the silhouette, and people dressed similarly to royal families.

The significant development of London during this period, combined with the flourishing of the social scene - which included balls, theater performances and court presentations - contributed to the growing success of the city, which encouraged artisans and clothing entrepreneurs to establish their base in the capital.

In the 19th century, the London clothing industry expanded rapidly and the West End gained a reputation for producing and selling high-end luxury products in the market, while working-class areas in the East End became home to lower-value production.

British fashion in the 20th century noticed a number of different trends and styles, which changed significantly from decade to decade. The change of styles in this period is fascinating and was greatly

influenced by the key events in history that took place at that time. During World War II, it became acceptable for women to wear pants due to the rationalization of fabrics.

London in the 1960s, led by designers like Mary Quant, was very influential in styles adopted by the whole world and inspired many "youth subcultures", such as punks. At the end of the 20th century, rebellious fashion and unusual styles took center stage thanks to the influences of The Mods from Carnaby Street from the 1960s. The fashion was created by Vivienne Westwood with Malcolm McLaren in her famous store on King's Road. The couple got inspiration from different concepts of the sixties. It was a trend that was adopted around the world, and London quickly entered the center of attention as one of the main world capitals that sets trends.

Figure 3: *Mary Quant*

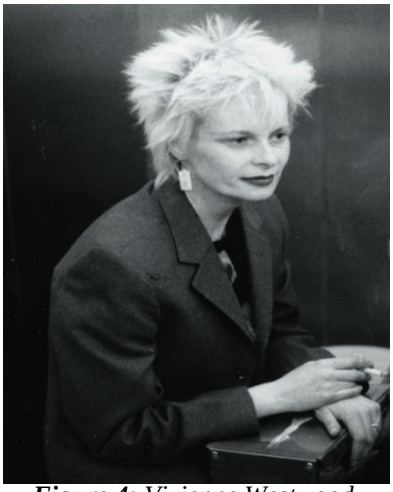

Figure 4: *Vivienne Westwood*

The 1980s brought decadence into fashion, along with the first London Fashion Week show in 1984. What defines London style as a fashion city is the influence of Britpop with an influx of Doc Martens and hats, now parts of the typical "London" style.

London Fashion College, one of the world's best fashion schools, is educating new talents that are shaping what is being shown at fashion week. They had a different vision of fashion design, thus completely changing the course of fashion and giving the city special significance. Bond Street and Oxford Street serve as a shopping district in London.

Alexander McQueen paved the way for decadence in fashion by creating a disturbing atmosphere at his fashion shows, while John Galliano turned to carnival motifs, colorfulness and lush costume design. Both have left a lasting mark on London’s fashion deliberations and extended their eccentricity to Parisian fashion houses as well: Galliano, as executive art director at Dior, and McQueen at Givenchy.

NEW YORK

New York was not the first to produce ready-to-wear fashion, however, it was the first capital city to start showing Fashion Week, which is why Fashion Week is first held in New York every year. In America, the production of textiles and clothing began only in the 1800s, with the Industrial Revolution. This really enabled the mass production of clothes. men's clothing has been produced since the mid-1800s. work clothes were produced by Levi Strauss. Women's clothing originated in the 1900s, reflecting the fashion styles of the rest of the world. New materials were developed, such as rayon and synthetic dyes, which helped mass production of clothing. Charles James was the first in the 1940s and 1950s to produce extravagant dresses with a focus on structure. The Garment District was also home to New York, where a lot of clothes were made. During World War II, fashion houses in Europe closed, so the production of uniforms was moved to New York. New York challenged Paris

fashion by producing sportswear, something Europe has never seen. This remarkable rebellion put New York on the fashion map. In addition, they were the first hosts of Fashion Week. Originally called "Press Week", Fashion Week was originally intended for American designers to present their work to fashion industry insiders who could not travel to Paris due to the war.

Fashion magazines such as Harper's Bazaar, Vogue, Mademoiselle, Ladies' Home Journal, Woman's Day, McCall's, The New Yorker, Town and Country, Good Housekeeping, Bride's, Woman's Home Companion, and Collier's helped the most in shaping the new style and advertising fashion. Vogue and Harper's Bazaar contained French fashion, especially Vogue which accompanied it with editions from 1892 to 1938 when it devoted an entire edition to American fashion, while Harper's Bazaar attached equal importance to both Parisian and American fashion. American designers were first introduced at Vogue.

Figure 5: *Vogue, August 1938.*

Figure 6: *Harper's Bazaar, May 1945.*

New York, considered the cultural center of the world, is home to several of the world's largest corporations. The reason why the city is one of the capitals of fashion is the increased exchange of cultural goods on a global scale. The designers who ruled New York in the 1980s were Calvin Klein, Donna Karan and Ralph Lauren. They designed a style that was glamorous and feminine, and supermodels like Claudia Schiffer, Linda Evangelista, Cindy Crawford and Naomi Campbell further solidified it. In the late 1990s, designers like Diana von Fürstenberg and Marc Jacobs appeared, whose design continues the giants of the 1980s.

Currently, New York Fashion Week is the first of four major fashion weeks that showcases many designers over a period of 7-9 days. In addition, 5th Avenue is generally considered a top shopping district in New York, because most designers have leading stores.

MILAN

The relationship between fashion and Milan is very old and takes us back to the Middle Ages, when there were centers in the city and its surroundings for the production of fabrics, jewelry, tapestries, shoes, etc. At that time, Italy was not a united country as it is today, and different kingdoms had their own interests. For that reason, Rome and Florence stood out in the territory we call Italy today: they also produced and marketed products of the highest quality materials and beautiful aesthetics. Italian fashion suffered under the dictates of the French court in the mid-17th and then from haute couture in the early 19th century. From then until the beginning of the First World War, Italy gradually modernized the textile industry and distribution. The first fashion house was founded and opened in 1865 on the main streets of Milan, and its owners were the brothers Ferdinando and Luigi Bocconi.

Italy was finally united in 1891, and three cities began to fight for the privileged place of the fashion capital. Only after the Second World War did Milan stand out. It was difficult, because Florence already held fashion shows and had international customers, and Rome also had internationally known tailors who also provided services to Hollywood stars.

In the late 70's Milan became the capital of fashion, as a place of production and creation. Like New York, Italy became a modern fashion power after World War II. Milan emerged in the 1970s as a key Italian fashion city, but had to fight to gain this position, which it draws from a long Italian tradition of luxury and fashion excellence, led by Armani and Versace. The factor of success of Italian fashion was the distrust of American consumers towards French fashion. Italian brands and styles, focused on wearability, offered a satisfactory alternative that complemented the growing taste of American fashion houses.

Milan became a dynamic city in the eighties, rich in fashion events. Giorgio Armani and Gianni Versace marked Milan's prêt-à-porter, and were later joined by new forces such as Dolce Gabbana, Romeo Gigli and Miuccia Prada. During the 1990s, prét-â-porter entered a difficult period due to decentralization and the rise of new Asian competitors. Miuccia Prada, who launched the famous backpack in the early 1980s, had to break into the New York scene to solidify her name as a prêt-à-porter designer.

Today, with a very mixed population, Milan is a cosmopolitan city, and design and fashion professionals have decided to make it their home. The well-known "Quadrilatero D'oro" houses boutiques and palaces of brands such as Prada, Miu Miu, Valentino, Gucci, Versace, Bulgari and Marni, among others. There are also closed studios, jewelers, bags, shoes and charming thrift stores, where you can find various modern and valuable things. Located in the very center of Milan, the well-known "Quadrilatero della moda" is a set of four streets that dictate the world trend.

Figure 7: *"Quadrilatero D'oro", Milan*

FASHION WEEK

Fashion Week lasts approximately a week and here fashion designers, brands or "houses" present their latest collections at fashion shows to customers and the media. These events affect trends in the current and upcoming seasons. From January to April, the designers present their autumn / winter collections, and during September to November, they present the spring and summer collections.

The most prominent fashion weeks are held in the fashion capitals of the world; New York, London, Milan and Paris are getting the most reports in the press this fashion week as well. The program begins with New York, followed by London, with a third week in Milan, and ends with fashion shows in Paris.

The concept of Fashion Week began in Paris, when traders employed women to wear fashion items in public places. These parades gradually began to become their own social events. In France, catwalk shows are still called "defiles de mode", which literally means "fashion parades".

In 1903, a store in New York called Ehrich Brothers organized what is believed to be the first fashion show. Until 1910, many large department stores held their own shows. These shows were an effective way to promote stores and improve their status. Until the 1920s, the fashion show was used by retailers across the country. They were staged and were often kept in the restaurant shop during lunch or tea. The shows were extremely popular and attracted thousands of people.

In 1943, the first "Fashion Week" was held, New York Fashion Week, with one main purpose: to give fashion buyers alternatives to French fashion during World War II, when fashion workers could not travel to Paris.

Figure 8: *The first New York Fashion week*

Figure 9: *The first Paris Fashion week*

Paris began holding fashion shows in 1945, Milan Fashion Week was founded by the Italian Chamber of Commerce in 1958, Paris Fashion Week was further organized in 1973 within the French Fashion Federation, and London Fashion Week was founded by the British Fashion Council in 1984.

Figure 10: *The first London Fashion week*

Figure 11: *The first Milan Fashion week*

There are primarily two types of shows, female and male. There are also shows specific to each location. For example, most high fashion shows are held in Paris, while most weddings are held in New York. High fashion shows in Paris are held in Paris in January and July. Due to the rules laid down in the Chambre Sindicale de la Haute Couture, haute couture can only be shown in Paris.

Designers are increasingly showing off-season collections between the traditional fall / winter and spring / summer seasons. These collections are usually more commercial than the main seasonal collections and help to shorten the wait of customers for new seasonal clothes.

Some fashion weeks may be genre-specific, such as Miami Fashion Week and Rio Fashion Week, which focus on swimsuits, high fashion shows in Paris showing a unique designer original. Bangalore Fashion Week shows formal clothes and Bridal Fashion Week, while Portland (Oregon, USA) Fashion Week shows some environmentally friendly designers. Bread and Butter Berlin hosts the leading fashion show for everyday fashion.

CONCLUSION

There is constant competition among fashion capitals as to who is the main fashion city in the world. Currently, the title is held by New York, but at one time or another it may be one of the other capitals. The future of fashion capitals is not written, but it is possible that at least one Chinese city and one Indian city will be fashion capitals in the coming years. The twenty-first century may witness an increase in the number of fashion capitals, which will enable the fashion industry to better connect with consumers in emerging markets that are becoming increasingly important around the world.

The Internet and bloggers distribute information almost instantly. Fashion shows, which are a big spender for brands, can be immaterialized or simply become redundant. Each urban center could provide its styles to consumers locally and globally. With advances in digital art and technology and nurturing fashion through all aspects of art, designers are discovering new ways to maintain the stories of their collections in a more efficient and surprising way.

People send information about their status, taste, occupation and social identity with their clothes, whether they like it or not. In the same way, each of the analyzed cities is a representative of a certain fashion trend, informing us about their history, the development of trade and the economic system, and how they have become the fashion centers of the world. Each city has developed its own unique style and transformed into the clothes they show at fashion week. They all contribute to something different in the world view of fashion, which will continue for a long time. What enables them to continue to play the role of fashion capitals are the media, without which they would not be able to have such an impact on the whole world, nor would they be able to attract the attention of all important manufacturers. Education and the opening of design schools, the opening of museums and galleries that hold textile items and the employment of young people in existing fashion houses - all this makes the fashion system work and strengthens their status as capitals.

REFERENCES

[1] Franklin K. (2015). Fashion
[2] Elzingre M &Hodgson P. (2010) *Paris as a Fashion City*, Berg Encyclopedia of World Dress and Fashion
[3] Ehrman, E. (2010) *London as a Fashion City*, Berg Encyclopedia of World Dress and Fashion
[4] Segre Reinach S. (2010) *Milan as a Fashion City*, Berg Encyclopedia of World Dress and Fashion
[5] https://womens-fashion.lovetoknow.com/Why_is_Paris_the_Capital_of_Fashion
[6]https://www.biddlesawyersilks.com/london-fashion-the-history-of-the-british-fashion-capital/
[7]https://thefoxmagazine.com/fashion/milan-italy-the-capital-of-design-and-world-fashion/
[8]https://collegian.com/2014/09/fashion-capitals-became-fashion-capitals/

Smart clothes in health care

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ABSTRACT

Textile products in history of civilization, from the earliest periods to modern times have a special role and place. The protection of the human body with textile material was the original, primary and basic purpose of these materials. Clothing and clothes characterize only the human race, and the role of clothing in addition to physical and functional properties also implies an aesthetic component. Improving the quality of textile materials, introducing and applying new textile raw materials, perfecting the methods of their processing and production, which has enabled a wider and more diverse application of textiles has significantly contributed to the overall evolution of human society. By constantly improving textile products including clothing, people's needs are met at an even higher level, creating new needs that need to be met. The development of science and technology has led to the advancement of clothing, which is achieved by integrating ''intelligent elements'' into fabrics, resulting in interactive textiles or ''smart clothes''. Technologists use a combination of sensors, mechanical engineering and large amount of data to provide consumers with more information about their bodies and life.

INTRODUCTION

Smart clothes represents garments that have been enchanced with technology to add functionality beyond those of traditional uses. It it also often referred to as high-tech clothing, smart clothing, elctronic textiles, smart textiles, e-textiles, control clothing or smart fabrics. There are several variations of achieving smart functions in clothing. This type of clothing uses advanced textiles with intertwined cureent, built-in sensors and additional hardware to give it smart functionality. Today, most smart clothes can be connected to an application or program on a secondary device using Bluetooth or Wi-Fi , however, this wireless connection is not necessary to classify clothes as a type of smart clothes . It is a ''smart system'' that is able to feel and communicate with the environment, conditions and stimulation of users. Stimulants and responses can be in electrical, thermal, mechanical, chemical, magnetic or other forms.

DEVELOPMENT OF SMART CLOTHES

Although it gained momentum during the 2000s smart clothes slowly began to develop a thousand years ago. Like the evolution of smartphones and tablets, smart clothing began to develop very quickly and now threatens to grow into a leader in the electronics market. The new wearable electronic systems concept is designed to meet innovative applications in the military, public safety, health care, sports, the fashion industry and many more. The advent of intelligent clothes has made it possible to realize many ideas that were previously unthinkable. Responding to external stimulation (temperature, light, electricity, magnetic forces), ''intelligent clothing'' changes its properties, structure, shape, and even function.

Intelligent electonic textiles is a relatively new area of research within the textile industry with huge potential within the health care industry. These textiles have electronics and interconnections integrated into the fabrics, and then into the garment, which makes them wearable.

SMART CLOTHES IN HEALTH CARE

The use of wearable technologies in medicine and health care has become important in order to significantly improve the provision of services in appropriate health care to patients and those who provide it.
Intelligent medical clothing and textiles have the potential to significantly change the providing of health services for large groups of the populaton, such as those suffering from chronic diseases, as cardiovascular disease, diabetes, respiratory and beurological disorders, the elderly people with special

needs or facilitating pacients that stay in hospitals. Integrating high technology into textiles and clothing such as modern communications or monitoring systems, developing new materials with new features, smart sensor systems and new approaches to data analysis and interpretation, along with cost-effective approaches can fundamentally change the patient- health care relationship. Patients discharged from the hospital after major surgeries (eg heart bypass), mentally ill patients (for example, those suffering from manic depression), athletes during training and competiton, injured soldiers, etc. Should be monitored on a regular basis. This can provide a better understanding of the relationship between vital signs and their patterns of behavior, so that treatment can be applied immediately or modified accordingly, if necessary. All this influences the opening of a new era in the field of e-textiles for it's application in a better way for medical services.

In addition to the patients themselves, sensor technology will be built into the clothing of medical workers, who will be able to monitor body mechanics and biometrics and then transmit information to a centralized system. Custom smart clothing is the basis of a solution that uses data analytics to prevent injuries.

The key technology is sensors that measure the heartbeat, movemnt and mechanics of the body, and the key to reducing injuries to medical staff is to monitor, detect and predict dangerous situations before they occur.

It is thought that widespread use of clothing used for health monitoring or treatment assistance could reduce reliance on exprensive equipment and a heavily burdened health system.

Smart clothes in health care is used for monitoring:

- ECGs
- Patient breathing
- EMGs
- Physical activities
- Pregnancy and the fetus itself
- Blood pressure
- Vital functions of the child and many others.

Segmentation of the market of smart clothes in health care can be in the following way:

1. Global market of medical smart textiles, technology:
   - Wearable technology
   - Textile sensors
2. Global medical market of smart clothes, throught the application:
   - Bio-Monitoring
   - Surgery
   - Therapy and health
   -
3. End-user market of global medical smart textiles:
   - Hospitals
   - Clinics
4. Global medical market of smart textiles devided by region:
   - USA
   - Canada
   - Latin America
   - Germany
   - UK
   - France

- Italy
- Spain
- East Europe
- Japan
- China
- India
- Australia
- South Corea
- Africa

SMART CLOTHING PRODUCTS USED IN HEALTH CARE

Smart mattress, bedding and pillow:

We spend about one third of our lives in bed, which is why scientists came up with the idea to use smart textiles directly on a mattress, bedding and pillow. While we sleep (or do other activities that require the use of bed), the fabric will record and analyze what happens to your sleep based on the data it collects. This should provide useful information for recognizing sleep anomalies and help achieve a more peaceful sleep. Today's smart pillows are designed to follow sleeping habits, helping to avoid snoring problems. If the user snores kompanija ''Nitetronic'' offers a *Goodnight* pillow that uses sensors to detect head position and any signs of snoring. If the device ''thinks'' the user is snoring, the pillow will inflate slightly, pushing the head to the side and helping the airways open by reducing snoring. The pillow is also connected to a mobile app, which monitors snoring so you can see if it has occurred to change (for the better).

Figure 1: *Smart pillow*

SmartDuvet is the company that first started the production of smart self-adjusting bedding. It now offers a second edition that allows two people to adjust the desired temperature on their side of the bed. The SmartDuvet Breeze like it's predecessor, is practically a blanket that inflates through a series of circulating air ducts. It is placed on a quilt in a quilt cover, and it is attached to a control box that can be hidden under the bed. The control box has a mechanized pump inside it that discharges air and adjusts the bedding to the desired shape. The application regulates the temperature of the bedspread on the desired side of the bed. Oxygenation in bed will reduce the sweating of the user and prevent the appearance of mites.

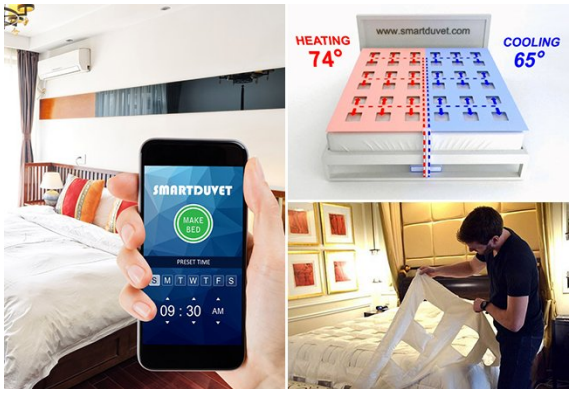

Figure 2: **Display of smart bedding**

The smart mattress can analyze the work of the heart and the frequency of breathing, which allows it to calculate how many hours the user actually slept and how long he spent in REM and deep sleep. It gives the possibility to adjust the temperature, depending on whether the user wants the mattress to heat or cool it during the night. It also offers the ability to adjust the hardness using airbags.

Figure 3: Smart mattress

Pregnancy monitoring belt

The safety belt is a wearable device for long-term heatlh monitoring that facilitates monitored pregnancies and the fetus itself. On the other hand, hospitals and obstetric clinics can avoid frequent visits by additional patients by providing remote monitoring. This belt will significantly reduce the burden on hospitals. In this way, the efficiency of hospitals can be increased, as well as the quality of services provided. It enables remote monitoring of patients, assessment of automated preliminary diagnosis based on collected and analyzed vital signs, access to medical data of patients at any time and most importantly warns when potential complications of pregnancy require physical examination of the patient. In addition, obstetricians are able to use data to organize their work and increase work efficiency, so this belt is very useful in the case of pregnant women.

Figure 4: Pojas za praćenje trudnoće

Owlet smart socks for babys:

Owlet smart socks use the same pulse oximetry technology used in hospitals to monitor toddlers heartbets, making sure their sleep and breathing are not interrupted. Syncs with iPhone or Android phone for real-time data delivery. The smart sock wraps itself comfortably around the baby's feet to monitor the heart rate, oxygen level. The base station lights up green to inform parents that everything is fine, and lights and sounds to let them know if your heart rate or oxygen level is leaving predefined zones. Owlet's new platform will help identify potentical health problems such as: sleep disorders, RSV, pneumonia, bronchitis, chronic lung disorders and heart defects.

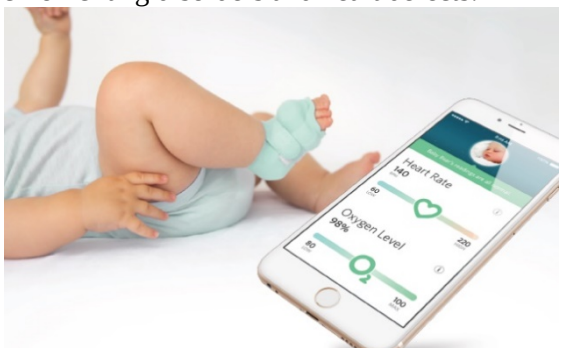

Figure 5: Smart socks for babys

Bra for monitoring tumors:

The bra has the ability to detect tumors even before examination and mammography. It looks like a sports bra, but the baskets are lined with a series of 16 small sensors that read temperature changes deep in the breats tissue. The patient carries the bra home and wears it for 12 hours; the device stores data all the time, which is then downloaded and analyzed by pattern recognition software to see if there is a problem. In early testing, the bra is more accurate than current breast cancer testing methods.

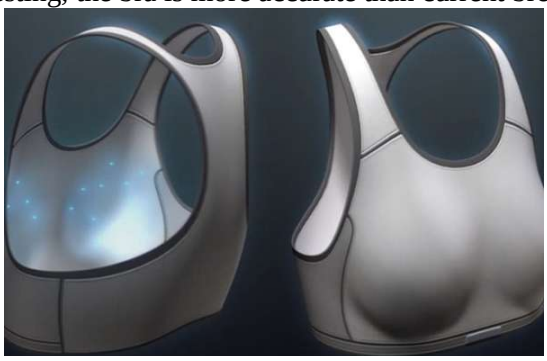

Figure 6: Bra for monitoring tumors

Temporary tattoo Biostamp company MC10:

Company MC10 has developed flexible electronic assemblies that stick directly to the skin like temporary tattoos and monitor the health of users. Biostamp is a thin electronic network that extends through the skin and monitors temperature, hydration and stress. ''

Epidermal electronis'' could be developed for use in health care to monitor patients without connecting to large machines. Not only would this be more convenient, but the results could be more accurate if patients were examined in their normal environment doing normal activities, and not in the hospital ward.

Other applications may include a patch that allows the athlete to know when and how much to hydrate during peak performance or when it is necessary to apply sunsceen.

Earlier versions were applied on and elastomer base, but latest prototype is applied directly to the skin with a rubber seal. It can be covered with a bandage or spray available in pharmacies to be durable and waterproof enough to withstand the sweating or bathing of users. It lasts up to twoo weeks.

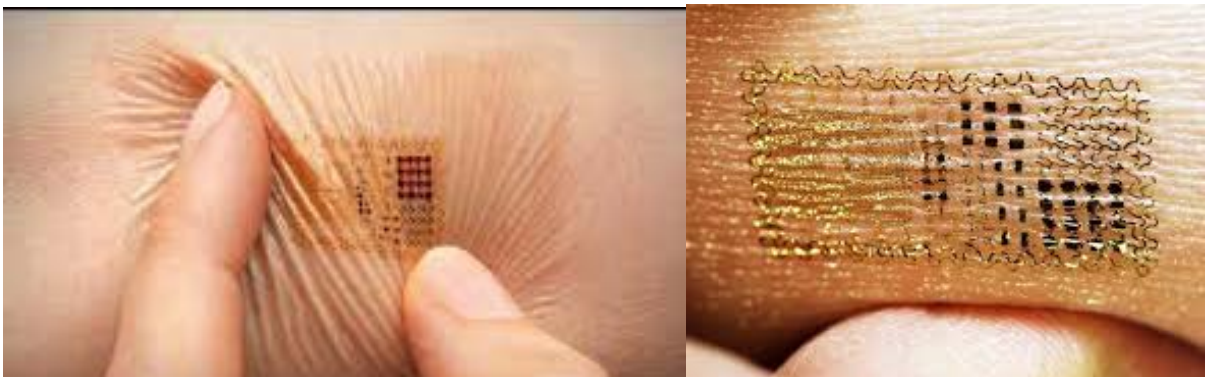

Figure 7: Temporary tattoo

GLOBAL USE OF SMART CLOTHES IN HEALTH CARE

The growing propensity for wearable technology, such as sensors and other types of electronic devices, are key factors responsible for the growing demand for smart textiles. The increasing use of wearable technology, which is widely used in heart rate sensors and other health monitoring sensors, plays an important role in the development of the smart textile market in health care. Significant use of these technologies is expected to change the way personal health is monitored.

Some of the key manufacturers in the global medical smart textile market are Google Inc. (USA), Intelligent Clothing Ltd. (UK), International Fashion Machines (US), Textronics, Inc. (USA), Interactivewear (Germany), Sensoria Inc. (US), Schoeller Textiles AG (Switzerland), Vista Medical Ltd. (Canada) and Gentherm (US) and others. Based on statistical data conducted at the global level, the results of the research were determined.

It is expected that the increasing of diseases will stimulate the growth of the global market of smart textiles in health care during the foreseen period. According to research from 2017, from 1990 to 2017, the leading causes of premature death were: neonatal disorders, heart disease, lower respiratory tract infections, diarrhea, chronic obstructive pulmonary disease (COPD) and stroke. These diseases caused more than a million deaths worldwide in 2017.

The global market of smart textiles for medicine is segmented by technology, application, etc. The market, based on technology, is divided into: wearable technology, textile sensors and others. Based on the application, the market of smart textiles for medical products is divided into bio-monitoring, surgery, therapy, wellness, etc. The global market for smart textiles for medicine, based on the end user, is divided into hospitals, clinics and others. Hospitals and clinics had a share of 67,3% in 2018, as shown in the figure below.

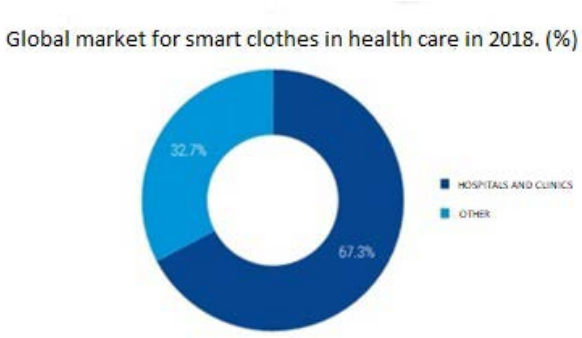

Figure 9: Global market of smart clothes in health care for 2018.

Europe has had a significant share of the global market for smart textiles for the medical industry. This can be attributed to growing government spending to promote the health sector in the region. For example, according to Eurostat, in 2016 health expenditure per person was 5000 € or higher in three EU Member States, namely Luxembourg (€ 5,600), Sweden (€ 5,100), and Denmark (€ 5,000), which shows that consumption in Europe is very high and constantly growing.

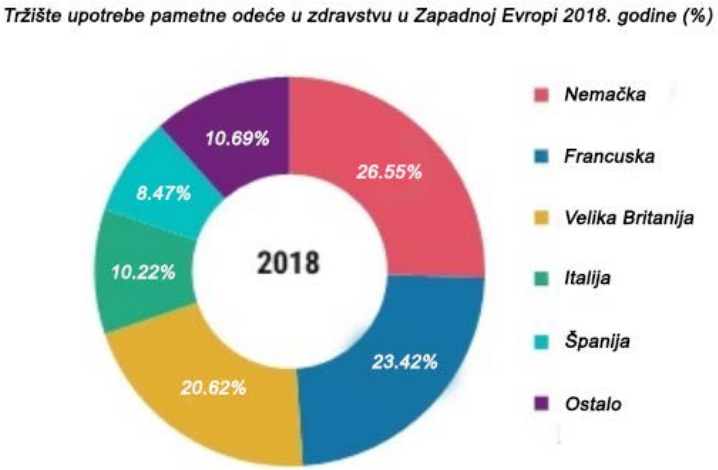

Figure 10:. Market of smart clother in health care in West Europe for 2018.

According to the latest report published by the Market Research Future (MRFR), the global market for smart textiles for global medical products should show a growth rate of 7,51% in the forecast period for 2018-2017. While newly conducted research shows a growth rate of 9,5% in the period 2019-2027. Based on all the conducted research, the global medical market of smart textiles is divided into Europe, North America, South America, Africa and the Asia Pacific and the Middle East.

Currently, North and South America collctively lead the global market for smart textiles for medical production and can be expected to be the leaders during the forecast period. In America, most market participants are involved in the ongoing technological development of medical equipment for effortless monitoring, treatment and diagnosis. In addition, increasing state aid is aimed at patient well-being, which has a positive impact on the smart textile market in health care. Europe holds the second position in the global market of medical smart textiles. The health sector in Europe encourages productive research activities and innovations in the medical device market that promise continuous progress in the smart textile market for medical use. The Asia- Pacific world is considered a promising market for the global medical sector of smart textiles. This is due to the growing incidence of the disease, the widespread need for innovative medical equipment, the increaing application of expertise in the initial stages of diagnosing the condition and the increasing number of health centers. In addition, the growing rate of older people in the region contributes to the further development of the market. India, Japan and China are key players. The Asia- Pacific region is expected to represent the fastest growing market for medical smart textiles during the forecast period.

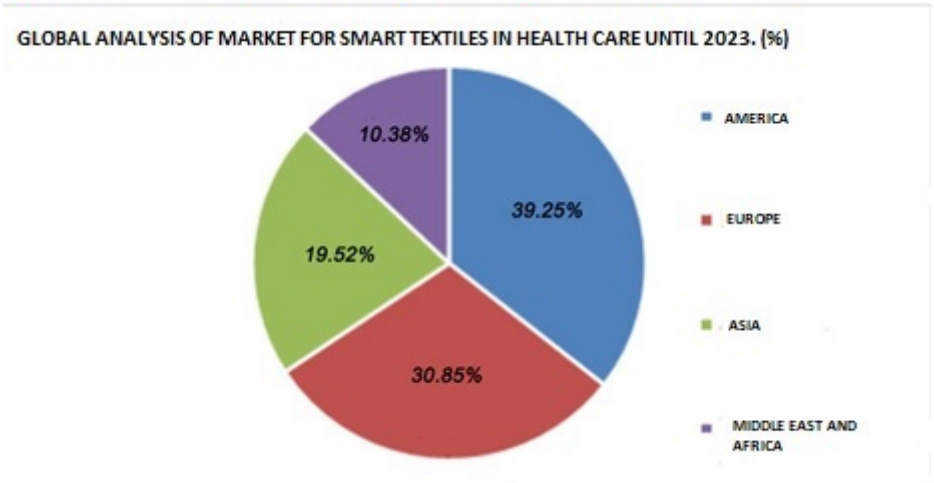

Figure 11:*Analysis of global market for smart clothes used in health care until 2023. (%)*

CONCLUSION

The paper presents the use of smart clothes in health care on a global level. The reason for this study is to show the impact of the development of smart clothes on the health sector, which aims to prove the increase in the use of smart slothes in health, and to draw attention to the importance of smart clothes for both users and employees in the health sector. The analysis of statistical data defined the global market of smart textiles for medicine, based on the region, which is divided into America, Europe and Africa. According to these data, it is estimated that America with 39,25% is likely to dominate the global market of medical smart textilesm while Europe with 30,85% would also have a significant share in the global market of smart textiles for the medical industry. Based on the data, it is estimated that the Asia is the fastest growing region on the global market. Which is why the medical smart textiles market in the Middle East and Africa is expected to experience a modest growth rate from 2019 to 2027. The Middle East would lead market growth in this region. Summarizing all the results, we come to the conclusion that we can clearly see the growth of use, as well as the development of smart clothes in health care on a global level.

REFERENCES

[1] S Firšt – Rogale, D. Rogale, Lj. Radišić: Pametna odjeća, Tekstilno-tehnološki fakultet sveučilišta u Zagrebu, 2014.
[2]Rebeccah Pailes-Friedman: Smart Textiles for Designers (INVENTING THE FUTURE OF FABRICS), Laurence King Publishing, 2016; ISBN10: 1780677324, ISBN13: 9781780677323
[3]Tilak Dias - Electronic Textiles: Smart Fabrics and Wearable Technology, Elsevier Science & Technology; Cambrige, UK, 2015; ISBN10: 0081002017, ISBN13: 9780081002018
[4]Xiaoming Tao – Smart fibers, fabrics and clothing, CRC Press INC, 2001; ISBN: 9781855735460
[5]Gilsoo Choo – Smarth chlothing; Technologi and Applications, CRC Press Inc. 2009; ISBN10: 1420088521, ISBN13: 978-1420088526
[6]V.Petrovic: How digital is the Adriatic Textile Industry? Reality and Trends, Lectra Deutschland GmbH, September 23. 2019., Zagreb, Croatia.
[7]V.Petrović, M.Gašović: Modna kolekcija, Tehnički fakultet „Mihajlo Pupin“, Zrenjanin, 2016., ISBN 978-86-7672-257-0, COBISS.SR-ID 299045383
[8]D. Ujevic, V. Petrovic, Računarski programi u funkciji razvoja konfekcijske proizvodnje muške i ženske odece, Savremene tehnologije i privredni razvoj, Tehnološki fakultet Leskovac, oktobar, 2015.godine.
[9]C. Lagat, X. Ming, V. Petrovic, N. Zivlak: Analysis of cooperation between China, Kenya and Serbia in the Framework of the World University Union in the Belt and Road Initiative (WTUA), 2019 Sino-Africa International Symposium on Textiles and Apparel (SAISTA2019), Proceedings, November 8-10 2019, Shanghai, China

[10]Petrovic, V. M. Pesic, D. Joksimovic, A. Milosavljevic: Digitalization in the textile industry – 4.0 Industrial revolution in clothing production, International Joint Conference on Environmental and Light Industry Technologies, 7th International Joint Conference on Environmental and Light Industry Technologies, The Faculty of Light Industry and Environmental Engineering of Obuda University, 21-22 of November 2019, Budapest, Hungary, pp. 11-21.

FASHION IN THE AGE OF COVID-19
- A NEW ERA IN THE FASHION WORLD -

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ABSTRACT:

The fashion industry has been hit by an epidemic of the corona virus at all conceivable levels - production has stalled, retail outlets have closed, and demand has plummeted. The coronavirus has already changed a third of the entire planet in many ways. Many important cultural, sporting and fashion events have been postponed due to new circumstances for a better time, postponed for next year or will be held in a different form - and it is mostly online. Protective masks and fashion have been closely linked since the coronal virus pandemic took over the world. Numerous designer houses are largely releasing winter models, and others are preparing for the spring of 2021. Whether they are monochromatic or colorful, masks are slowly becoming one of the "must have" accessories.

Key words: *fashion, coronavirus, protective masks, epidemic*

INTRODUCTION

The coronavirus has already, in many ways, changed a third of the entire planet. Many important cultural, sports and fashion events have been postponed due to new circumstances for a better time, postponed for next year or will be held in a different form - and it is mostly online.

The question is whether fashion shows online will be a temporary solution or will continue after the corona virus pandemic.Many fashion houses have planned to organize fashion shows online, hoping that this is only a temporary solution, but it is predicted that everything will be switched and stay online. The clothes themselves are more or less created "soulless". What gives it "liveliness" is actually that framework, that is. the context of the emission and movement of the model; the whole show. Can livestream really convey things faithfully? It requires a lot of planning and I don't believe that brands are ready to do all fashion shows just for streaming. It would be difficult for customers to process fabrics and bring in creativity. It was very inconvenient to leave clothes that you did not see in the real environment.

Namely, on September 5, the first "International Digital Fashion Week" was held, where talented fashion designers had the opportunity to participate and present their new collections. It was followed by over 300,000,000 viewers around the planet who watched the presentation of the new collections through short videos via TV screens, social networks and play store platforms. After that event, the fashion industry went online and most of the fashion weeks were digitized.

Our everyday life consists of protective masks, which are now an indispensable fashion detail. Most people today have masks in various designs and adapted to their clothing combination. Soon after the creation of COVID-2019, fashion designers started placing their designs on masks and selling them.
Normal life after COVID is almost unthinkable, although we eagerly await it, this virus will leave a big mark in our lives as well as in the fashion industry. Coronavirus has ushered in a new era in the fashion industry.

THE IMPACT OF CORONAVIRUS ON THE FASHION AND TEXTILE INDUSTRY

This has been a tough time for every imaginable sector of the economy. In order to slow the spread of the virus, governments closed down manufacturing plants, malls and stores. The fashion/clothing

industry – one of the biggest industries in the world with $2.5 trillion in global annual revenues – found itself highly exposed to the negative effects of the pandemic.

As many people are working from home and spending most of their time at home, getting dressed lost its importance. And, since events are canceled or postponed, such as weddings, celebration parties and vacations, these caused another hit on demand. As a result, according to the BOF's The State of Fashion 2020: Coronavirus Update, the average market capitalization of apparel, fashion and luxury players dropped almost 40% between the start of January and March 24th, 2020.

Lockdowns increased and accelerated the growth of e-commerce – a good reminder that crises can create new ways of growth. *"The sudden closure of all apparel retail stores across all major global markets has shaken up the channel mix in an unprecedented way this year. It's five years' worth of growth achieved in about six months,"* said Bernstein's Aneesha Sherman.

Small textile industries felt the greatest consequence. Large industries and companies have higher turnovers of money, and so often huge profits, and these industries certainly feel the decline in turnover, but they can also "survive" it. In contrast, small brands operate on small profits and a much smaller drop in money turnover is enough to shut them down.

Mostly, these are small businesses, small textile industries, and at the same time "domestic", while global brands, logically, are usually huge. Thus, this damage turns out to be twofold - not only small textile producers suffer, but also many small national economies.

The textile industry is much broader than fashion, but the production of garments and accessories are undoubtedly the largest part of it. That is why we must also touch on how the CORONA-19 has changed fashion trends. At the time of the pandemic, fashion brands shifted to designing "for the home" garments, and it seems to have remained largely the same after the pandemic. Comfort has become another word for the fashion trend, and people's awakened desire for nature has begun to be reflected in their desire for natural materials. The fashion industry has seen a significant jump in the online market, and it seems that online textile shopping will remain much more popular than it was before the pandemic.

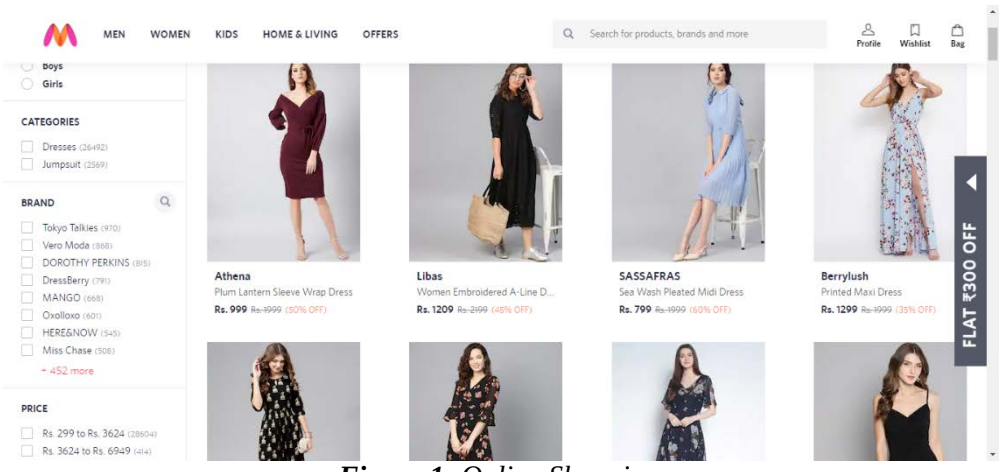

Figure 1: *Online Shopping*

Apart from the consequences that affected the textile industry, caused by the global pandemic, in this period, in addition to the damage, it was also significantly changed in the essential sense.

The previous importance of the aesthetics of garments and other textiles in the pandemic era has been replaced by functionality, comfort, and sometimes completely focused on the fight against the pandemic. The production of face masks, protective equipment for doctors and gloves has experienced a rise that has never been seen before in this sector.

Many fashion brands, both global and small domestic, have focused their activities on the production of these useful textiles, and thus managed to maintain their business, while doing a very humane thing, useful for the whole society.

Surgical masks were never considered a fashion statement, but many Thai fashion designers and apparel manufacturers have turned the face mask into more than a shield. They want to add style to what is fast becoming an everyday accessory.
The face mask has become a new accessory category at a time when sales of traditional fashion apparel are slumping.

Figure 2: *Fashion brand masks*

The fashion industry has been hit by a coronavirus epidemic at every conceivable level - production has stalled, retail outlets have closed, and demand has plummeted. This led to a real existential crisis in the fashion industry. With sales currently at a very low level, many brands have completely stopped advertising - although some still use influential people from social networks to promote their products.

From plantation to factory, from factory to store around the world - the textile industry relies heavily on the carefully designed transport chain through which it operates.

Closed borders, increased measures, difficult or completely blocked traffic, and even suspended air traffic, which many countries have introduced as measures to combat the spread of the coronavirus, and how it has hampered the textile industry and prevented its normal functioning.

Italy, which is one of the world's centers of renowned brands, including the great brand Marella, certainly was not at the time when this country was the biggest hotbed of coronavirus, and the question is how long it will take for brands to make up for lost time and return transport chains textiles into normal, standard flows. However, even once the corona virus pandemic has subsided somewhat, no matter how long it takes, the question remains as to what the fashion industry will look like after that.

SUSTAINABLE FASHION AFTER CORONAVIRUS

Given the current situation regarding the fashion and textile industry, the question arises as to what the fashion industry will look like after the coronavirus? Will it affect the purchase of clothing?
There was a lot of talk, especially about the harmful impact of the so-called "fast fashion", in which consumers buy something cheap, barely wear it and then throw it away. Wintour said the industry needs to "slow down a bit" so people can "enjoy it more" without having to constantly frantically look for the next big new thing.

Today, fashion brands have about 52 "microseasons", collections on an annual basis. The idea of the industry is that, every time a customer comes to the store, they come across something they have not seen before, which will lead that customer to come to the store again soon.
Mass production of clothes also means mass production of fabrics. As we wrote in the text "How much does our clothes cost the environment", for growing plants and animals from which raw materials are made for the production of fabric, many resources are needed.

Mass production can only be profitable by mass purchase, so the prices of a piece of clothing are reduced to a price that is affordable to everyone. Due to the lower quality material, the clothes last shorter than before, so consumers quickly decide to throw away a piece of clothing and then buy a new one.

The fashion industry is a huge polluter, with about 1.2 billion tons of carbon emissions a year - and has been under enormous pressure for some time to become more sustainable. One of the big problems of the textile industry is not only the production of clothes, but also textile waste, that is - what do we do with clothes when we no longer want to wear them? Some of the clothes will be donated or recycled, but that is only about 15 to 20 percent worldwide. The rest is waste. About 70 percent of that waste is dumped in landfills, while 30 percent is incinerated. The United States produces more than 15 million tons of textile waste each year. That amount is twice as much as 20 years ago. In 2015, about 16 million tons of textile waste were produced in Europe. When found in landfills, even natural fibers sometimes take hundreds of years to decompose. In addition, they can emit methane and CO2 into the atmosphere. Synthetic materials are not designed for decomposition, so they can release toxic substances into landfills and the surrounding soil at landfills.

***Figure 3**: Sewing in an industrial atmosphere*

Coronavirus has partially influenced this type of fashion, which has become increasingly prevalent. Purchase reduced, the production of the textile industry is stagnating and the awareness of both buyers and producers and designers has been awakened. This virus will definitely have a big impact in the next 10 years, it has left a big mark in this industry. It is predicted that today's shopping habits will remain after COVID.

Sustainable fashion may be a conscious decision for some, but for others it's a consequence of logistical and economic shifts caused by the onset of a new normal. One thing's for sure: It's a solid strategy for the future. Mass production of disposable items remain stalled for now, as more and more consumers seek out eco-friendly options.

For brands to thrive, keeping agile with sustainability in mind is essential for the future. Jumpstarting the industry again may mean returning to fundamental fashion principles, like simple, beautiful, and unique pieces.

Figure 4: *Sustainable fashion*

Sustainable fashion is finally coming to the fore and her idea is starting to make sense, and the coronavirus has helped a lot.

After the pandemic that hit us this year and which will last for at least another half a year, we will see the final situation in the economy. And so is the survival of sustainable fashion in the market. The very idea of sustainable fashion now only makes sense when people's collective awareness is awakened, and it depends on the consciousness of the people how long it will be attractive. But we must agree that we will feel the consequences of the coronavirus in this segment of life as well.

In the fashion world, there must be no stagnation as far as the fashion show is concerned. Most of the fashion weeks have been digitized, fashion houses have decided to record fashion shows without an audience and reproduce them online. The feeling is not even close to when the collections are presented live through fashion shows, but it is certainly better that way than not at all. For this reason, fashion houses have decided not to stagnate completely, but that when they already have all the opportunities online to take advantage of it. It is true that the shopping has been significantly reduced, but for that reason the production has also been reduced. That is why quality and handmade clothes finally got space.

The first international Digital Fashion Week was held on September 5, 2020. It attracted a lot of attention from social network users and the event was followed by the majority of the population

dealing with fashion. In this way, fashion responded to the virus that struck us and told him that he would not stop even when it was hardest. It can slow down fashion, but not stop it!

Although everything is online, it is also possible to buy the same models presented at the show.

Figure 5: *Fashion Show*

The first International Fashion Week attracted a lot of attention and everyone started practicing that kind of presentation of fashion shows.

On September 5, 2020, the first "International Digital Fashion Week" was launched, in which talented designers from Serbia and the whole of Southeast Europe participated through this important contract that we signed. Over 300,000,000 viewers around the planet watched the presentation of new collections of 100+ designers from all over the world through digital platforms, TV screens, social networks and play store platforms. The world media called the launch of the IDFW an “epic event” marking the “beginning of a new era” of the fashion industry!

Although we are all eagerly waiting for fashion shows to return to the light as we all know them well, this will become and remain some of the solutions we will face even after the pandemic. Fashion shows will no longer have the same image. Although the models return to the runway, the number of guests is likely to decrease and will no longer be what we have become accustomed to in the last 20 years. I sincerely hope that this situation will not happen, but as everything calmed down, I would not be surprised. It remains to be seen how the situation will develop further.

CONCLUSION

Coronavirus has a significant impact on other industries as well as the textile and fashion industries. Sales have dropped, production has stagnated, a lot of fashion events have been postponed or switched online. Sustainable fashion is becoming a kind of everyday life that we have been encountering more and more in the past year. The consciousness of the people is slowly awakening and they are becoming supporters of this new way of production and purchase. Many fashion industries have significantly reduced production and seasonal collections due to the new crisis that has occurred this year. Many interpret this as the biggest financial crisis in the fashion and textile industry, from which it will recover for many years. The question is, will the fashion industry continue after this crisis in the same course in which it went before the coronavirus, or will it remain in sustainable fashion for the benefit of the planet and the people who live on it. A good question is how long the fashion week itself will be digitalized and whether our favorite designers and design houses will ever return to the catwalk in front of the audience. All we have to do is follow the flow of time and to hope for a normal life again without a mask on our faces.

REFERENCES

[1]https://digitalfashionweek.com/about
[2]http://krpica.inspiringchange.rs/brza-moda/
[3]https://www.bbc.com/news/av/uk-politics-54155449
[4]https://mondo.rs/Magazin/Stil/a1314677/Kako-ce-izgledati-moda-posle-epidemije-korona-virusa.html
[5]https://www.criteo.com/blog/fashion-after-lockdown/
[6]https://www.bbc.com/serbian/lat/svet-52516674
[7]https://www.seebiz.eu/kolumne/tekstilna-industrija-u-vrijeme-pandemije-koronavirusa/239313/
[8]https://www.bbc.com/news/av/uk-politics-54155449

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