Department of Textile and Fashion

Head of Department: Prof. Dr. Genti GUXHO

Scientific Board of the Conference:
Academic Jorgaq KAÇANI  Rector, Polytechnic University of Tirana
Prof. Dr. Genti GUXHO  Vice Rector, Polytechnic University of Tirana
Prof. Dr. Spiro DRUSHKU  Head of Industrial Chemistry Department, University of Tirana
Prof. Asoc. Ermira SHEHI  Textile and Fashion Department, Polytechnic University of Tirana
Prof. Lucas VAN WUNNIK  Polytechnic University of Catalonia
Dr. Ilda KAZANI  Textile and Fashion Department, Polytechnic University of Tirana

The Scientific Board bears no responsibility for the content from the authors of articles included and published in this proceeding

© Department of Textile and Fashion at Polytechnic University of Tirana

ISBN: 978-9928-171-14-6
PREFACE

The Textile and Fashion Department at the Mechanical Engineering Faculty, Polytechnic University of Tirana (PUT) since 2004 every two years organizes the textile conference with the participation of the professors/lectors of the Department of Textile and Fashion, other departments at PUT, University of Tirana and foreign universities with similar research areas in textile technology and textile materials.

The Department of Textile and Fashion in PUT is full member of AUTEX since 2008. The mission of AUTEX (Association of Universities for Textiles) is to facilitate cooperation among members in research and teaching in textile field at the top level. Full members and associates members are consolidated reputable universities in higher education and research in the field of textile. AUTEX was established in 1994. Currently there are 34 members from 28 countries. PUT, Department of Textile and Fashion is accepted as full member in June 2008. The current president is Prof. C. Dominique Adolphe, Université de Haute Alsace, France.

The First Conference of Textile Tirana was organized in July 2004. At the first conference that coinciding with the 20th anniversary of the Textile Department at the Faculty of Mechanical Engineering there were presented 12 papers. (Proceedings book, Scientific Library FIM)

The Second Textile Conference in Tirana was organized in July 2006. At this conference there were presented 12 papers. (Proceedings book, Scientific Library FIM).

The Third International Conference of Textile in Tirana was organized on November 20, 2008 in the framework of FP6 “RETEXRESALB”, in which the Department of Textile and Fashion was the coordinator. The primary objective of conference was technology transfer. There were presented 14 papers. (Proceedings Book ISBN 978-99956-16-27-4).

The Fourth International Conference of Textile in Tirana was organized on November 19, 2010. At this conference there were presented 26 papers. (Proceedings book, Scientific Library FIM).

The Fifth International Conference of Textile in Tirana was organized on December 7, 2012 at this conference there were presented 20 papers. (Proceedings book, Scientific Library FIM).

In the Sixth International Conference of Textile in Tirana, November 20, 2014 organized by the Department of Textile and Fashion in PUT, the participants will be from:
ALBANIA
Polytechnic University of Tirana
Faculty of Mechanical Engineering,
Department of Textile and Fashion
Department of Production and Management
Faculty of Mathematical Engineering and Physical Engineering
Department of Mathematical Engineering
Faculty of electric Engineering
Department of Electrotechnics
Department of Automation Industry
University of Tirana
Faculty of Natural Sciences
Department of Industrial Chemistry
Faculty of Economy
Ministry of Education and Sports, National Agency for Examinations,
Department of admissions and matriculation
Department of database and systems
Albanian Institute for the Research and Education in Information Technology (ISSETI)

CROATIA
University of Zagreb, Zagreb
Faculty of textile technology, Department of Clothing technology

ENGLAND
London College of Fashion, University of the Arts London

FRANCE
University of Haute Alsace
Laboratory of Mechanical and Physical Textiles

MACEDONIA
University of Saint Cyril and Methodius
Faculty of Technology and Metallurgy
University Goce Delčevo
Faculty of Technology, Štip

TURKEY
Anadolu University, Faculty of Architecture and Design
Department of Fashion Design Eskisehir
Ege University
Textile Engineering Department, Izmir
TOPICS OF THE CONFERENCE

Garment Manufacturing
Textile Testing and quality control
Textile Processing
Biopolymers and Biotechnology
Comfort and Wellbeing
Developments in Textile Machinery
E-activities and E-commerce
Ecology and Environment in Textile Production
Fibre Physics and Textile Mechanics
Finishing, Dyeing and Treatment
Medical Textiles
Modelling and Simulation
Nanotextiles
Smart and Interactive Textiles
Supply Chain Management and Logistics
Technical and Protective Textiles
Textile Design and Fashion
Textile Education
INFORMATION ON THE DEPARTMENT OF TEXTILE AND FASHION, PUT

The Textile and Fashion Department (TFD) is unit of the Faculty of Mechanical Engineering at the Polytechnic University of Tirana. The Textile Engineering was established in 1968 in Berat as The Branch of Textile in the Faculty of Engineering at the University of Tirana.

The curricula was based on a 3 years part-time system. In 1984 the department was renamed The Chair of Textile at the Mechanical and Electrical Engineering Faculty, University of Tirana when it changed its curricula into a four and half year’s program in textile engineering. In 1994 it was renamed to The Department of Textile. The academic program covered all the required subjects for the Textile Engineering Diploma.

The '90s were a challenge for the economy, politics and society and also for university education in Albania. In 1991 the group of the engineering oriented faculties created the Polytechnic University of Tirana. During the 90s, the Department of Textile and Fashion started the transformation process of the curricula, syllabuses, and the organization structure and strategy for transforming this department not only into a university teaching units but also into a research and development centre in the field of textile industry. During these years many improvements and modifications have been occurred such as: the introduction of new subjects in the 5-year study cycle e focusing in the garment manufacturing, garment design and marketing of the Textile Laboratory (1996), participation in several Tempus projects etc.

The period 2000 – 2012 was for the Department of Textile and Fashion the transformation decade of curricula and organization in the education system of textile and fashion branch in accordance with the Bologna Declaration signed by the government of the Republic of Albania.

The curriculum in textile and fashion engineering is organized in three study systems:

- Bachelor degree (3 years study) in "Textile Engineering and Fashion" with three orientations
- Master degree (2 years study) in "Textile Engineering and Fashion"
- Doctorate (PhD) school in "Materials Science" orientation "Textile materials" (at least 3 years study and PhD thesis)

It was a great effort and exceptional work of the relatively medium size department for seeking the harmonization of some specific requirements for this study:

- Provision of similar studies with those of western universities
- Adaptation of the academic curricula to the needs of the Albanian labour market.
- Qualification of the staff.

During 2000 - in the curriculum, the focus of our work has been in the staff qualification and research. Thus, only during the last fourteen years have been developed and approved nine micro theses, six doctorates in the textile area. Two achieved in Western universities, one in our
Department other five PhD studies are in process, and 12 post-graduate students, compared to only one PhD thesis during 90s.

The Textile laboratory was accredited under the new standard for accreditation of testing laboratories ISO/IEC 17025 and expanded its activities with the pilot testing of the chemical nature of textiles and leather materials. But during these years the Department of Textile and Fashion has participated and ran five national research projects funded by the Albanian government, two projects "Quality and Equity in Higher Education" funded by the World Bank, an EU FP6 Project. The Department has also participated in a number of Tempus projects, FP7, CARDS and technical expertise in special fields.

The history of the Textile and Fashion Department is closely linked to the enormous work done by its dedicated academic staff. This dedication has resulted in the development of the academic programs, the teaching process, the effort put in scientific research and the publishing of scientific papers.

Since the establishment of the Textile and Fashion Department hundreds of specialists have been graduated in the fields of spinning, weaving, knitting and garment industry. The first group of lecturers were graduates of the Polytechnic University of Lodz, Poland. Among the most celebrated were such figures as Prof. Dr. Taxhedin Baholli, M.Sc Eng. Kozma Xhero, M.Sc. Eng. Eva Budina, M.Sc Eng. Shega Shapllo, M.Sc. Eng. Magdalena Ktona, etc.

The staff has since expanded to accommodate new lecturers. Most of them are graduates of the Polytechnic University of Tirana but there are also graduates of international universities.

TFD has also participated in many national and international cooperative projects, conferences and workshops.
INFORMATION ON TIRANA

Tirana is the capital of Republic of Albania since 1920. Polytechnic University of Tirana (1951), University of Tirana (1957), Agricultural University (1951), Academy of Science (1972), National Library (1922), as well as many museums, among which Museum of National Culture, Museum of Natural Sciences (1948), Museum of Archeology (1948) and Museum of National History (1981) are in Tirana. Tirana has the only international airport “Nene Tereza”. Tirana is only 40 km away from the most important harbor of Albania (Durres). In 2000 the center of Tirana, from the Polytechnic University’s Main Building to Skanderbeg Square, was declared Cultural Heritage.

Geography. Tirana is located 110 meters above the sea level. The average height of the Tirana region is 521 m, while two high mountains near Tirana are Dajti and Mali me Gropa, respectively 1612 m and 1828 m high. The area of the city of Tirana is around 31 km². In Tirana prevails subtropical-Mediterranean climate.
For more information:

Department of Textile and Fashion: www.upt-tekstilmoda.org

AUTEX: www.autex.org

Faculty of Mechanical Engineering www.fim.edu.al

Polytechnic University of Tirana www.upt.al
CONTENTS

PLENARY SECTION...............................................................3

SECTION I: Technology & Textile Materials..................................17

SECTION II: Finishing & Technical Textiles..................................59

SECTION III: Smart Textiles & Advanced Technology....................101

SECTION IV: Garment Manufacturing & Design.............................141

SECTION V: Textile Education..................................................187

SECTION VI: Quality control, Management & logistic....................239

POSTER SESSION......................................................................269

LIST OF AUTHORS....................................................................343
PLENARY SECTION
STATISTICAL SURVEY OF THE PERFORMANCE IN YEARS OF
TEXTILE AND FASHION DEPARTMENT

F. Shakaj¹, A. Fagu², M. Fagu³

¹Ministry of Education and Sports, National Agency for Examinations, Department of admissions and matriculation
f_shakaj@live.com

²Ministry of Education and Sports, National Agency for Examinations, Department of database and systems
arbenfagu@yahoo.com

³Albanian Institute for the Research and Education in Information Technology (ISSETI)
fagumarsela@hotmail.com

Keywords: Textile and Fashion, Date Base, statistical analysis, correlative regressive, average grade, grades of State Graduation (Matura examinations), points collected

Abstract

The purpose of this study is the statistical survey of quantitative and qualitative performance of the last five years of Textile and Fashion Department, of the Faculty of Mechanical Engineering, of the Polytechnic University of Tirana. The performance of this department is compared with the other study programs offered by the faculty.

The methodology used is the statistical analysis methods of general mathematical and correlative regressive analysis, which will not only give us the possibility of creating an accurate picture of performance in years, but will also; give us the prognosis of this performance in the coming years.

The survey will include the statistical analysis of the distribution of students accepted in this study program the last five years, in accordance with: gender, demography (geographical distribution, population stratification and social origin) and quality assessment (average grades, grades Matura exams, points collected). This statistical analysis was compared with other study programs of the faculty and the use of correlative regressive analysis was done in order to study the performance in years and the prognosis for the next few years of the quantitative and qualitative indicators such as: variability of gender ratios, enrolment rate of winners, average points or score, results Matura exams, points collected, etc.

The results of this survey will help the Textile and Fashion Department to be acquainted with the situation and build new policies to attract the best students in this study programme.
Preface

Background on establishing the strategy and policies for the Digitalization of The State Graduation Exams (Twelfth Grade of High School).

a) First Stage: The first attempts to computerize the process of the State Graduation Exams began in 2006, which led to the establishment of a research unit at the Ministry of Education and Science (MES) named Informatics Processing Centre (IPC). In cooperation with the National Educational Centre for Evaluation and Examination (NEC/EE), this center managed and digitalized the whole process of the State Graduation Exams and the accession competitions organized by IALP. The innovations this process brought are:
   - The standardization and computerization of optical reading tests (answers sheet) through OMR (Optical Mark Recognition)
   - The computerization of estimations of points
   - The computerization of points conversion into grades through the cut-off
   - The distribution of winners in various study programs offered by IALP

b) Second Stage: During the State Graduation Exams process in 2007, based on the previous experience on managing the State Graduation Exams process during 2006, QPI’s specialists at MES improved IALP admissions process by introducing the concept of Application Form A2, in which every high school graduate / candidate can freely select no more than 10 preferences for different programs of study offered by IALP’s. Again to read the selected preferences was used the optical reading technology. In order to be more precise regarding the use of this technology, we are presenting the manner of filling key data in this form.

COMPLETION OF AVERAGE MARK BY SUPERVISOR TEACHER:

In the following example there is shown the filling of three different average marks by the supervisor teacher, using Arabic numbers and a coded manner to enable optical reading from OMR or professional programmed Scanners.

COMPLETION OF PREFERENCES FROM STUDY PROGRAMMES BY PUBLIC MATURE GRADE STUDENT / APPLICANT
In the following example there is shown the filling of three selected preferences by the graduated candidate, using Arabic numbers and coded manners to enable optical reading from OMR or professional programmed Scanners.

c) **Third stage:** The attempts of the mentioned teams in the informatics management of the STATE graduation exams 2006-2007 brought as a necessity the institutionalization of the Merit-Preference System and the foundation of the National Agency of Admission in the Higher Education Institutions. The main task of this Agency is:

- Defining the winners among the high school graduates for the University based on the Merit-Preference System explained below:
  - The principle of merit is established based on the accumulated points of high school grades, graduation state exams and for other studying programs based on the specific requirements which are established from the higher education and approved from the Education and Sport Ministry.
  - The principle of preference is set by the will of the candidate, expressed through the top preference chosen by him/her.

In order to explain better the Merit-Preference System and its implementation thanks to the A2 form and the informatics process of distribution of the studying programs offered from IALP, we are making the following explanations:

**The Merit-Preference competition:**

- The principle of Merit is established based on the accumulated points of high school grades, state graduation exams and of other certain study programs like: Arts, Sports, Architecture etc. based on the fulfillment of other criteria proposed from IALP and approved from the Education and Sport Ministry.
- The principle of Preference is established from the will of the candidate, expressed through the 10 or less preferences chosen by him/her.
1. What do we understand by the concept of “Merit”?

- The high school graduate who wants to continue studies in IALP must have won 5 results: an average mark of 4 or 5 years of study in high school, two staggered marks in the obligatory exams of Literature and Mathematics and two staggered marks in optional subjects. Based on these marks, the scores that he/she wins are calculated for each high school graduate and this serves to compete in various study programs of IALP. The much simpler and more usable formula for calculation of points is:

\[
[(D1 + D2 + MES) + DC + Z1\times KZ1 \ Z2\times KZ2]\times 100
\]

where: \(D1, D2, MES, Z1, Z2\) are respectively staggered marks with two digits after the decimal point of literature, mathematics, average school and the subject of the first and second choices.

\(SC\) - is the school coefficient. For each type of school-IALP proposes relevant coefficients depending on the direction of the high school. Said in a simpler way, faculties with study programs for the natural direction prefer high school graduates with more tendencies in exact sciences. All this is done so that Faculties absorb contingents better prepared in the required direction by offering programs of study.

\(KZ1, KZ2\) - are the coefficients of optional subjects, also proposed by IALP’s based on the same reason. For cases, where high school graduates require to study in programs of study that provide competitions as Architecture, Physical Education, Arts, Education specialized, etc., the formula for calculating the score takes into account the results of the competitions according to their importance.

The calculated formula is:

\[
\frac{\text{measured points}}{\text{Max measured points}} \times \%\text{measured} + \frac{\text{contest points}}{\text{max contest points}} \times \%\text{contest}
\]

- At last, we should emphasize that the calculation of points for each high school graduate is made by his high school profile and his preferences for the various programs of study. This way, every high school graduates at the end of high school and four Matura exams has accumulated an amount of points that constitute his merit.

2. What do we understand by the concept of preference?

Starting from 2007, the list of academic programs that IALP offers is made available to high school graduates. This list includes 232 programs of study in 2009 and 265 graduate programs in 2010. All study programs are published in guest-card A2. With the completion of Form A2, the high school graduate expresses his/her wish to study in one of the ten or fewer programs of his
favorite study, and he is announced the winner in the highest preference of the group of preferences where he is announced the winner (so he achieves the necessary points). This means that high school graduates should be very careful in filling preferences.

- **What means selecting and sequencing preferences?**

A high school graduate with very high results, with scores that he/she has collected can be the winner in the ten preferences selected by him, but the system announces him winner of his very first preference. A high school graduate with very poor results is not announced winner in any of his preferences. If the high school graduate has average marks, declaring him the winner depends on the results of the group of the high school graduates who have applied the same study programs as he/she has.

As it looks, the main factor is “Merit”, the amount of the accumulated points.

- **Fourth Stage: Project** “The establishment of an electronic system in use of the state exams evaluation” in the framework of "Quality and Equality in Education “(CBA)”, Procurement Procedure no. MOES/CS/QCBS/001/2010

The indicated objectives of this project

Key objectives of the project are:

The integration of ICT in Albanian educational system will enhance the quality and the efficiency in education and, therefore, will establish greater access to any information and service to all groups of interest.

The aim of this project is creating an online electronic system for the admittance of high school graduates into the institutions of higher public education. For the implementation of this study initially was necessary to establish online supported software (web-based). The basic structure of the system must provide online communication and high security for each action and the confidentiality of personal data for each user who has the rightful use of this system.

1. To gain the right to proceed into Higher Public Educational Institution of the state, each senior who wants to continue his studies in a higher level must complete the A2 form online in any internet access providing area.

To access the State Exams online portal follow the following link:

*matura.akp.gov.al*
So, as shown above in these past 9 years, student admission process into a Higher Public Educational Institution according to the principle Merit-Preference has undergone consecutive qualitative changes reaching the current consolidated system of online application on the State Exams portal.

The purpose of the survey concerned is to carry a statistical survey of the new students flow into the new studying program of Mode and Textile in the last 8 years compared alongside to the same respective data of the Material Engineering study program.

**The Statistical analysis of the student’s application and registrations dynamics**

Firstly, the statistical records of the performance throughout years it's displayed below based on gender. The table 1 reflects these statistics.

A significant statistical indicator, regarding to politics of industry development undertaken by the Government in years, is the index of the quotas approved by the branch executive of the Fashion Textile compared to the Material Engineering.

Fact appeared best in the chart below:

As shown in this chart and additionally in the table above, the number of quotes approved by the Government in 2007 is twice higher in the Material Engineering compared to the studying program of the Fashion Textile.
Table Nr. 1
Number of students gender based throughout academic years

| Academic year | Textile Engineering | | | | Material Engineering | | | |
|---------------|---------------------|---------------------|----------------------|---------------------|---------------------|----------------------|----------------------|
|               | Female | % | Male | % | Total | Female | % | Male | % | Total |
| 2007 - 2008   | 46     | 76.7 | 14   | 23.3 | 60    | 61     | 45.2 | 74   | 54.8 | 135   |
| 2008 - 2009   | 43     | 72.9 | 16   | 27.1 | 59    | 9      | 28.1 | 23   | 71.9 | 32    |
| 2009 - 2010   | 66     | 82.5 | 14   | 17.5 | 80    | 20     | 26.7 | 55   | 73.3 | 75    |
| 2010 - 2011   | 56     | 84.8 | 10   | 15.2 | 66    | 13     | 21.0 | 49   | 79.0 | 62    |
| 2011 - 2012   | 67     | 84.8 | 12   | 15.2 | 79    | 19     | 31.7 | 41   | 68.3 | 60    |
| 2012 - 2013   | 92     | 97.9 | 2    | 2.1  | 94    | 35     | 38.9 | 55   | 61.1 | 90    |
| 2013 - 2014   | 86     | 93.5 | 6    | 6.5  | 92    | 34     | 36.2 | 60   | 63.8 | 94    |
| 2014 - 2015   | 52     | 86.7 | 8    | 13.3 | 60    | 17     | 30.4 | 39   | 69.6 | 56    |
| Average       | 64     | 85.0 | 10   | 15.0 | 74    | 26     | 32.3 | 50   | 67.7 | 76    |

The statistic analysis of the application range and registration of the students

At first, we are presenting the statistic performance of the registrations in years, focusing on gender. We are presenting table nr.1, which reflects this performance from the statistical point of view:

Table Nr. 1
The number of students according to gender through the academic years

| Academic Year | Textile Engineering | | | | Material Engineering | | | |
|---------------|---------------------|---------------------|----------------------|---------------------|---------------------|----------------------|
|               | Females | % | Males | % | Total | Females | % | Males | % | Total |
| 2007 - 2008   | 46       | 76.7 | 14   | 23.3 | 60    | 61      | 45.2 | 74   | 54.8 | 135   |
| 2008 - 2009   | 43       | 72.9 | 16   | 27.1 | 59    | 9       | 28.1 | 23   | 71.9 | 32    |
| 2009 - 2010   | 66       | 82.5 | 14   | 17.5 | 80    | 20      | 26.7 | 55   | 73.3 | 75    |
| 2010 - 2011   | 56       | 84.8 | 10   | 15.2 | 66    | 13      | 21.0 | 49   | 79.0 | 62    |
| 2011 - 2012   | 67       | 84.8 | 12   | 15.2 | 79    | 19      | 31.7 | 41   | 68.3 | 60    |
| 2012 - 2013   | 92       | 97.9 | 2    | 2.1  | 94    | 35      | 38.9 | 55   | 61.1 | 90    |
| 2013 - 2014   | 86       | 93.5 | 6    | 6.5  | 92    | 34      | 36.2 | 60   | 63.8 | 94    |
| 2014 - 2015   | 52       | 86.7 | 8    | 13.3 | 60    | 17      | 30.4 | 39   | 69.6 | 56    |
| Average       | 64       | 85.0 | 10   | 15.0 | 74    | 26      | 32.3 | 50   | 67.7 | 76    |

An important statistical indicator, connected also with industry development policies undertaken by the government in years, is the index of quotas approved by the executive for the Fashion Textile branch compared with Materials Engineering branch. This is best reflected by the chart below:
As shown in this graph and in the table above, in 2007, the number of quotas approved by government was more than two times greater for Material Engineering study program compared to that of Textile Fashion. In the subsequent years the Fashion Textile department’s quotas have always been higher than the comparative department, because in the recent years the Clothing Industry has had a steady rise and consequently has increased its demand for the production engineers of this field of industry.

Another statistic indicator obtained from the study is the variability through the years of the student gender ratio of this department of study. As shown in the table no. 1, as well as the accompanying charts of the gender ratio in all years of the study is in favor of the female gender with an average of 85% versus 15% male in 8 years.
We have taken into consideration the index (indicator) of GPA, which reflects the quality of the senior year students registered in this studying program. The GPA as a high quality indicator of evaluation reflects the average of 5 elements of evaluation quality of senior student, the GPA of 3 years of high school and the marks on the graduation exams:

- The GPA of 3-5 years of high school
- The mark on the Albanian-Literature test
- The mark on the Mathematics test
- The mark on the first optional test
- The mark on the second optional test

<table>
<thead>
<tr>
<th>The academic year</th>
<th>Textile-Fashion ENGINEERING</th>
<th>Material ENGINEERING</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007-2008</td>
<td>6.67</td>
<td>6.35</td>
<td>0.32</td>
</tr>
<tr>
<td>2008-2009</td>
<td>6.91</td>
<td>5.84</td>
<td>1.07</td>
</tr>
<tr>
<td>2009-2010</td>
<td>7.5</td>
<td>6.8</td>
<td>0.7</td>
</tr>
<tr>
<td>2010-2011</td>
<td>7.16</td>
<td>6.65</td>
<td>0.51</td>
</tr>
<tr>
<td>2011-2012</td>
<td>7.28</td>
<td>6.9</td>
<td>0.38</td>
</tr>
<tr>
<td>2012-2013</td>
<td>7.44</td>
<td>7.04</td>
<td>0.4</td>
</tr>
<tr>
<td>2013-2014</td>
<td>7.7</td>
<td>7.17</td>
<td>0.53</td>
</tr>
<tr>
<td>2014-2015</td>
<td>7.65</td>
<td>7.34</td>
<td>0.31</td>
</tr>
<tr>
<td>The GPA</td>
<td>7.29</td>
<td>6.76</td>
<td>0.53</td>
</tr>
</tbody>
</table>
As it can be seen from the above table the index of evaluation of seniors accepted as students at the Textile-Fashion engineering has experienced an increase through years and higher by comparing the same index with the Material engineering. So this studying program is chosen by students with a higher index based on these 8 years of study. As it can be seen the students accepted in the Textile engineering have the GPA 7.39, so 0.53 higher than the Material Engineering. The two charts below explain graphically this phenomenon.

The graphic shown in the figure nr.5 can be used to study the trend of this index based on the use of the correlative-regressive analyze below:

As it’s seen the correlation among the two indexes taken in study, academic year and GPA of the 5 indicators of evaluation is very powerful. The correlation coefficient R=0.87 and the coefficient of representation is 0.76. The regressive equation y=0.128x + 6.7129 can be used for the prediction of probable GPA in the following years.
Below we are presenting the GPA based on gender

<table>
<thead>
<tr>
<th>Academic year</th>
<th>GPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015-2016</td>
<td>7.8649</td>
</tr>
<tr>
<td>2016-2017</td>
<td>7.9929</td>
</tr>
<tr>
<td>2017-2018</td>
<td>8.1209</td>
</tr>
</tbody>
</table>

TABLE NR.3  
The GPA of students based on gender through the academic years

<table>
<thead>
<tr>
<th>The academic year</th>
<th>Textile-Fashion ENGINEERING</th>
<th>Material ENGINEERING</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>2007-2008</td>
<td>6.65</td>
<td>6.7</td>
<td>6.47</td>
</tr>
<tr>
<td>2008-2009</td>
<td>6.91</td>
<td>6.92</td>
<td>6.15</td>
</tr>
<tr>
<td>2009-2010</td>
<td>7.53</td>
<td>7.36</td>
<td>7.1</td>
</tr>
<tr>
<td>2010-2011</td>
<td>7.18</td>
<td>7.05</td>
<td>6.9</td>
</tr>
<tr>
<td>2011-2012</td>
<td>7.33</td>
<td>7.01</td>
<td>7</td>
</tr>
<tr>
<td>2012-2013</td>
<td>7.45</td>
<td>7.39</td>
<td>7.3</td>
</tr>
<tr>
<td>2013-2014</td>
<td>7.7</td>
<td>7.6</td>
<td>7.2</td>
</tr>
<tr>
<td>2014-2015</td>
<td>7.68</td>
<td>7.43</td>
<td>7.3</td>
</tr>
<tr>
<td>The GPA</td>
<td>7.30</td>
<td>7.18</td>
<td>6.93</td>
</tr>
</tbody>
</table>

From the observation of the two diagrams above it’s clear that the female student who follow the Textile engineering have higher grades during high school. The same difference can be seen in the quality of the students (male and female) who follow textile-mode engineering compared with material engineering.
### TABLE NR.5

The average points of students through the academic year

<table>
<thead>
<tr>
<th>The academic year</th>
<th>Textile-Fashion ENGINEERING</th>
<th>Material ENGINEERING</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007-2008</td>
<td>4231.88</td>
<td>3834.68</td>
<td>397.2</td>
</tr>
<tr>
<td>2008-2009</td>
<td>4361.3</td>
<td>3375.98</td>
<td>985.32</td>
</tr>
<tr>
<td>2009-2010</td>
<td>4710.46</td>
<td>4236.48</td>
<td>473.98</td>
</tr>
<tr>
<td>2010-2011</td>
<td>4562.92</td>
<td>4210.03</td>
<td>352.89</td>
</tr>
<tr>
<td>2011-2012</td>
<td>4582.63</td>
<td>4540.63</td>
<td>263.97</td>
</tr>
<tr>
<td>2012-2013</td>
<td>4782.63</td>
<td>4540.63</td>
<td>242</td>
</tr>
<tr>
<td>2013-2014</td>
<td>5013.99</td>
<td>4700.87</td>
<td>313.12</td>
</tr>
<tr>
<td>2014-2015</td>
<td>5234.8</td>
<td>5019.9</td>
<td>214.9</td>
</tr>
<tr>
<td>The GPA</td>
<td>4719.9</td>
<td>4314.1775</td>
<td>405.4225</td>
</tr>
</tbody>
</table>
Fig. nr. 9
The variety of max and min points through the years
Textile-Fashion department

Fig. nr. 10
The GPA through the years
SECTION I: Technology & Textile Materials
ECONOMIC AND TECHNICAL CONSIDERATIONS ON POTENTIAL RECURSES OF ALBANIA IN TEXTILE NATURAL FIBERS

G. Guxho

Polytechnic University of Tirana, Department of Textile and Fashion, Square ‘Mother Teresa’, No. 4, Tirana, Albania
gguxho@fim.edu.al

Keywords: natural textile fibers, consumption of fibers, production of fibers, classification according quality, fiber price

Abstract

The paper’s aim is to present some economic considerations on natural textile fibers, historically produced in Albania, based on their quality and feasibility. Natural textile fibers, traditionally produced in Albania are: sheep’s and goat’s wool, cotton, silk, hemp, flax and Spanish broom. Also, there were a short-lived and non-productive tentative in producing natural textile fibers from agave. The highest point in natural fibers production was the period 1950-1990, when Albania has developed a large textile industry based on natural fibers. However, for most of them cultivation and production has date long before, but them was aimed to export or for handicraft products (wool and flax from ancient times, cotton at least from 17th century, silk from 16th century and hemp from 1st century). The world history of production and consuming of natural textile, fibers has its ups and downs, especially after introducing the synthetic and regenerated fibers in the beginning of last century. Meanwhile, nowadays global demand of natural fibers is growing exponentially and global consuming of them has a new perspective due to their ability to be environmental and human friendly.

1- Introduction

In Albania the hay day for the production of natural textile fibers intended for industry was during 1950-1990. However, for some of them we can say that cultivation had started long ago, and was intended for export or for local craft products (wool fiber and flax from ancient times, cotton since at least the 17th century, silk fibres 16th century, hemp fibers 1st century).
Animal fibers

Silk. Albania is among the European countries, which has cultivated and processed natural silk. Greater development of this industry has taken place between the 16th century and the 19th, at which time its cultivation became a family tradition, for weaving fabrics, handcrafted clothes and for trade with neighbouring countries. [1] In the following centuries the principal place of silkworm cultivation in Albania, was Shkodra. The variety of silk worms in the Shkodra area manifest great bio – technological value, so distinct from other varieties of Bombyx mori, that now is known as "Seta Scutarina". [2] During the last century (20th), natural silk production in Albania has experienced highs and lows: after World War I it dramatically decreased due to many factors, prebine epidemic [3] and the introduction of artificial fibers, which tried to imitate silk . The second period is that after World War II until 1990, when the Albanian economy was concentrated in the hands of the state by reducing private silk production. The first State run Station had 5 silk production lines. Its role was scientific work and the production of 30 kg eggs each year of hybrids silkworms. A station for egg production of silk was built near the city of Tirana (Kërrabë). During the same period it was experimented with the growth of oak silk, which had inferior properties compared with mulberry silk. During this period were planted over 1 million mulberry trees. The third period is that after 90 years, when the silk industry was destroyed as a result of major political changes in Albania. In the last 20 years there have been several attempts to re-optimize the industry but without success.

Wool Fibers. Among raw textile materials that are produced in Albania, protein fibers (fibers of animal origin) are the earliest fibers produced and the ones most produced. This is due to:

- Geographical position of Albania near to the growers and producers of the earliest products with fibers of animal origin. The multipurpose characteristics of animals farmed
- The irreplaceable and precious value of the fiber of animal origin in terms of quality and natural production limitations.
- Specific characteristics of economic development [4]
- Distribution of races that are the source of woolen textile fibers is shown in Figure 1.

While the production of wool fibers in Albania has increased after 1990, their quality has dropped, due to lack of destination. The number of livestock has increased and increasingly the
structure of the races has changed because of their import. [4] The sale price of wool fibers in the domestic market has shown a reverse tendency to that of the global market, as appears from the Graph 4.

Graph 3 Wool production in Albania [5][6]

Graph 4 Price of wool in internal market and price’s trend in global market [6]

Plant’s fibers

Cotton. Albania has cultivated cotton since at least the 17th century. Tirana area has been renowned for the cultivation of this crop farmed in the period when the Albanian territories were part of the Ottoman Empire. Cotton continued to be cultivated in Albania, but to be perfectly honest this culture really developed after World War II. Albania's communist government with the help of the former USSR and later the People’s Republic of China established a network for industrial processing of cotton fiber and cotton textile production or its mixtures with synthetic fiber. Tirana, Berat, Korça were major centres of industrial textiles and cotton fields in Myzeqe was the main area of cotton cultivation in Albania. The largest production of cotton in Albania was during the 1980s, and during the early 1960s, Albania also exported cotton fibers. Albania due to the installation of large cotton processing factories was forced to import large quantities of cotton, often equal in weight to its annual output. Areas where cotton is cultivated in our country are: Vlora, Delvina, Berat, Durres, Tirana, and the largest manufacture has been Fier. [7]
Spanish Broom or Spartium junceum, has been known since antiquity for its use as a textile fiber. Cultivating broom for textile purposes has been concentrated in the Mediterranean basin, particularly in Albania, France, Greece, Spain and Italy [8]. Larger studies to revitalize broom for textile production are concentrated in Italy, in the area of Arbëresh villages. It is widely cultivated in Albania. In Albania it grows mainly in Mediterranean forest and shrub areas (height up to about 700 m) mainly in the western and southwestern regions. In the second half of the 20th century in Saranda and Vlora there were factories producing ropes and rugs from the broom. However, with the introduction of synthetic fibers, as in Europe, there was a drop in interest for this plant. Unfortunately, today in these areas this plant is used only for the production of cleaning brooms. It grows wild in the hilly area of Saranda (Lukovë, Borsh, Nivicë, etc.)

**Hemp.** Most industrial hemp for fiber and textiles nowadays is produced in China. Separation of fibers from steam (retting) is made in water, in order to better control the process and to produce high quality fiber. Unlike Spanish broom, hemp fibers require long preparation of the water that will be used separating them from the stem, in order to obtain fibers capable of producing high quality textiles. [9] Albania, as part of the Balkan Peninsula, has been the subject of the spread of the hemp plant, from the 1st century BC. There are no accurate records on the use of the hemp plant in Albania but literature suggests that Albanians have been the first country in Europe to be aware of the hemp plant and it is part of their indigenous linguistics. As part of Roman culture, of course, today's settlements in Albania have known the manifold uses of the hemp plant and have used them. It has been documented that hemp textile fiber was available in Albania on the 14th - 15th century. [10]. Albania established the first factory processing industrial hemp in 1946. This factory was destined for processing Spanish broom and hemp, for the production of ropes [9].

**Flax or Linum usitatissimum** is used in Albania since prehistorically times (around 3500 BC). The use of flax since ancient times has caused for other similar cotton and silk products to be referred to by that name. Together with hemp it was used throughout the 20th century for the production of ropes.

**Agave.** In the southern coast of Albania (mainly in the limestone cliffs of the Vlora and Saranda areas) in the area of the Mediterranean shrubs, endemic plants of the Agave americana has been cultivated for industrial intentions, in fact, the Agave americana was cultivated in Albania for experimental purposes during 1970-1980 for the production of rope. Although now there is little, if any interest in the industrial sense, this plant has survived and has won in the rivalry with other native plants. From year 2009 the Albanian government does not allow the entry of Agave americana plants in Albania and are considered as invasive plants.
2- Study method

The economic evaluation is based on the data of potential production prior to the year 1990 and the qualitative characteristics of the fibers according to the latest Albanian studies. The study of economic value is focused on income that could have been accumulated from the direct sale of the products in the world market without analyzing profits that the industrial processing in the native market or the production costs. For both variables it has been thought that they would simply bring advantages for Albania through income benefits from its sale in global markets. The experimental results have been used to classify by quality of the fibers produced in Albania and to set a real correlation with the global market value.

3- Experimental results

The experimental results were obtained from recent studies conducted for classification of quality of domestic textile fibers. The exception is cotton, for which the date prior to 1990 was used. Table 1 gives some valuable features for classifying the quality of fibers produced in our country.

<table>
<thead>
<tr>
<th>Fibers</th>
<th>Finesses (μm)</th>
<th>Finesses (number)</th>
<th>Length (mm)</th>
<th>Tensile strength (cN)</th>
<th>Tenacity (G/tex)</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wool</td>
<td>27.5-32.5</td>
<td></td>
<td>100-250</td>
<td>9-18</td>
<td></td>
<td>[14,15,16]</td>
</tr>
<tr>
<td>Silk</td>
<td>20-32</td>
<td>21-50den</td>
<td>Filament</td>
<td>60-150</td>
<td>22-46</td>
<td>[1]</td>
</tr>
<tr>
<td>Spanish broom</td>
<td>30-34</td>
<td></td>
<td>300-1000 (47*)</td>
<td>12-14</td>
<td></td>
<td>[17]</td>
</tr>
<tr>
<td>Hemp</td>
<td>2.32tex</td>
<td></td>
<td>20-22</td>
<td>18</td>
<td>32-67</td>
<td>[13]</td>
</tr>
<tr>
<td>Flax</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>[18]</td>
</tr>
<tr>
<td>Cotton</td>
<td>N_m,5000-7000</td>
<td></td>
<td>&gt;30mm</td>
<td>3-4</td>
<td>16-60</td>
<td>[19]</td>
</tr>
</tbody>
</table>

*) individual fibers

Qualitative characteristics of the fibers produced in our country are such that make their production competitive in the global market. According to the data in Table 1, the wool fibers can be classified into cross breed average (medium crossbred), silk is the middle class and low specificity and cotton has average length.

4- Economic evaluation

In assessing the economic impact we will rely mainly on the average selling prices of natural fib textiles in the global market (Table 2)
### Table 2: Current prices in global market of fibers under consideration [6]

<table>
<thead>
<tr>
<th>Fibers</th>
<th>Price $/ton</th>
<th>Variance (s) $/ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pambuku</td>
<td>2001.8</td>
<td>1286</td>
</tr>
<tr>
<td>Kërpi *)</td>
<td>754</td>
<td>101</td>
</tr>
<tr>
<td>Leshi</td>
<td>1993.6</td>
<td>1512.8</td>
</tr>
<tr>
<td>Mëndafshi</td>
<td>7061.72</td>
<td>7158.55</td>
</tr>
<tr>
<td>Liri</td>
<td>601.6</td>
<td>95</td>
</tr>
<tr>
<td>Agave</td>
<td>325</td>
<td>44</td>
</tr>
</tbody>
</table>

*) Price is given for European short industrial

Just as prices and production of natural fibers in the world has experienced fluctuations arising from factors that do not always relate to the market (egg, weather conditions). Figure 7 gives the global production of natural fibers. In the economic evaluation the most important factor is the quality classification of fibers. Classification and fiber test results directly lead to a price corresponding structure. [20]

![Graph 7: Global production of natural textile fibers (mln ton) [6].](image1)

![Graph 8: Variance of prices of plant fibers ($/ton) [6].](image2)

![Graph 9: Variance of prices of animal fibers ($/ton) [6].](image3)

![Graph 10: Trade balance of Albania for “textile and footwear” (mln leks).](image4)
Evaluation of fiber production in Albania is based on the most optimistic scenarios in years, avoiding the analysis of natural factors and socio-economic factors. However, this simplified analysis can give us an estimate if the revitalization of textile fiber production in our country is to be achieved.

Table 3 Potential production of natural textile fibers in Albania

<table>
<thead>
<tr>
<th>Fibers</th>
<th>Production (ton)</th>
<th>Price USD/ton</th>
<th>Value USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wool</td>
<td>4,000 (1995)</td>
<td>1993.6</td>
<td>7,974,400</td>
</tr>
<tr>
<td>Silk</td>
<td>500</td>
<td>7061.7</td>
<td>3,530,850</td>
</tr>
<tr>
<td>Spanish Broom</td>
<td>3,000*)</td>
<td>4098**)</td>
<td>1,227,000</td>
</tr>
<tr>
<td>Hemp</td>
<td>2,500*)</td>
<td>754</td>
<td>1,885,000</td>
</tr>
<tr>
<td>Agave</td>
<td>1,500*)</td>
<td>325</td>
<td>487,500</td>
</tr>
<tr>
<td>Flax</td>
<td>2,200*)</td>
<td>601.6</td>
<td>1,323,520</td>
</tr>
<tr>
<td>**Total</td>
<td></td>
<td></td>
<td><strong>67,153,620</strong></td>
</tr>
</tbody>
</table>

*) approximate value based on area harvest [5]
**) approximate price from secondary data [6]

Among the fibers produced in Albania we can especially mention wool fibers, which are still produced in large quantities. For all natural fibers the data used is the one in the best year of production.

In terms of foreign trade Albania has a negative balance, which has been softened over the last 3-4 years. One of the major contributors to alleviate the negative balance of foreign trade in Albania is the group of goods "Textile and footwear". Albania's trade balance is covered only by about 40-45% and one of the priorities of government policies is the alleviation of the negative balance. As indicated by the graphs 14 and 15, the group of goods "Textile and footwear" exports (including textile raw materials), not only has undergone dramatic increase in exports over the last decade, but is the only positive voice of the balance at least since 2004 onwards with steady growth trend.

If we examine the current values of exports of fibers in more detail (HS¹ 50, 51, 52 dhe 53), as an alternative to understand the levels of production of natural fibers in our country, we notice that exports in the last 10-12 years have hit these peaks: for wool fibers in 2011 with about 437 tons (3,400 tons from the total production was in 2011), the silk fibers in 2004 with 32 tons of vegetable fibers and blast fibers (plant fibers without cotton) in 2005, 28 tons. In the absence of a processing industry in the country, it seems that the production of natural fibers available for

¹ HS – Harmonized System. of tariff nomenclature is an internationally standardized system of names and numbers to classify traded products. It came into effect in 1988 and has since been developed and maintained by the World Customs Organization (WCO).
textile industry in Albania is almost deserted. The annual value of exports of natural fiber textiles in good years is about $400,000 or only 0.13% of Albania's exports in the "textile"

![Graph 11 Exports of wool fibers (in USD and in kg) [21]](graph11)

Likewise, the area planted with vegetable fibers has fallen drastically, especially after 1990. Meanwhile, in Albania, about 200,000 hectares of agricultural land are unused, data by INSTAT.

Value added in export, if using the potential of production of natural raw materials, and if they will not be processed in the country, is around 10%. If so, there would a fivefold improvement in Albania's trade balance in the "textile" area and it would soften the negative overall trade balance by 20% (see Table 3 and graphs 15 and 16). But, beyond direct revenue, the development of this sector, of manufacturing natural textile raw materials would have important implications for employment and environmental protection. Similarly, the production of natural textile fibers associated with additional benefits of raw paper industry (the case of fibers of plant origin) and in some cases other additional raw materials for the pharmaceutical industry and cosmetics.

![Graph 13 Exports of blast fibers (in USD and kg) [21]](graph13)

**5- Conclusions**

Production of textile fibers in Albania has a long history, which has been conditioned by its geographical position as a country with Mediterranean climate and being nearby many larger centers of textile production in the world. This production has seen significant fluctuations as
anywhere in the world. Natural textile fibers produced in Albania have qualitative characteristics suitable for industrial processing, as can be verified by laboratory data. Textile Industry as an important contributor to the economy of the country and since it occupies first place in Albania's industrial exports, would have more opportunities to increase exports and production through a closed cycle if it was served from domestic raw materials. This would boost the possibility of increasing added value that Albania offers to the global market and stop/end a labor exporting economy. At the same time, it will decrease the percentage it coverage in the import / export balance, in a sector with such a significant positive trend.

The above analysis does not take into account the possibility, potentially large, of processing these raw materials and then export them to add a value even greater. Moreover, the structure of exports of manufactured goods to Albania remains rigid and stuck mainly in textiles and footwear, while the food industry sectors and metalworking have no essential importance, [23] although it may be based on local raw materials. Likewise, it becomes even more important if we consider that more and more in the structure of exported manufactured goods, we see an increase in paper [23], the raw material for fiber which can be not only from pulp timber. The ability of bio-degradation and in most cases better mechanical characteristics than glass or carbon fibers, create a significant advantage for natural fibers not only in textiles, but also in technical textiles and composite (used as the reinforcement material in matrix). Revival of textile fiber production in our country would have an effect on the production of raw materials for export or for domestic industrial processing. In the world we see a trend for the revitalization of natural fibers, which may have lost ground due to the cheap price of synthetic fibers, economic exigencies, policy development etc. Today naturally, along with care for the environment and limited resources for the petrochemical industry that produces synthetic fibers, attention was turned to natural fibers and Albania can make a quick comeback to the production of natural fibers and with a colossal benefit not only economic one.
References


[8] Progetto GANTT (Ginestra, Arte, Natura e Tecnologia Tessile), 2008


[16] Guxho, G. Shehu Y., Nika V. Experimental assessment of physical characteristics (length and crimp) of textile proteinic fibers from Albanian breeds Albanian Journal of Natural and Technical Sciences, 2009 Vëllimi 2 faqe 3


[22] INSTAT “Ecuria e tregtisë së jashtme”, Tirane 2013


27
EXPERIMENTAL EVALUATION OF TRANSVERSAL FRICTION BETWEEN FIBERS

A. Sinoimeri, H. E. Gassara, W. C. Wagner Kocher, G. Barbier

1 University of Haute Alsace, Laboratory of Mechanical and Physical Textiles
11, rue Alfred Werner, 68093 Mulhouse, France
artan.sinoimeri@uha.fr

Keywords: friction, fiber, modeling

Abstract

The mechanical behavior of fibrous assemblies, particularly the transverse behavior of fiber yarns and multifilament strands depends, inter alia, on the fiber-to-fiber contact and sliding. All studies on interfiber friction presented in the literature focus on cases where the relative interfiber motion occurs either in longitudinal-to-longitudinal or longitudinal-to-transverse direction. The transversal-to-transversal interfiber friction plays an important role as far as the mechanical transverse behavior of fiber yarns and multifilament strands are concerned. Knowledge of law of transverse compression behavior is a relatively important lock at numerical modeling of the mechanical behavior of fibrous structures. Note that measuring of the frictional properties of very fine fibers is not easy because of very low levels of normal and tangential interfiber forces developed during the fiber contact. The present study proposes an original method to evaluate the case named here ‘transversal friction’.

Introduction

During the processing of fiber assemblies in a well-organized structure, either yarn or thin or 3-dimensional fabrics, the fiber characteristics play an important role in the properties of the final product. Depending on the fiber type – staple or filament one –, many researchers have been carried out to study the effects of fiber length, distribution in length, fiber fineness, tensile properties, etc. on the mechanical properties of final products. However, very few studies are concerned with fiber surface properties, and especially their frictional properties. This is despite the common assumption that during the fiber-to-fabric transformation process as well as during the fabric use, the relative fiber slippage influences significantly the fabric structure and its mechanical behavior. Particularly, the yarn and/or fabric transverse compression behavior is a
relatively important lock at numerical modeling of the mechanical behavior of fibrous structures in 3-dimensional composite structures.

**Backgrounds**

The frictional force can be calculated following the Amontons approach (1663-1705: when two bodies slide over each other with a certain speed $v$, the tangential frictional force $F$ is proportional to the coefficient $\mu$ of friction and the normal force $N$ as follows:

$$ F = \mu \cdot N $$

(1)

However, as shown by Coulomb (1736-1806), Amontons law is not rigorously observed as it is necessary to consider the nature and extent of the contact surfaces, the presence of fluid on the surfaces (the third body), the surface pressure, etc.

Since 1950, the shear-adhesion theory of Bowden and Tabor [1] proposed new methods in the study of friction and cohesion. According to this theory the frictional force $F$ is generally connected to the normal force $N$ using the following equation:

$$ F = \alpha \cdot N^n $$

(2)

where the $n$ index takes into account the type of deformation (plastic, elastic…etc) of the micro asperities of the two bodies in contact.

Let’s consider now the fiber surfaces. Due to spinning and drawing processes of man-made fibers, their surface characteristics are generally oriented longitudinally, as it can be seen from Figure 1. It follows that fiber-to-fiber or fiber-to-other bodies frictional behavior will depend strongly on the direction of inter-surface movement relative to the fiber axiss.
In the scientific literature, we can find a lot of studies and measuring devices concerning fiber-to-fiber and fiber-to-other body friction. Despite the large number of these devices, they can be classified in two main groups according to their measuring principles: \( l-t \) friction measurement type (case a in Figure 2) and \( l-l \) friction measurement type (case b in Figure 2). Unfortunately, nothing is proposed in the experimental literature on the \( t-t \) friction measurement type (case c in Figure 2).

Howell [2] used a simple device (Figure 2-b). A filament C is suspended from a fixed point A at a weight W. A second filament is mounted horizontally on a horizontal frame B. The E filament is brought into contact with the filament C until it makes an angle to the vertical. When this position is reached, the frame B is moved in the direction of the arrow. Due to the frictional force, the fiber E drags the fiber C until an equilibrium position. Then fiber C slides back to a distance L. From simple considerations, the author concludes that \( \mu = \frac{L}{S} \).

\[
\mu = \frac{F}{W}
\]  

(3)
The method of "twist" to measure the inter-fiber friction was developed by Lindberg and Gralen [3]. In this method two filaments A and B are twisted together n times, the angle between the filaments during torsion is noted \( \theta \). A known force \( P_1 \) is first applied to both filaments (see Figure 2-a). By releasing one end of one of the filaments and charging the other end by a force \( P_2 \), a sliding occurs; this gives the value of the static friction force. The coefficient of static friction is given by and Lindberg Gralen as follows:

\[
\mu = \frac{\ln \frac{P_2}{P_1}}{\pi n \beta}
\]

where \( P_2 = P_1 \cdot e^{\mu \pi n \beta} \)  \hspace{1cm} (4)

El Mogahzy [4] has developed another equation that characterizes the friction measured by Lindberg device:

\[
\mu = a \left[ P_1 \beta^2 / 4r \right]^{-1}
\]

where \( P_2 = P_1 \cdot e^{\left[ \pi n \beta \left( P_1 \beta^2 / 4r \right)^{n-1} \right]} \)

\hspace{1cm} (5)

From what is stated above, it appears that:

- the interfiber friction in the transverse direction, t-t is not yet measured by any existing device;
- this transversal friction cannot be deduced from measurements in other directions.
Materials and methods

A first experimental device was designed to measure frictional forces between the two filaments in contact. Two filaments are subjected to controlled tensions, equal or different, and then placed, as in Figure 4, in contact. The horizontal and vertical contact angels can be chosen freely. Thereafter, the ends of one of the fibers are moved according to the figure. Friction prevents relative movement at the contact point, but later, when the tangential force due to fiber tensioning becomes higher than the fiber-to-fiber frictional force, the slippage occurs abruptly. Direct measuring of interfiber forces, normal and tangential, is very difficult due to their very low levels. On the other hand, the use of any contact sensor perturbs substantially the measure itself. For this reason, the authors have chosen to evaluate these forces by considering the equilibrium state (see Figure 4).

![Experimental device](image)

**Figure 3.** Experimental device

Two digital cameras follow the position of each filament in terms of horizontal and vertical angles as shown in Figure 4.
Dotted lines show the initial configuration of filaments after being contacted together and before the relative movement takes place, whereas full lines represent the filament position just before the slippage occurs. Point C and C’ represent the contact point at these two moments.

Let’s note $F_1$ and $F_2$ the frictional forces between the two filaments and $R$ the normal force. The projection of $F_1$ and $F_2$ on two virtual directions, the first one given by the angle $\alpha_{AB}$ which is equal to $(\alpha_A - \alpha_B)/2$, and the second given similarly by $\alpha_{DE}$ which is equal to $(\alpha_D - \alpha_E)/2$, will lead to the calculated the forces $F_{L1}$ and $F_{L2}$ which are respectively the longitudinal and transversal friction forces acting on the filament 1. If the force $R$ is known, the longitudinal and transversal frictional coefficients may be easily calculated by the ratio $F/R$.

In the present case, only are known the forces $F_B$ and $F_E$, given by two calibrated weights, as well as the different angles. In order to calculate the unknown variables – $F_1$, $F_2$, $R$, $F_A$ and $F_D$ – five equations are necessary. We have 9 equations provided by static equilibrium following x and y directions: equilibrium of moving filament alone, equilibrium of fixed filament alone, and equilibrium of the two filaments considered together.

Finally the equilibrium state may be written as follows:

$$
\begin{pmatrix}
A_{11} & \cdots & A_{15} \\
\vdots & \ddots & \vdots \\
A_{91} & \cdots & A_{95}
\end{pmatrix}
\begin{pmatrix}
F_1 \\
F_2 \\
R \\
F_A \\
F_D
\end{pmatrix} =
\begin{pmatrix}
B_1 \\
B_2 \\
\vdots \\
B_9
\end{pmatrix}
$$
For such a system has a unique solution, it is necessary that the rank of the matrix $A$ is different from the rank of the matrix $(A \mid B)$, which is not the case because of the angle measurement errors. It is useful in this case to use the least squares method and find an approximate solution such that:

$$\text{Min} \cdot |IAF-BI|^2 = (AF-B)^T(AF-B)$$

(7)

**Results and discussion**

At this point, a set of variables to be changed is determined. These variables are:

- $AV$: initial vertical angle between filaments;
- $AH$: initial horizontal angle between filaments;
- $F_B$ and $F_E$;

It seems interesting to check first if the results are significant, i.e. if the results are affected by errors. Four replications have been carried out in the same conditions: the same initials points, same hygrometric conditions, but changing the filaments at each trial. The $R^2$ regression has been calculated by the formulae:

$$R^2 = \frac{(A,F)^T(A,F)-(B)^T(B)}{B^TB-(B)^T(B)}$$

(8)

as well as mean values, standard deviation and interval coefficients. Table 1 summarized these results.

**Table 1. Analyses of Variance**

<table>
<thead>
<tr>
<th></th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
<th>Trial 4</th>
<th>Mean</th>
<th>St. deviation</th>
<th>Confidence Interval $\bar{a}=0.05$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$AH(\degree)$</td>
<td>20,424</td>
<td>20,392</td>
<td>20,358</td>
<td>20,490</td>
<td>20,416</td>
<td>0.05607</td>
<td>0.08922</td>
</tr>
<tr>
<td>$AV(\degree)$</td>
<td>6,202</td>
<td>6,250</td>
<td>6,345</td>
<td>6,283</td>
<td>6,270</td>
<td>0.06014</td>
<td>0.09570</td>
</tr>
<tr>
<td>$Flm$</td>
<td>0.896</td>
<td>0.909</td>
<td>0.836</td>
<td>0.843</td>
<td>0.871</td>
<td>0.03707</td>
<td>0.05899</td>
</tr>
<tr>
<td>$Fnm$</td>
<td>0.171</td>
<td>0.186</td>
<td>0.165</td>
<td>0.172</td>
<td>0.173</td>
<td>0.00898</td>
<td>0.01429</td>
</tr>
<tr>
<td>$Flf$</td>
<td>0.899</td>
<td>0.917</td>
<td>0.840</td>
<td>0.850</td>
<td>0.876</td>
<td>0.03715</td>
<td>0.05912</td>
</tr>
<tr>
<td>$Fnf$</td>
<td>0.156</td>
<td>0.145</td>
<td>0.139</td>
<td>0.135</td>
<td>0.144</td>
<td>0.00898</td>
<td>0.01429</td>
</tr>
<tr>
<td>$R2$</td>
<td>0.9996</td>
<td>0.9996</td>
<td>0.9996</td>
<td>0.9996</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Where:

$Flm$ : the coefficient of longitudinal friction calculated for the moving filament ;
Fnm : the coefficient of transversal friction calculated for the moving filament;

Flf : the coefficient of longitudinal friction calculated for the fixed filament;

Fnf : the coefficient of transversal friction calculated for the fixed filament;

The variance of the vector F has been calculated following the formulae:

\[
\text{Var}(F) = \sigma^2 (A^T A)^{-1} \text{ with } \sigma^2 = \frac{\sum e^2}{n-1}
\]

(9)

Table 2 summarized these results.

<table>
<thead>
<tr>
<th></th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
<th>Trial 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{Var}(F_1) )</td>
<td>0.00059</td>
<td>0.00059</td>
<td>0.00058</td>
<td>0.00058</td>
</tr>
<tr>
<td>( \text{Var}(F_2) )</td>
<td>0.00359</td>
<td>0.00356</td>
<td>0.00355</td>
<td>0.00353</td>
</tr>
<tr>
<td>( \text{Var}(R) )</td>
<td>0.00056</td>
<td>0.00056</td>
<td>0.00055</td>
<td>0.00055</td>
</tr>
<tr>
<td>( \text{Var}(F_A) )</td>
<td>0.00356</td>
<td>0.00352</td>
<td>0.00352</td>
<td>0.00349</td>
</tr>
<tr>
<td>( \text{Var}(F_D) )</td>
<td>0.00342</td>
<td>0.00339</td>
<td>0.00338</td>
<td>0.00335</td>
</tr>
</tbody>
</table>

From these results, it appears that the device, as well as the mathematical approach which is attached to it, are not significantly affected by measurement errors.

Let’s see the effects of device experimental variables - initial AH, AV and \( F_B, F_E \) – on the calculated frictional coefficients. Figure 5 visualizes the effects of these initial variables.
The initial angles affect strongly the friction coefficients. From (a) and (b) cases, it can be concluded that the increase in contact angle leads to a decrease in the friction coefficients. These results may be explained by the fact that where the angles increase, it causes a reduction of the contact surface. In our model, the contact surface is not involved, which could mean that the model of frictional behavior should not follow the Amontons form, but probably a power model (similar to equation 2), as specified for certain polymeric materials studied by the authors (not referred here).

**Conclusion**

Measuring the frictional properties of fibrous materials or fibers seems to be a difficult topic, first due to the smallness of dimensions and forces involved, and second due to the perturbation caused by the use of eventual force or displacement sensors.
A new device has been developed and shows a stability as far as the error effects are concerned. Nevertheless, the results obtained suggest that it would be interesting to evaluate the interfiber contact surfaces and introduce them in the frictional model.

References

CAN NATURAL PRODUCTS’ WASTES BE REUSED? NATURAL DYESTUFFS: AN ALTERNATIVE FOR RECYCLING

T. Gülümser, A. Demir, E. Özdoğan, N. Seventekin

Ege University, Textile Engineering Department, Izmir, TURKEY
tulay.gulumser@ege.edu.tr, asli.demir@ege.edu.tr, esen.ozdogan@ege.edu.tr,
necdet.seventekin@ege.edu.tr

Keywords: Natural Products, Natural Dyestuffs, Natural Wastes, Textile Dyeing

Abstract

Sustainability of the natural products is an important issue in today’s world. Increasing interest over natural dyestuffs led the researchers to find new types of raw materials as colorants. When sustainability is combined with natural products’ waste, interesting studies can be made. Natural colorants are dyes and pigmentary molecules that are obtained from plant, animal or mineral sources. They are organic compounds, having the hydroxyl group in their nucleus and are sparingly soluble in water. Many investigations are made by researchers worldwide for extraction of colorants from different plant parts. The main criterion for selection of a plant source of natural colorant is the availability of the material. Besides the availability, sustainability determines the future application of natural dyestuff dyeing in the industry. So the idea of reusing the wastes of natural products can be a good alternative. By this way, the truth of “production of the plant material for extraction of natural colorants must not compete with farming of crops for food production” can be realized. By-products of food industry and wastes from forestry are reasonable raw materials for natural dyeing. But there are some important points that mustn’t be ignored: Sustainability is not provided by only solving the raw material problem. It should be based also on clear defined savings in resources consumption such as energy, water, chemicals or emission of greenhouse gases, effluents and land-use.

The global demand for natural dyes world over is about 10,000 tones which is equivalent to 1% of the world synthetic dyes consumption. This is expected to rapidly grow in near future. In order to meet the requirements of the natural resources to derive the natural dyestuffs, new perspectives such as recycling the natural raw materials of other industries must be taken into account. To maintain the sustainability of natural dyeing, other factors affecting this issue should also be searched.
1- Introduction

As the branches of industry developed, environmental concerns became parts of our lives. Pollution of our world brought some important concepts such as clean environment, ecological materials, green technologies, sustainability and recycling. As the dangers and negative effects of industrialization increase, subjects that aim to bring solutions for the environment problems attract the attention of researches and producers. There are many regulations, legislations and laws for preventing pollution.

Textile industry is one of the major environmental polluters. In order to process a ton of textile, one might have to use as much as 230-270 tons of water. The waste water of this production would pollute the environment as it may contain a heavy load of process chemicals. There are some ways to limit the environmental impact of textile processing. One is to construct sufficiently large and highly effective effluent treatment plants, and the other way is to make use of environment friendly dyestuffs and chemicals or use clean technologies reducing the use of water [1, 2].

Nowadays interest is growing in finding nature friendly sustainable technologies and materials that can be used as alternatives to fossil-based raw materials and conventional methods. There has been a growing tendency towards the use of natural dyes in textile coloration because of the increasing awareness of environment, ecology, pollution control and sustainability in recent years [3, 4, 5, 2] The use of natural dyes is also on the rise because they offer diverse and unique shades on different natural fabrics and some of them have UV protective, deodorizing, antimicrobial and antioxidant properties [3]. Environmental concerns arising due to accelerated development in textile wet processing industry paved the way for ongoing interest in the development of cleaner production strategies for making also cost-effective value added textile products. Sustainability of raw materials and processed products, biodegradability are the other approaches that attracted the attentions of researchers [2].

Coloring of textile materials was made by natural sources, until synthetic colors/dyestuffs were invented and commercialized. For the easy access to synthetic dyestuffs of different types/classes and their cost advantages, most of textile dyers/ manufacturers preferred the usage of synthetic colorants. Besides these factors, their lower prices, repeatability and wide range of bright shades with considerably improved color fastness properties increased the demands and usage of synthetic dyestuffs. In manner of ecology, there are doubts about synthetic colorants being synthesized from petrochemical sources through hazardous chemical processes. Natural dyes are known for their use in coloring of food substrate, leather as well as natural fibers like wool, silk and cotton as major areas of application since pre-historic times. Due to the wide availability of synthetic dyes at an economical price, a rapid decline in natural dyeing continued, but the usage of natural dyes never stopped completely and they are being still used in different places of the world [6, 7].

Recently, most of the people dealing with textiles have started re-looking to the maximum possibilities of using natural dyes for dyeing and printing of different textiles for targeting niche
market. Besides the unique colors and effects of natural dyeing, ecological issues gave rise to the investigations and uses of natural dyestuffs [6].

Socio-economic and environmental impacts are some of the most important factors in industrial utilization of natural dyes in modern textile industry. Today most of the studies about natural dyestuffs are based on laboratory results or model processes. However, some of the researchers have investigated the ecological position, future demands and availability of raw material, the handling, products properties, renewability and standardization for large scale production of natural dyes, leveraging on environmental and economic sustainability to reach out to new market niches.

Basically, main sources of natural dyestuffs can be divided in three categories:
1. Primary products from agriculture
2. Waste and by products from farming and forestry
3. Wastes from the food and beverage industries [2]

Most of the studies by natural dyestuffs are centered on collecting plant materials from wild. However, direct commercial use of native plants in dyestuff production without investigating sustainability issues seems to bring problems in future. For the commercial exploitation, the selected species must also be screened for their appropriateness in purview of modern sustainable cultivation techniques. Because recycling is weak in the industrial system, industrial sectors are experiencing the challenges of building up new systems which have the capacity to recycle or reuse these waste materials at minimal cost leading to the fulfilment of economic development and environmental sustainability objectives [2].

It is very reasonable to use the natural wastes in natural dyestuff production. The notion that ‘every biological waste is food for some other organism’ should be applied in industrial productions to lower the costs and to contribute the sustainability. Use of cheap by products from agriculture and forestry is, wastes of industrial food and beverage production can be utilized as promising source of natural dyes for textile industries after some careful investigation of supply chain system and optimization of processing variables [2].

2-Natural Dyestuffs

Since prehistoric times, natural dyes have been used for different coloring purposes. Natural textile fibers, fur, leather, cosmetic products, inks etc. were colored by natural dyestuffs, but the use of them in textiles decreased very rapidly after the discovery of synthetic dyes by Perkin in 1856. In the mid 1960s, by the international awareness of environment, ecology and pollution control attracted the attentions to natural dyes again. Recently, the dye industry is more and more forced to reduce toxic effluents and to stop the production of potentially dangerous dyes or pigments. There are some data about synthetic colorants as causing some complaints, and various illnesses in some situations. Natural dyestuffs are believed to be safe because of their non-toxic, non-carcinogenic and biodegradable nature. They represent a more environmentally friendly alternative to synthetic dyes. Besides the natural character, they have also some
functional properties. The demand for natural dyes throughout the world is increasing day by day [1, 8, 9].

The global demand for natural dyes world over is about 10,000 tonnes, which means 1% of the world synthetic dyes consumption. This is expected to increase in near future. Natural dyestuffs can be obtained from plants, minerals, and even some insects. As seen in Table 1, most of the natural dyestuffs are found in the roots, bark, leaves, flowers, skins, and shells of plants. Eco-friendly nature of the natural dyes is a great advantage and they do not create any environmental problems at the stage of production or use and maintains ecological balance [10, 2] However, limited availability and high-cost restricted the industrialization of many natural dyestuffs [8].

Table 1. Showing some common natural dyestuffs obtained from different vegetable origin [6].

<table>
<thead>
<tr>
<th>Part of the Plants</th>
<th>Dyestuffs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Root</td>
<td>Turmeric, Madder (Manjistha), Onions, Beet-root</td>
</tr>
<tr>
<td>Bark/ Branches</td>
<td>Purple bark, Sappan wood, Shillicorai, Khair, Red, Sandalwood</td>
</tr>
<tr>
<td>Leaf</td>
<td>Indigo, Henna, Eucalyptus, Tea, Cardamon, Coral Jasmine, Lemon</td>
</tr>
<tr>
<td>Grass</td>
<td></td>
</tr>
<tr>
<td>Flowers (Petals)</td>
<td>Marigold, Dahlia, Tesu, Kusum</td>
</tr>
<tr>
<td>Fruits/Seeds</td>
<td>Latkan, Pomegranate rind, Beetle nut, Myrobolan (Harda)</td>
</tr>
</tbody>
</table>

Advantages of natural dyestuffs:

i. The shades produced by natural dyes/colorants are usually soft, unique

ii. The color range of natural dyestuff is wide and colors can be combined. A small variation in the dyeing technique or the use of different mordants with the same dye can create totally new colours.

iii. Natural dyestuffs produce rare colour ideas and are automatically harmonizing.

iv. The natural dyes are usually renewable, being agro-renewable/vegetable based and at the same time biodegradable.

v. In some cases, the waste in the process becomes an ideal fertilizer for use in agricultural fields.

vi. Many plants thrive on wastelands.

vii. Dyeing with natural dyestuffs is a labour intensive industry, providing job opportunities.

viii. Application of natural dyes has potential to earn carbon credit by reducing consumption of fossil fuel based synthetic dyes.

ix. Natural dyestuffs are mostly non-hazardous to human health.

x. Some of the natural dyes are enhanced with ageing.

xi. Most of the natural dyes bleed but do not stain other fabrics.

xii. Natural dyes are usually moth proof.
Disadvantages of natural dyestuffs

i. It is difficult to reproduce shades by using natural dyestuffs as these agro products cannot be standardized.

ii. It is difficult to standardize the dyeing recipes because natural dyeing process and its colour development depends not only on colour component but also on the textile materials.

iii. Natural dyeing is expensive because of the need of skilled workmanship, low colour yield, long dyeing time and excess cost for mordants and mordanting.

iv. Scientific backup of natural dyeing is weak.

v. Lack of availability of precise technical knowledge on extraction and dyeing techniques.

vi. Generally light fastnesses are not satisfactory.

vii. Almost all of the natural dyes require the use of mordants for the fixage. A careful choice of the mordant is necessary in manner of effluent disposal problem.

viii. Sometimes colour fastness grades are inadequate for modern textile usage [6].

In general, there are two main requirements for natural dyestuffs as to be met by all textile dyes:

1. The quality of the dyed goods has to reach at least a minimum level with regard to fastness, levelness and reproducibility but for niche products and so called eco-products some flexibility is possible.

2. In any case of sustainability, dyeing with of natural dyestuffs should be based on clear defined savings in resources consumption among them energy, water, chemicals or emission of greenhouse gases, effluents and land-use.

Production of the plant material for extraction of natural colorants must not compete with farming of crops for food production. The usage of by-products food industry and wastes from forestry should be preferred [4].

3-Natural Wastes as Raw Material for the Natural Dyestuffs

In the last few years, an increasing interest has been developed to the potential use of plant waste as raw material to produce natural dye for dyeing textiles due to environmental aspects [11].

The production of natural colorants from by-products and wastes from food, timber and agricultural industries is an alternative to lower specific costs and to establish sustainable strategies for textile dyeing. Table 2 summarizes some of the plant pigments that have been recently extracted from several industrial wastes and used in textile dyeing [12].
Table 2: Wastes and by-products from different industries as sustainable sources of natural dyes.

<table>
<thead>
<tr>
<th>Plant/crop</th>
<th>Type of product</th>
<th>Wastes as natural dye source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grape</td>
<td>Wine</td>
<td>Pomace</td>
</tr>
<tr>
<td>Onion</td>
<td>Food</td>
<td>Peel</td>
</tr>
<tr>
<td>Red beet</td>
<td>Food</td>
<td>Peel</td>
</tr>
<tr>
<td>Black tea</td>
<td>Food</td>
<td>Extracted residue</td>
</tr>
<tr>
<td>Raspberries</td>
<td>Juice</td>
<td>Pomace</td>
</tr>
<tr>
<td>Black elder</td>
<td>Juice</td>
<td>Pomace</td>
</tr>
<tr>
<td>Sour cherries</td>
<td>Liquor</td>
<td>Distilled residue</td>
</tr>
<tr>
<td>Cherries</td>
<td>Strong liquor</td>
<td>Distilled residue</td>
</tr>
<tr>
<td>Blackcurrent</td>
<td>Juice</td>
<td>Pomace</td>
</tr>
<tr>
<td>Elder</td>
<td>Strong liquor</td>
<td>Distilled residue</td>
</tr>
<tr>
<td>Pomegranate</td>
<td>Food</td>
<td>Peel</td>
</tr>
<tr>
<td>Olive tree</td>
<td>Food</td>
<td>Waste water extract</td>
</tr>
<tr>
<td>Rosemary</td>
<td>Oil</td>
<td>Extracted residue</td>
</tr>
<tr>
<td>Rose</td>
<td>Oil</td>
<td>Extracted residue</td>
</tr>
<tr>
<td>Lavender</td>
<td>Oil</td>
<td>Extracted residue</td>
</tr>
<tr>
<td>Mate tea</td>
<td>Oil</td>
<td>Extracted residue</td>
</tr>
<tr>
<td>Saffron</td>
<td>Spice</td>
<td>Petal</td>
</tr>
<tr>
<td>Ash-tree</td>
<td>Timber</td>
<td>Bark</td>
</tr>
<tr>
<td>Teak</td>
<td>Timber</td>
<td>Leaves</td>
</tr>
<tr>
<td>Orange</td>
<td>Food</td>
<td>Peel</td>
</tr>
</tbody>
</table>

Usage of colored plant wastes released from the food and beverage industry in textile dyeing is an important economical and sustainable source for natural textile dyeing [12].

As one type of the most popular fruits, oranges have an annual yield over 100 million tons globally. China produces oranges of about 15 million tons each year. The orange peel (OP) represents roughly 20-30% of the total orange mass, and therefore is an abundant, cheap and readily available biomass from the expanding orange juice and can industry. OP by product from orange processing industry creates increasing disposal and potential environmental problems. In recent studies it is seen that with a bright orange color, extracts from OP could be an attractive dyestuff for various applications. Because OP is an abundant, cheap and readily available agricultural byproduct, it is a good solution for the sustainability of the coloring material. [8].

Onion peels and pomegranate peels are good alternatives to the agro products that are used as natural dyestuffs. These wastes can be collected from local vegetable processing companies [4]. Some plant wastes such as rosemary, rose, lavender, mate tea extracts left after oil extraction from factories may create serious environmental pollution, however these may be efficiently utilized for the extraction of natural dyes and satisfactory results can be obtained [12]. For example in Isparta, a city located in south-west of Turkey, ranks top in producing the by-products of rose oil in the world.
There are many factories that process rose crop and other plants in order to obtain oil. Approximately 1.5 t rose oil, 8 t concrete, 1.5 t absolute is produced every year in Isparta. Isparta’s income is about 10 million euro due to exports of these products annually [7]. Factories work seasonally or all year round to obtain other plants’ oil. The weight of pulp content obtained after the process is approximately two times greater than that on plant to the wet weight basis. Plant pulps achieved from these companies in Isparta region can be used as natural dyestuffs because satisfactory results were obtained in a study [7].

The olive oil industry has a great economical importance in many Mediterranean countries, i.e., Spain, Italy, Greece, Turkey, Tunisia and Morocco. It is estimated that there are approximately 95 million olive trees and 658,000 ha olive orchard in Turkey. The annual production of olive oil in Turkey is 100,000–250,000 tons. Highly polluted wastewater and/or solid residue are generated during olive oil production [13,5]. Olive mill wastewater (OMW) is a byproduct of olive extraction industry responsible for serious environmental concerns in Mediterranean countries, as around 30 million m³ of OMW produced annually in this region. There are studies that proved the usage of OMW as prospective source of natural coloring substances in olive oil producing countries which are renewable, available in high quantities and free costs. These studies also indicated that olive mill wastewater as a natural dye contributes to resolve the environmental problem of wastewater of olive oil production [5, 2, 12]. Due to the high organic and polyphenols content of olive mill wastewater OMW, its direct disposal may pollute both land and aquatic environments [5].

Olive waste is suggested as a valuable source of colorant. For example with the development of olive production in Tunisia, the amount of crude olive pomace may reach 1.250 thousand tons in 2016. This huge amount of waste is rich in compounds which play an important role in giving color. The powder obtained from this waste by rinsing, drying and grinding process can be used as a dyestuff [9].

In a study made in India, the plant materials such as waste leaves and bark of the plant species L. sebifera (family: Lauraceae), G. lanceolarium (family: Euphorbiaceae) and M. indica (family: Anacardiaceae) were selected as natural dyestuffs. It was stated that findings of the paper revealed that the natural dyes extracted out of the natural wastes, otherwise wasted, could be a sustainable alternative to synthetic dyes in developing countries like India in the long run [11].

4- Conclusion

Natural dyestuffs are popular again and many researches are going on in order to use them effectively in textile dyeing. It is safe to use natural colorants because they have non-toxic, nonallergic, non-carcinogenic and biodegradable nature. Nowadays some of the studies about natural dyestuffs are concentrated on the issue of sustainability. If the sources of natural dyestuffs are the agro products, then the farmers need to grow them in huge quantities. It is also hard to get standardization in the quality of these products which vary from one crop season to another crop season, place to place and species to species. But if the sources of natural dyestuffs
are from waste and by-products from farming and forestry or from wastes of the food and beverage industries, then this can be a sustainable solution of the raw material problem of natural dyeing. Also unfavourable environmental problems caused by the wastes of natural products are prevented.

Usage of natural wastes as renewable raw material for natural dye production serves for the cost reduction besides sustainability. Therefore reducing raw material costs, availability of the coloring materials and eco-friendly production are the main advantages of reusing natural products’ wastes as dyestuffs and very promising prospects for future textile industry.

References


APPLICATION OF APPAREL CUTTING WASTE AS INSULATION MATERIAL

S. Jordeva¹, E. Tomovska², D. Trajković³, K. Zafirova²

¹University “Goce Delčev”, Faculty of Technology, Štip, Macedonia
sonja.jordeva@ugd.edu.mk

²University “Ss Cyril and Methodius”, Faculty of Technology and Metallurgy, Skopje, Macedonia

³University of Niš, Faculty of Technology, Leskovac, Serbia

Keywords: apparel cutting waste, thermal conductivity, thermal insulation

Abstract

Thermal insulation materials for buildings provide thermal energy cost savings; hence much attention is directed towards improving their performances and construction of new ones. Inorganic fibrous materials - stone and glass wool and organic foamy materials- expanded and extruded polystyrene are dominant on the European market. However, the EU priorities of creating products with improved ecological footprint have led towards research for developing new insulation materials. Evaluation of the performance of insulation materials is a multi-criteria problem, which has to be carried out with respect to: physical properties, health and environmental protection, applicability as building elements and their cost. Recycled textile waste has already found commercial application as insulation material but so far only waste that is easy to open down to fibers has been used. This paper proposes an alternative solution of a new textile structure that will be used for thermal insulation of buildings’ internal walls in order to prevent the loss of a valuable resource, pre-consumer apparel cutting waste. The designed textile structure is composed of polyester fabric apparel cutting waste which is shredded, rather than opened. Thermal conductivity – λ (W/mK) of the textile structure was measured with the Heat flow meter FOX600 instrument. The main goal was to determine the thermal insulation of the structure compared to the standard insulation structures, as well as textile insulating structures in form of fibers. The results of the 10 samples showed thermal conductivity coefficient (λ=0.052-0.060 W/mK), comparable to the values of standard insulation materials (λ=0.030-0.045 W/mK) and the values of insulation materials made from recycled textile fibers (λ=0.039-0.041 W/mK). In addition to the economic benefits, production of this kind of insulation material will have an ecologic benefit by decreasing environmental pollution arising from polyester apparel cutting waste.
1. Introduction

Insulating materials are the most powerful tool for the designer and the constructor to achieve high energy efficiency in buildings. Economy and reducing energy consumption is a major potential resource, in recent years were made remarkable progress on the improving the performance to thermal insulation materials, concurrently with the development of methods for measuring thermal parameters. Inorganic fibrous materials - stone and glass wool and organic foamy materials- expanded and extruded polystyrene are dominant on the European market. However, the EU priorities of creating products with improved ecological footprint have led towards research for developing new insulation materials. Nowadays, a significant number of modern insulation materials can be met in European market; they are characterized by their very low thermal conductivity factor and good overall performance in terms of physical properties. Evaluation of the performance of insulation materials is a multi-criteria problem, which has to be carried out with respect to: physical properties, health and environmental protection, applicability as building elements and their cost [1, 2].

Textile waste integrates the group of reusable materials that can be included in the building construction and which have different possibilities of application. These textile wastes may have origin in the textile industry or may simply result from clothes that are no longer used. Recycled textile waste has already found commercial application as insulation material but so far only waste that is easy to open down to fibers has been used [3].

The assessment of insulation materials is an issue which needs to be analyzed from different aspects: the physical properties of the material, their effect on people and the environment, installation difficulty and price. However, the most important property of every insulation material is the coefficient of thermal conductivity -λ (W/mK). Most of typical thermal-insulation materials have a coefficient of thermal conductivity λ=0,030–0,045 (W/mK) [4].

This paper proposes an alternative solution of a new textile structure that will be used for thermal insulation of buildings’ internal walls in order to prevent the loss of a valuable resource, pre-consumer apparel cutting waste.

2. Experimental part

The designed textile structure is composed of polyester fabric apparel cutting waste which is shredded, rather than opened. Polyester fabrics of various mass and structure were used as materials for the insulation structures. The structural characteristics of fabric A differ greatly from those of fabrics C and D. Fabric D differs from A and C because of its raw material content, as it contains 5% Lycra® fibers. The polyester fabric was shredded using a cutting machine with rotational knives.

Sample B with raw material content (%) 70/25/5 PES/cotton/Lycra® obtained from knitted polyester fabric by mechanical recycling in partly fibrous form was used for comparison. Casing made of 100% polypropylene was filled with these materials. 10 samples for research were made from these materials. The samples had 60x60cm length and width and height (thickness) of 50,
70 and 100 mm. The isolation structure was stitched with 4 stitches along its length and width
distanced on 15 cm leading to a change in height, and therefore a change in density. Thermal
conductivity - $\lambda$(W/mK) of the textile structure was measured with the Heat flow meter FOX600
instrument. In the same time the instrument automatically measures the sample thickness.
Based on the measured value of the coefficient of thermal conductivity $\lambda$ and equation 1 the
value of thermal insulation $R$ of the sample is determined [5],

$$R = \frac{h}{\lambda} \quad (m^2\text{K}/W)$$

Where :
$h$ - thickness (m)
$\lambda$ - coefficient of thermal conductivity (W/mK).

<table>
<thead>
<tr>
<th>Fabric</th>
<th>A</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness(mm)</td>
<td>0,16</td>
<td>1,2</td>
<td>1,6</td>
</tr>
<tr>
<td>CV (%)</td>
<td>2,17</td>
<td>1,80</td>
<td>1,38</td>
</tr>
<tr>
<td>Mass per unit area (g/m²)</td>
<td>92</td>
<td>245</td>
<td>272</td>
</tr>
<tr>
<td>CV (%)</td>
<td>3,13</td>
<td>1,16</td>
<td>1,38</td>
</tr>
<tr>
<td>Raw material content (%)</td>
<td>PES 100</td>
<td>PES 100</td>
<td>PES/Lycra®95/5</td>
</tr>
<tr>
<td>Weave</td>
<td>Twill 3/2 Z</td>
<td>Twill 3/2 Z</td>
<td>Twill 2/1 S</td>
</tr>
</tbody>
</table>

Table 1 Used fabrics

3. Discussion

The main goal was to determine the thermal insulation of the structure compared to the standard
insulation structures, as well as textile insulating structures in form of fibers. The results of the
10 samples showed thermal conductivity coefficient ($\lambda$=0,052-0,060 W/mK), comparable to the
values of standard insulation materials ($\lambda$=0,030-0,045 W/mK) and the values of insulation
materials made from recycled textile fibers ($\lambda$=0,039-0,041 W/mK). A significant correlation
was not found between the thermal conductivity –$\lambda$ and the thickness-$h$ nor density-$\rho$. The values
of thermal insulation ranged from 1,658 m²/WK (sample D) to 1,924 m²/WK (sample A₂). The
coefficient of variation of thermal insulation between the samples was 5,44 %. The fabric with
the smallest pieces A₂ shows a higher thermal insulation.
4. Conclusion

Cutting waste from polyester fabrics is usually thrown away which is a loss of valuable resource, on top of environmental pollution. Instead, it can be used to make thermal insulation material- eco-friendly insulation for internal double walls in buildings. The production process is simple: shredding the waste into small pieces and consolidation of the structure, in this case with sewing. In addition to the economic benefits, production of this kind of insulation material will have an ecologic benefit by decreasing environmental pollution arising from polyester apparel cutting waste.

References

RFID APPLICATIONS IN TEXTILE AND APPAREL SECTORS

B. E. Şamil, M. Ç. Erdoğan

Ege University, Faculty of Engineering, Department of Textile Engineering, Turkey
behiye.elif.samli@ege.edu.tr

Keywords: RFID, textile, apparel sectors.

Abstract

In many industries, automatic identification systems are used especially in the manufacturing processes or product shipments. RFID (Radio Frequency Identification) system has emerged as a method appropriate for these purposes.

The use of automatic identification systems in the apparel industry has become a necessity because of the detailed production and product distribution processes of these sectors. Apparel industry has a worldwide supply chain and under the influence of fast fashion concept. Via usage of identification systems in apparel sector, the control becomes simplified, and the productivity increases. In this way, it becomes easier to survive for the enterprises that are trying to exist in an intense competitive environment.

In this study, the applications of RFID systems in the textile and apparel industry (that are becoming more commonly used day by day) were investigated.

Introduction

Textile and apparel sectors have an important role in the world economy, in terms of providing employment, having high production and consumption quantities. Turkey is one of the world's most competitive countries, in terms of labor and raw material qualities; marketing and distribution factors. Firms should benefit from technology-based innovations to develop and maintain their position. The effects of fast fashion concept and global trade have a driving force on quickening the process from raw material to consumer. Ever-increasing numbers of businesses have noticed automatic recognition systems, which provide secure data storage and efficiency.

RFID is used to construct an “internet of things”’ a linkage that would permit enterprises to track their products throughout the global supply chain and run countless applications concurrently. RFID application applied across various sectors like retail, healthcare, textile, automotive and
luxury goods industries [1]. Application area of RFID is limited by dimensions of imagination. Typical applications of RFID (in transportation, logistics, manufacturing, processing and security) include; animal detection, road toll collection, toxic-medical or municipal solid waste management, postal tracking, airline baggage management, manufacturing processes with robotics, money/drug anti-counterfeiting, monitoring of offenders, passports, vehicle immobilisers and alarms, retail stock management, fabric and clothing, food safety warranties, health, library services, mining, museums, ski lift access, theft prevention, railway rolling stock identification, movement tracking.

Among various technological advances, RFID system is a tool which has been generally believed to be beneficial for fashion supply chain management, textile and apparel sectors. In this study, various applications of RFID systems in the textile and apparel industry (that become more widely used in processes esp. logistics) are investigated.

**Radio Frequency Identification**

Radio Frequency Identification (RFID) is an Automatic Identification (Auto-ID) system. Auto-ID systems attach a name or identifier (represented optically, electromagnetically, chemically) to a physical object by some means that may be automatically read. Auto-ID systems consist of different technologies that are Barcode System, Optical Character Recognition (OCR), Biometric Systems (Fingerprint, Face/Eye Recognition and Voice Recognition), Chip Cards and RFID. The basic system of RFID technology is composed of Tag, Reader and Antenna [2]. RFID transmit radio signals via wireless technology in order to tag, recognize, track and trace the movement of items (such as containers, products, human objects). RFID technology is originated in early 1940s. It came into light, when the US government used transponders to distinguish friendly aircraft from enemy aircraft [1]. Prototype systems were developed in the 1960s. Some commercial systems used as an effective anti-theft device (i.e., Sensormatic and Checkpoint; first and most widespread commercial use of RFID). These systems used 1-bit tags detecting the presence or absence of a tag and were used in retail stores attached to high value items and clothing [3]. The evolution decades of RFID could be seen from Table 1.

RFID could be used successfully in manufacturing, after-sales service support, and total product life cycle management. Its use in manufacturing has not yet reached the critical point but that is only a matter of time. The hardware is available. As the prices of technology decline and the applications become more economical, RFID becomes very valuable and applicable in terms of productivity. Currently, RFID may be evaluated mostly for efficient tracking. However, the most valuable impact of RFID will be realized from new applications after using most of the technological opportunities. The RFID technology will play an increasingly important role in the manufacturing and wireless Internet manufacturing in the future [4, 5].
Table 1. Developments in RFID research [3].

<table>
<thead>
<tr>
<th>Decade</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1940s</td>
<td>Radar refined and used; RFID invented in 1948.</td>
</tr>
<tr>
<td>1950s</td>
<td>Explorations, laboratory experiments.</td>
</tr>
<tr>
<td>1960s</td>
<td>Development of the theory of RFID. Start of application field trials.</td>
</tr>
<tr>
<td>1980s</td>
<td>Commercial applications of RFID.</td>
</tr>
<tr>
<td>1990s</td>
<td>Emergence of standards. RFID becomes a part of everyday life.</td>
</tr>
</tbody>
</table>

Via this technology, the real-time, efficient, dynamic and automatic data management could be applicable, and also effect of worker mistakes reduces. RFID will accelerate rate, efficiency and precision of processes through the automation and needed reports can be formed quickly and accurately.

The most commonly used Auto ID system, for identifying an object is barcode at the present time. It is being used since 1970s for the identification of items in service sectors [1]; and also it is widely used in textile and apparel sectors to maintain process and product control. In future, it is expected that RFID system will take place of barcode system. Some properties of RFID and barcode systems are compared in Table 2.

Table 2. Comparison of some characteristics of RFID and barcode systems.

<table>
<thead>
<tr>
<th>RFID System</th>
<th>Barcode System</th>
</tr>
</thead>
<tbody>
<tr>
<td>The information on the tag could be changed.</td>
<td>The information could not changed without changing the tag.</td>
</tr>
<tr>
<td>The information storage capacity is high.</td>
<td>The information storage capacity is less.</td>
</tr>
<tr>
<td>Non-contact, non-line-of-sight characteristics of the technology</td>
<td>Tag should be included within the reader’s sight</td>
</tr>
<tr>
<td>Reading speed (avg. 0.5 sec) and distance are high.</td>
<td>Reading speed (up to 4 sec) and distance are low.</td>
</tr>
<tr>
<td>Tags could be read collectively (several hundreds)</td>
<td>Tags could be read individually.</td>
</tr>
<tr>
<td>Difficult to copy/see content of tags.</td>
<td>Easy to copy/change content of tags.</td>
</tr>
<tr>
<td>Tags can be read through a variety of visually and environmentally challenging conditions such as snow, ice, fog, paint, grime, inside containers and vehicles and while in storage.</td>
<td>Tags could not be read through a variety of visually and environmentally challenging conditions.</td>
</tr>
<tr>
<td>Automation of the identification process lowers time and personnel cost.</td>
<td>Manual identification increase costs.</td>
</tr>
</tbody>
</table>

Capacity, shape, size, price and some other properties of RFID tags are varied. Tags with robust
components are able to withstand even at high temperatures like those found in baking ovens; also they are cost effective, too. Before any applications of the RFID technology, the correct systems and optimizing ranges must be properly selected [5].

Besides advantages of RFID, there are various obstacles that prevent its spreadability; such as cost of implementation, security of information, threats on privacy and security of individuals and organizations. For example it is very easy to follow the movement of customers through radio signals or misusage of data by authorized people or to collect data on consumer behaviours without their knowledge. For these reasons, visibility (during sale), neutralizability-removalability (after sale) of tags are important.

For a successful deployment of RFID in industry, it is important to have a set of widely accepted standards and regulations [3, 4]. The lack of standardisation and the lack of harmonisation of frequency allocation are hampering growth in this industry [3]. In RFID systems, the developments of international standards are important in terms of ensuring compatible operation and expansion of applications via reducing hardware costs.

EPC Global, ISO, ANSI, FCC, ECC, ETSI organizations have various studies on development of RFID standards. Both EPC Global and International Standards Organization (ISO) have adopted RFID in their standards. The ISO 18000 series covers both Active and Passive RFID technologies; while ISO 15418, 15434, 15459, 24721, 15961, and 15962 cover data content of RFID and ISO 18046 and ISO 18047 cover conformance and performance standards [4]. Internationally, there are differences in frequencies allocated for RFID applications although standardisation through ISO and similar organisations is assisting in compatibility. Frequency allocations are generally managed through legislation and regulation by individual governments. Currently very few frequencies are consistently available on a global basis for RFID applications [3]. For example, EU use 868 MHz for UHF and the USA use 915 MHz. Although, there are anti-collision procedures, the collision (reader collision, tag collision) is a big problem in the RFID technology. Another technical problem is difficult to trace the tag, due to influence of the antenna with liquid and metals. Separately electromagnetic radiation has direct and negative effects on human health. Several studies have been made to find solutions on storage/usage of huge data produced by RFID. Also, there are researches discussing suitability of infrastructure for overloaded information.

Besides threats and disadvantages, RFID is generally considered as one of the most exciting and fastest-growing technologies in terms of scope of application in the next generation of business intelligence.

**Applications in Textile and Apparel Sectors**

Textile and clothing industries are characterized by short product lifecycles and highly uncertain market demand. In apparel industry, RFID is in controlling manufacture, distribution and retail [6]. Success for many fashion companies hence relies on effective and efficient supply chain management scheme [7]. Apparel retailers face a dynamic, competitive retail environment and
different products-brands-styles. They are looking for solutions to lower cost and prevent exhaustion of stocks in order to prevent loss on sale. RFID technology is particularly valuable for apparel retailing which is characterized by short life-cycles, high seasonality, high volatility, and high-impulse purchasing and complicated distribution and logistics operations [8]. All parts of the apparel supply chain including manufacturers, distributors and retailers will be able to have instant access to information about an individual product at any time. In the fashion industry, it is well-agreed that the use of information is a crucial part of supply chain management [7]. The establishments of RFID technologies are widely believed to provide efficient and effective tools to facilitate information flow and inventory visibility along the fashion supply chains. Inventory tracking becomes easier than ever and many other probable applications of RFID technologies, such as customized services for customer relationship management, have been proposed [7].

Wal-Mart is one of the largest companies to deploy the RFID technology in supply chain [9]. Wal-Mart ‘encouraged’ their suppliers to attach RFID transponders to cases and pallets. Since the system is operational, Wal-Mart has a 16% reduction in the out of stock rate. RFID-enabled stores were 63% more effective in replenishing outof- stocks than the control stores (Conair, Dillard’s, JCPenney, Jockey, Jones Apparel, Macy’s, Decathlon, LCWaikiki, eProvenance, Unileve) [10]. In summer of 2010, Wal-Mart announced that it was working with suppliers of men’s jeans and basics (socks, undershirts and underwear) to track these items using ultra high-frequency RFID tags with Electronic Product Codes. In the future, when the prices of RFID tags are reduced further, more companies will show interest to put tags at the item level as well [9]. The major clothing company VF Corp., which produces Lee, Wrangler, the North Face, is also committed to tagging its shipments of jeans, intimate apparel and sportswear to Wal-Mart’s RFID-enabled distribution centers [9]. Also from beginning of ‘00s, Marks and Spencer (M&S), Benetton and Gap Inc.s continue to use RFID tags, despite the boycotts (www.boycottbenetton.com, www.stop-rfid.fr, www.boycottgillette.com).

American Apparel is another company, that use RFID system at eight of their stores. Via RFID usage, no reductions were observed in labor (about 60-80 h/week) and out-of-stock products. Sankei (Japanese apparel manufacturer) utilizes from RFID to track clothes on manufacturing and to facilitate online sales [6]. Levi Strauss & Co. has launched an item-level radio frequency identification (RFID) pilot at one of its retail stores in Mexico. All garments are tagged. The tags (inside the price tags) are read as they are loaded onto the truck and then scanned again at the store. Shelf inventory is checked with a cabled, hand-held reader that looks a bit like a vacuum cleaner. Levi wanted to improve its in-stock rate at the store (previously at 80%), improve inventory accuracy and automate replenishment. The in-stock rate is now at 99%. Reducing out of stocks will account for 70% of RFID’s benefits, based on Levi’s estimates. The company reads the tags at the point of sale, which can automatically decrement the store inventory [10]. Beside its valuable contribution to retail, RFID system enhances customer shopping experience [6]. Apparel retailers could succeed in building up a close but discriminating relationship with each customer [8]. The RFID system is able to differentiate consumer preference frequency of clothes and to provide customized advertisement on picked clothes according to the RFID tags.
Kaufhof installed in its shop in Essen Germany ‘smart clothing shelves’, ‘smart try-out cabins’ and ‘smart mirrors’. On the clothes RFID transponders were attached and in the ‘smart’ devices (and at the check-out terminals) RFID readers were mounted. Dislocation of clothes is automatically spotted, stock is automatically replenished and customers are given advice on clothes that fit the clothes they are trying out. The “smart mirror” shows product information and advice on additional clothing and accessories, Marks and Spencer tagged 10,000 items of men’s suits, shirts and ties with “intelligent labels”. This offers the benefits of knowing exactly what stock is in each store. Prada’s New York shop uses RFID not only for stock tracking and checking but also to provide extra information to the client about the clothes using plasma screens and streaming videos [10]. Alternatively, customers can take an item to Prada’s smart dressing room and use the touch screen monitors to browse images of accessories that match their outfit. Inside the dressing room, there are two boxes showing thick, flat bronze ribbons embedded in them—the RFID antennas. By pushing buttons on the screens, customers can mix and match outfits, and find out more details (i.e. color, size) about the clothing and accessories [10]. The chief benefit of the Prada RFID retailing concept is to provide a unique level of service that is not found in competitor stores. If a customer wants to try on an item, she enters the high-tech dressing room and sees all the different ways that she can match it to her taste [10, 11].

Yang et al. have proposed an RFID-based CRM system with intelligent characteristics for apparel retail. The core function of this system is identifying a customer automatically and making personalized recommendation intelligently to the customer in a short time. It is composed of five functional modules: RFID-based garment information management module, RFID-based customer information management module, personalized recommendation and service module, sales management module, web-based communication and service module. When a customer with an RFID VIP card enters the shop, his/her personalized information including preferences and purchasing history can be detected, and then, the system may recommend the adequate services and suitable clothes to him/her to meet his/her individual requirements. Classification is primarily in accordance with the apparel-category, fabric, price, brand etc. The criterion is designed for the style of clothing and the standard of its adjective gradable antonym pairs: conservative – sexy, masculine - feminine, formal – arbitrary [8]. RFID tags have also been used as a pedigree for high-fashion items (such as garments or high-value apparel accessories) and to enhance the consumer shopping experience, for example by providing bonus discounts while shopping.

RFID is a method to identify counterfeit products. If tags can be used to identify genuine or fake apparel products, data protection on tags have to be addressed. In apparel business, it is necessary to use passive tags because its size is quite small and is easy to embed in the garments. As the resource and capability of passive tag is limited, it may not be possible to have data security and authentication for passive tags, esp. for passive RFID Class 1 tags. RFID tags should have strong computation power in order to do complex and intensive computational tasks. Thus, the size of the tags is quite large and it is difficult to embed in the high-value apparel products, such as dresses and suits. Miniaturization is a growing trend, in addition to this
security, moisture resistance, heat resistance, impact resistance are the properties trying to be developed. In literature, there are no real implementations on tag security and authentication for RFID tags of Class 1 Generation 1, which are the most common tags to be used in the market, especially in apparel business [9].

The RFID technology will play an increasingly important role in the manufacturing and wireless Internet manufacturing in the future [7]. Also there are examples for RFID applications in the production processes. In a study discussing effect of RFID usage at intermediate product storage of hand knitting yarn manufacturers (10,000 tonnes/year); reductions were observed even at 1st month in sale loss, labor costs (35%) and stock volumes (40%). For a company having 9 intermediate product storage, 40,400$ cost benefit were envisaged for each store with 20,000$ initial RFID investment.

On the other side, RFID can coordinate with ERP software which is used in the production line and monitor the real-time production process. The managers can control and administrate the production wherever they are. The RFID system which can save time can change the traditional mode of piece wages. Because with the help of the system, we don’t need to make the production records or count the pieces of products each worker finished. The manager can monitor the real time output of every process, comparing with the original established plan. It can establish effective target responsibility system to achieve the goal of promoting production quality. The managers can find out the bottlenecks and change their production arrangement based on the production data. Li C. ve Zhao Q. set up a garment production line with RFID, in this system, every worker show their cards and sewing equipments before they started to work. When the workers on the production line get the sewing materials, they will take the card and insert into the reader and it make the station being on line [2]. Via this way, 3-8% daily increases were observed sewed clothes output.

In hospitals of countries like Switzerland, Holland, Germany, Norway; RFID system is used to identify patient and staff’s laundry (clothes, beds, mattresses). Its usage reduces the garment inventory level and saves up of the total garment expenditure. Laundry can be cleaned appropriately and efficiently. Content of laundry could be tracked instantaneously, for example clean uniforms could be differentiated from dirty ones or properties like garment type, size could be detected. First and foremost, appropriate disinfection procedures to clean the beds and mattresses could be applied successively with RFID in cases of highly infectious/risky diseases [7, 10].

There are various interesting RFID applications; i.e. process parameters (e.g., baking time) could be read and forwarded to the target automatically or read–writable RFID tags in clothes for washing machines (how many times the given piece has been washed and select the proper washing program) [10]. According to Global Retail Theft Barometer (GRTB-2010), clothing and fashion accessories are most prone to theft. RFID would be a good solution to decrease losses.

Some industrial reports, such as AMR Research, Inc. Report, have estimated that the use of RFID systems can reduce supply chain cost by 3 to 5% and increase revenue by 2 to 7%. In addition to all these benefits, there are actually failure cases with the use of RFID technologies in
inventory management. The stability of RFID on reading the tag depends on various environment factors such as tagged object, tag placement, angle or rotation, and read distance. Existing studies also comment that RFID is also suffering from read rate inaccuracy and in real time applications read rate RFID tags are often just in between 60 and 70%. It could not be accurately stated that RFID is better than the barcode system in all situations without any in-depth investigation [7].

**Conclusion**

In today’s business environment, systems to plan and control the flow of goods, based on paper documents are increasingly being replaced by automated computer systems [10]. Identification technology is worth billion $ and has a big and extremely fast developing market share. Since manual identification is costly, time consuming and error prone; RFID provide an advantageous and easy way to track products from design to recycling. Tracking place of production/packaging of products, expiration date, price, properties of fabrics, location of products and time passed at that location.

Sectors having wide and continuously varied product diversity just like textile and apparel, need automatic identification systems in operations. RFID is a technology with acknowledged great potential, feasible and competitive for many application areas. For now, RFID could be used only in high-cost products. Prices (of equipment, tags and infrastructure) are decreasing permanently while properties are enhanced. The positive developments in RFID technology and fall in tag prices shows that this technology is becoming appropriate for mass application. The initial setup costs are higher compared to the barcode system. Costs seem lower in total, because RFID tags could be used repeatedly and add value to the process. Some of the benefits are hidden and not easy to measure in the short term. It is not easy to estimate the reduction in storage costs or profits resulting from the decrease in error rates or sales turnover relating customer satisfaction. Difficulty in the calculation of depreciation of investment, high investment costs, necessity of reconstruction in processes are driving forces of making cost-benefit analyses carefully before process. RFID investments should be considered as information technology investment and evaluated as a strategical decision.

As illustrated in examples, new identifier-based solutions may contribute to the clothing industry as in the many other industries. Application areas of RFID technology will proliferate. Different types of RFID applications have different requirements for translating RFID techniques, options and parameters. Though the RFID technology had been used in many fields, research is still continuing. A lot of research should be conducted in order to ensure secure communications for extensive global applications.
References

SECTION II:
Finishing & Technical Textiles
THE INFLUENCE OF ENVIRONMENTAL CONDITIONS ON THE MECHANICAL PROPERTIES IN FINISHED LEATHER

M. Hylli¹, G. Guxho¹, S. Drushku²

¹¹Polytechnic University of Tirana, Mechanic Engineery Faculty, Textile and Fashion Departament.
²University of Tirana, Natyral Science Faculty, Industrial Chemistry Departament.

Keywords: Finished leather, mechanical properties, environmental condition

Abstract

Leather products during wear undergo cyclic deformation and the cracking of material. Parameters, such as environment temperature, tensile modulus, stress amplitude have a significant effect on the lifetime of products. The product designer needs to know how these properties translate into product performance.

The influences of environmental temperature and humidity on the mechanical properties (tensile strength and elongation) of finished leather have been investigated.

We performed mechanical property measurements with tensile tester to obtain tensile strength and elongation at break. The experiments were done on shoe-upper leather prepared from cattle hides. Tensile strength is defined as the maximum stress to break leather.

1. Introduction

Leather is a valuable material used in a wide range of products. For each application the leather of different physical and mechanical properties is obtained by means of variation in the processing technology [4]. Leather processing specially tanning and lubrication had a great importance in the performance and characteristics of the leather product [1].

Physico- mechanical properties of leather are also affected from the age of the animal, the area where the sample is taken and the orientation of fibers [8]. The mechanical properties of leather were found to have the characteristics of a viscoelastic material and ridge and wright [10].

The interest of deformability and relaxation behavior of leather has been continuously growing. Previous studies have been focused on the effect of temperature and humidity in the behaviour of
leather product. The most common reason of threadbare of clothing product is the cracking of leather in areas where folds are more numerous and frequent during wear. Parameters, such as environment temperature, stress amplitude, mean stress level, frequency and etc., have a great influence on the cyclic lifetime behaviour [3]. The product designer needs to know how these properties translate into product performance. To achieve a better understanding on the influence of environmental temperature and humidity on the performance of leather products, the mechanical properties (tensile strength and elongation) of finished leather have been investigated. Leather products during wear undergo cyclic deformation and the cracking of material influenced from the environmental conditions.

2. Materials and methods

The tensile strength and elongation at break of different leathers kept in different temperatures and humidity was determinate based on the Standard method [15]. A Tensile testing machine type YG026B was used for determination of tensile strength. Leather testing samples are extended at a specified rate until they breaks.

2.1 Sampling and preparation of samples

Different cows and pig leather are tested for the tensile strength and the percentage elongation. Leather sampling and conditioning are done according to standard methods [12] and [13]. The analysed samples are listed in table 1. Each sample has an indexed which will be used in this paper.

<table>
<thead>
<tr>
<th>Index</th>
<th>Sample description</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-1</td>
<td>Cow finished leather 1</td>
</tr>
<tr>
<td>L-2</td>
<td>Cow finished leather 2</td>
</tr>
<tr>
<td>L-3</td>
<td>Cow lustered finished leather</td>
</tr>
<tr>
<td>L-4</td>
<td>Pig finished leather</td>
</tr>
</tbody>
</table>

There are tested 36 samples. The testings are carried out by six series changing the temperature and humidity, which are given in table 2. For each environmental condition are tested six samples, parallel and perpendicular to the backbone. Six tests leather samples parallel and perpendicular to the backbone were conditioned for 24 hours in a standard atmosphere with a temperature of 23±2°C and a relative humidity of 50±5%.
Table 2. Environmental conditions

<table>
<thead>
<tr>
<th>Temperature °C</th>
<th>Humidity %</th>
</tr>
</thead>
<tbody>
<tr>
<td>- 10</td>
<td>55</td>
</tr>
<tr>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>10</td>
<td>35</td>
</tr>
<tr>
<td>23</td>
<td>50</td>
</tr>
<tr>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>40</td>
<td>25</td>
</tr>
</tbody>
</table>

2.3 Method

For each test sample are determined the dimensions, width and thickness. First was measured the width of each sample at three position on the grain side and three on the flesh side. The arithmetic mean of the width of each sample is 10 mm. Then was measured the arithmetic mean of the thickness of the test samples in accordance with method [14] as it is shown in the Figure 2. As it can be seen there is a variety of thicknesses. Leather L-1 has the highest value of 2.16 mm and leather L-4 has the lowest value of 0.91 mm.

![Figure 1. The thickness of leather samples analyzed](image)

After this the tensile strength testing apparatus is runned and the curve of Pull (N) and Elongate length (mm) is generated automatically. Tensile strength is defined as the maximum stress to break leather. Elongation is the percent the leather stretched until failure [2]. The tensile strength ($T_n$), percentage elongation caused by a specified load ($E_l$) and percentage elongation at break ($E_b$) for each sample in different conditions are calculated using the equations according the standard [15].

3. Results and discussion

The influence of environmental conditions on mechanical properties for the leather samples are carried out.
There are chosen to show only the graphs in standard atmosphere (23°C, 50%) for analysed leathers in both directions parallel and perpendicular.
In the graphs is given the maximal force in Newton and elongation (mm) for three parallel samples.
As it can be seen in the graphs the degree of fibre orientation is associated with the observed tensile modulus [5]. Tensile strength is also influenced by thickness and the kind of analysed leather.

**Figure 2.** Graph of Pull (N) and Elongate Length (mm) of L-1 in parallel direction (standard atmosphere).

**Figure 3.** Graph of Pull (N) and Elongate Length (mm) of L-1 in perpendicular direction (standard atmosphere).
Figure 4. Graph of Pull (N) and Elongate Length (mm) of L-2 in parallel direction (standard atmosphere).

Figure 5. Graph of Pull (N) and Elongate Length (mm) of L-2 in perpendicular direction (standard atmosphere).

Figure 6. Graph of Pull (N) and Elongate Length (mm) of L-3 in parallel direction (standard atmosphere).
Figure 7. Graph of Pull (N) and Elongate Length (mm) of L-3 in perpendicular direction (standard atmosphere).

Figure 8. Graph of Pull (N) and Elongate Length (mm) of L-4 in parallel direction (standard atmosphere).

Figure 9. Graph of Pull (N) and Elongate Length (mm) of L-4 in perpendicular direction (standard atmosphere).
The influence of temperature in tensile strength in both direction parallel and perpendicular with the backbone are presented below in Fig. 10 and Fig 11.

**Figure 10.** Influence of temperature in tensile strength (Tn mes) in parallel direction

**Figure 11.** Influence of temperature in tensile strength (Tn mes) in perpendicular direction

As can be seen from Fig 10 and Fig 11, the temperature has a great influence in tensile strength. Tensile strength increases when the temperatures decreases. This happen because of the leather samples became more rigid in lower temperature and have delayed rupture. The tendency is
different in higher temperatures the tensile strength values are lower than in standard conditions because the leather samples became softer and they break in a short time.

The tensile strength is also influenced by the orientation of sampling. Mostly higher values of tensile strength had samples in lower temperatures and parallel direction.

In the table below there are shown the mean elongation (mm) caused by a specified load which is choosen different for analysed leather depending this in the kind of leather, age of the animal and for sure thickness.

Table 3. The mean elongation (mm) caused by a specified load, $E_i$ for each analysed sample in both direction.

<table>
<thead>
<tr>
<th>Temp. °C</th>
<th>L-1 F(300 N) $E_i$ (mm)</th>
<th>L-2 F(150N) $E_i$ (mm)</th>
<th>L-3 F(200N) $E_i$ (mm)</th>
<th>L-4 F(150N) $E_i$ (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-10</td>
<td>15.12 20.6</td>
<td>16.5 11.8</td>
<td>16 11.22</td>
<td>16.3 15</td>
</tr>
<tr>
<td>0</td>
<td>16.5 24.2</td>
<td>14.2 10.25</td>
<td>16.3 12.2</td>
<td>22 18.1</td>
</tr>
<tr>
<td>10</td>
<td>14 25.11</td>
<td>15.1 9.4</td>
<td>15.6 12.4</td>
<td>33 18</td>
</tr>
<tr>
<td>23</td>
<td>14.2 19</td>
<td>12 11.1</td>
<td>16.4 11</td>
<td>31 10.35</td>
</tr>
<tr>
<td>30</td>
<td>15 22</td>
<td>14.5 10.2</td>
<td>25 14</td>
<td>26 10.3</td>
</tr>
<tr>
<td>40</td>
<td>14.2 37.5</td>
<td>14 8.16</td>
<td>18.42 11.6</td>
<td>12.3 12</td>
</tr>
</tbody>
</table>

The elongation caused by a specific load which was different for analysed leather is higher for samples held at higher temperatures than the standard atmosphere and mainly in parallel direction. This certainly has an impact the extension of samples, softness of leather in higher temperatures and fiber orientation.

While for low temperatures leather becomes more rugged and has a decrease in the values of specific extension.

In the table 4 there are presented percentage elongation at break for all samples in both directions.

Table 4. Percentage elongation at break, $E_b$ for each analysed sample in both direction.

<table>
<thead>
<tr>
<th>Temp. °C</th>
<th>L-1 $E_b$ mes (%)</th>
<th>L-2 $E_b$ mes (%)</th>
<th>L-3 $E_b$ mes (%)</th>
<th>L-4 $E_b$ mes (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-10</td>
<td>45.52 52.84</td>
<td>49.74 38.48</td>
<td>50.48 40.92</td>
<td>50.48 40.92</td>
</tr>
<tr>
<td>0</td>
<td>51.5 61.68</td>
<td>53.62 35.24</td>
<td>50.08 38.26</td>
<td>50.1 43.6</td>
</tr>
<tr>
<td>10</td>
<td>45.78 64.28</td>
<td>40.28 32.04</td>
<td>46.26 38.7</td>
<td>81.84 39.92</td>
</tr>
<tr>
<td>23</td>
<td>46.24 51.42</td>
<td>36.52 32.66</td>
<td>52.12 38.24</td>
<td>79.2 32.7</td>
</tr>
<tr>
<td>30</td>
<td>47.58 57.64</td>
<td>42.16 30.14</td>
<td>50.86 37.52</td>
<td>56.48 30.66</td>
</tr>
<tr>
<td>40</td>
<td>34.1 50.06</td>
<td>40.08 22.32</td>
<td>51.16 33.76</td>
<td>35.3 33.62</td>
</tr>
</tbody>
</table>
Evident changes for percentage elongation at break for the analyzed samples are in extreme chosen temperatures -10 °C and 40 °C. Higher values of elongation at break are in -10 °C. There are no major changes of elongation at break in temperatures which are closer to standart temperature.

4. Conclusions

The tensile strength of analysed leather increases in low temperature and parallel direction and reduces in high temperature and perpendicular direction. The elongation of investigated leather differs depending on the temperature, mostly in extreme used temperatures. The environment temperature has a great influence on tensile strength and deformability. It is evident that the temperature influence in the mechanical properties of finished leather especially on which are used for shoes production. For the future investigation it will be very interesting to see the influence of different temperature and fatigue cycles during flexing.

5. REFERENCES


[12] EUROPEAN STANDARD EN I2007SO 2418:2002 Leather-Chemical, physical and mechanical and fastness tests- Sampling location


THE INFLUENCE OF THE SILICONE SOFTENER ON THE PROPERTIES OF CO AND CO/EL KNITTED FABRICS

A. Ivanovska, B. Mangovska

Sts. Cyril & Methodius University, Faculty of Technology and Metallurgy, Department of Textile Technology, R. Boskovic 16, 1000 Skopje, Macedonia
adicka_654@yahoo.com

Keywords: Co, Co/EL knitted fabrics, silicone softener, structural properties, air

Abstract

The wet processing stages of cotton or cotton/elastane based single jersey knitted fabrics include several sequences: scouring, bleaching and optical brightening for white products and scouring and half bleaching or only scouring and mainly dyeing with reactive dyes for dyed products. Softening, the final step is carried out to improve the properties such are, attractiveness and serviceability of textile materials. Samples made of 100% cotton yarn; elastane yarn in alternating courses (half plating) and elastane yarn in every course (full plating) were produced. Half of them were scoured and bleached and the other half were scoured and dyed with reactive dyes and softened with silicone softener in industrial conditions. The influence of different processing stages on the structural properties and comfort of knitted fabrics have been studied. Elastane in blends increased the mass per unite area, thickness and decreased the air permeability. Silicone softener additionally increased mass per unite area, air permeability of 100% cotton knits and decreased air permeability of fabrics made of cotton/elastane blends.

1. Introduction

Knitted fabrics are an important part of the textile sector. Most of the people use knitted fabrics during their life. The knitted textile market is divided between the two production branches. Generally, weft knitting is used to produce clothing garments while wrap knitting is used for home textiles and technical products [1]. Four primary structures – plain (single jersey), rib, interlock and purl, are the best structures from which all weft knitted fabrics and garments are derived [2].
Knitted fabrics are elastic and stretchable due to their construction even if they do not contain elastane. The requirements in terms of function and wearing comfort, not only with sportswear, but also with underwear and outwear have increased. Without using elastane yarns it is not possible to satisfy these requirements in full. This explains why there are more and more articles containing elastane yarn in the circular knit fabric collections.

Elastane is a long – chain synthetic polymer comprised of at least 85% of segmented polyurethane. For jersey knit constructions in circular knitting machines, the process of co – knitting elastane is called “plating” [3]. Plating means the simultaneous formation of one loop from two threads, so that one thread will lie on the face of the fabric while the other thread is fed to the needles in such a way that it forms the back or reverse of the final fabric [4]. When the cotton yarn and the elastane yarn are knitted parallel or side – by – side in every course, with the elastane yarn always kept on one side of the cotton yarn, the method is classified as “full plating”. When the elastane is placed in altering courses, the method is classified as “half plating” [3].

The knitted fabrics undergo a series of different processing treatments like scouring, bleaching, dyeing, softening and relax drying. These processes are carried out to impart a particular property related to that process like scouring for absorbency, bleaching for whiteness, dyeing to impart color to fabric and finishing for improving softness and handle of the fabric [5]. Textile fabric softening is generally achieved to reducing the coefficient of friction in between fibers, in between yarns and in between fabric and other surfaces. Softeners can enhance fabric properties such as high softness, fullness, special unique hand, high lubricity and elastic resilience. Based on the polarity and the ionic nature, softeners can be classified into five categories: cationic, anionic, nonionic, amphoteric and silicones.

The aim of this investigation is to analyze the influence of micro silicone softening of knitted fabrics in white and dyed program on their structural and comfort properties.

2. Eksperimental

2.1. Materials

100% cotton single jersey and half and full plating elastane single jersey were knitted of 20 tex cotton ring–spun yarns and 22 dtex elastane yarns on Jumberca SYX – 3 circular knitted machine or on Paolo Orizio John/A circular knitted machine. Tubular knitted fabrics were kept on a flat surface under standard atmospheric conditions, and after dry relaxing structural parameters (weight per unite area in g/m², thickness in mm, vertical and horizontal density in cm⁻¹) were measured and presented in Table 1.

All knitted tubular fabrics were silt opened and laid flat. Half and full plating single jersey were heat set with very small traverse tension on heat setting machine, Santa Lucia RAMA with a speed of 10 m/min at 193°C. Fabrics were bleached and dyed in Jet THIES with a speed of 135 m / min.
Table 1: Parameters of greige (R) single jersey fabrics

<table>
<thead>
<tr>
<th>Fabric code</th>
<th>Fabric structure</th>
<th>Fabric weight (g/cm²)</th>
<th>Fabric thickness (mm)</th>
<th>Wales (cm⁻¹)</th>
<th>Courses (cm⁻¹)</th>
<th>Stitch density (s/cm²)</th>
<th>Air permeability (l/m²/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CoR</td>
<td>100 % cotton</td>
<td>135,15</td>
<td>0.487</td>
<td>12</td>
<td>19</td>
<td>228</td>
<td>1391,00</td>
</tr>
<tr>
<td>Co2ElR</td>
<td>Cotton/elastane half plating</td>
<td>159,67</td>
<td>0.545</td>
<td>14</td>
<td>20</td>
<td>280</td>
<td>601,40</td>
</tr>
<tr>
<td>CoElR</td>
<td>Cotton/elastane full plating</td>
<td>204,55</td>
<td>0.685</td>
<td>14</td>
<td>22</td>
<td>308</td>
<td>374,30</td>
</tr>
</tbody>
</table>

2.2 Pretreatments and treatments

First, greige fabrics were submitted to acid demineralization in an aqueous solution containing 1g/l Invadine DA as wetting agent, 1g/l Invatex SA sequestering and dispersing agent in a bath with material to liquor ratio (LR) 1:9 at 60°C for 15 min, and rinsed with cold water. After that one bath scouring, peroxide bleaching and optical brightening started at 40°C in the bath with liquor ratio 1:9 with 1g/l NaOH, 1g/l Albafluid CD, a crease preventing agent, 1g/l Clarite ONE as wetting agent, 8 g/l 50% H₂O₂, 0.8% Uvitek BHB as optical brightener and the bath was stabilizing 10 min. The temperature was raised to 100°C and bleaching and optical brightening proceeded for 30 min. The fabric was then rinsed with hot water at 80°C and neutralized with 0.4 g/l at Invatex AC at 60°C during 10 min. Half of the knitted fabrics were subjected to softening with 3% Ultratex FMV (silicone softener) at 45°C for 20 min and the other half only rinsed.

Dyeing in dark shade was done on alkaline scoured fabrics. Alkaline scouring started in the bath heated at 60°C with 1g/l Invadine DA, 1g/l Albafluid CD during 10 min, 2g/l Na₂CO₃ was added, the temperature rose to 90°C and the fabric treated for 30 min. After that, fabric was rinsed with hot water at 60°C 15 min, neutralized with 0.7 g/l Invatex AC 15 min at 60°C and in the next bath treated at 60°C with 1g/l Lyoprint RG protector of reduction of reactive dyes, 1g/l AlbateX CO and 80g/l NaCl for 10 min, than 0.42 % Avitera Yellow SE, 4.6 % Avitera Navy SE, 0.15 % Avitera Red SE were added and dyeing was conducted at 80°C for 20 min. Temperature was decrease to 60°C and in 20 min time 1g/L Na₂CO₃ was added dyeing continued for the next 10 min, than 4 g/l Na₂CO₃ and 1 g/l NaOH were added and dyeing continued for the next 20 min, pH between 10 and 11, the treatment continued for the next 40 min. After dyeing the fabric was rinsed with hot water for 40 min at 60°C, soapunified with 1g/l Eriopon R for 15 min at 60°C, rinsed with hot water for 15 min at 60°C and neutralized with 1g/l Invatex AC (pH 7). 2 g / L Albafluid ECO was added to fix the dye at 50°C 15 min. Half of the samples were treated with 3% Ultratex FMV (silicone softener) at 45°C for 20 min and the other half rinsed only. Fabrics were drained, dried and thermo stabilized.
2.3. Methods and standards

The following parameters were analyzed in the experiment: stitch density (BS 5441: 1988), mass per unite weight (MK F.S2.016), fabric thickness (with load of 100 kPa) was tested by FAST (ASTM D 1777 – 96 (2011), and air permeability (EN ISO 9237:1995) was tested by M021A Air Permeability Tester.

<table>
<thead>
<tr>
<th>Code</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>CoB</td>
<td>100 % cotton bleached</td>
</tr>
<tr>
<td>CoBS</td>
<td>100% cotton bleached and finished with silicone softener</td>
</tr>
<tr>
<td>CoD</td>
<td>100 % cotton dyed</td>
</tr>
<tr>
<td>CoDS</td>
<td>100 % cotton dyed and finished with silicone softener</td>
</tr>
<tr>
<td>Co2ELB</td>
<td>Cotton / elastane half plating bleached</td>
</tr>
<tr>
<td>Co2ELBS</td>
<td>Cotton / elastane half plating bleached and finished with silicone softener</td>
</tr>
<tr>
<td>Co2ELD</td>
<td>Cotton / elastane half plating dyed</td>
</tr>
<tr>
<td>Co2ELDS</td>
<td>Cotton / elastane half plating dyed and finished with silicone softener</td>
</tr>
<tr>
<td>CoELB</td>
<td>Cotton / elastane full plating bleached</td>
</tr>
<tr>
<td>CoELBS</td>
<td>Cotton / elastane full plating bleached and finished with silicone softener</td>
</tr>
<tr>
<td>CoELD</td>
<td>Cotton / elastane full plating dyed</td>
</tr>
<tr>
<td>CoELDS</td>
<td>Cotton / elastane full plating dyed and finished with silicone softener</td>
</tr>
</tbody>
</table>

3. Results and discussion

Fiber type, elastane yarn quantity, yarn count, fabric construction, pretreatment processes, dying and finishing, all have been found to have an influence on structural and comfort properties of the treated fabrics. Changes in the mass per unite area, thickness and air permeability of bleached and dyed knitted fabrics will be discussed as a function of quantity of elastine and different finishing processes.

![Fig. 1. Mass per unite area of bleached and dyed knitted fabrics before and after softening](image-url)
The increase of quantity of elastane in the bleached and dyed knitted fabrics increased the mass per unite area and thickness and decreased the air permeability. Elastane at half plating of the bleached knits increased the mass per unite area for 9,30 %, thickness for 11,32 % and reduced the air permeability for 32,53%, compared to cotton knits, Fig. 1, 2 and 3. The increase of these parameters on the dyed knit with elastane at half plating is lower compared to the bleached one 7,86%, 7,03% and decrease of the air permeability 27,77%, respectably. Elastane at full plating of the bleached knit, increased the mass per unite area for 15,88 %, thickness for 15,18 % and decreased the air permeability for 39,65%, compared to cotton fabrics. The dyed knits with elastane at full plating showed increased of the mass per unite area of 23,22 % and thickness of 22,67% and decrease of air permeability for 50,87%, compared to cotton fabric. The increase of fabric mass per unite are and thickness and decrease of air permeability of the bleached and dyed single jersey fabrics depends on fabric finishing stages. During pretreatment processes, the fabric shrinks.
Regardless of the amount of elastane, softened single jersey knitted fabrics have higher mass per unite area compared to unsoftened. The mass per unite area of the bleached softened knits increased up to 5.48 %, and for the dyed softened up to 2.95% compared to the unsoftened. Silicone softener decreased the air permeability of single jersey knitted fabrics made of cotton/elastane. Bleached 100% cotton knits softened with silicone softener have 7.12 % higher air permeability compared to non softened. For dyed knits, this percentage is 8.68. Bleached cotton/elastane knits softened with silicone softener have maximum 22.17 % lower air permeability compared to non softened ones. For dyed knits, this percentage is 14.50 %.

The coefficient of variance of mass per unite area and thickness are up to 3.76 %. Air permeability showed larger coefficient of variance up to 6.16 %.

4. Conclusion

Incorporation the elastane in knits increased the mass per unite area and thickness and decreased the air permeability. Silicone softener additionally increased the mass per unite area of all analyzed knits and air permeability of 100% cotton knits and decreased air permeability of knitted fabrics made of cotton/elastane blends.

5. References

DIMENSIONAL STABILITY OF MONOFILAMENTS AND THE PERFORMANCE OF ARTIFICIAL TURF

B. Kolgjini¹, G. Schoukens², S. Rambour², E. Shehi¹, P. Kiekens²

¹Polytechnic University of Tirana, Faculty of Mechanical Engineering, Department of Textile and Fashion, Square “Nëne Terza” no 4, Tirana Albania
bkolgjini@yahoo.co.uk
²Textile Departments, Ghent University, Belgium

Keywords: monofilaments, shrinkage, dimensional stability

Abstract

The extra heat treatment performed on monofilaments is a process to generate a stability on terms of dimensional and properties. Although the process itself is rather easy, it influences the behavior of the final product when it faces the real conditions. There is still a lack of knowledge concerning the influence of the ambient parameters, for which preliminary knowledge reveals that the elevated temperatures are of primary importance. This article reports the importance of dimensional stability of the final product. Pretreatment of the monofilaments at different temperatures are performed and it revealed that the heat treatment of the product is a guaranty for good performance of artificial turf.

Introduction

Artificial turf is a complex system composed by several layers [1-6], some of them stand together even before installing it on the real fields. The presences of these layers are important for securing the position of monofilaments and for meeting the requirements from FIFA standards. As it described the performance of entirely system is highly influenced by the performance of pile layer [5]. On several papers [7-10] are discussed about the parameters that influence on classical mechanical properties, bending behavior and resilience - the ability of pile layer to recover completely after the action of the players and the ball.

Among the processing parameters of the monofilaments and the polymeric materials used for monofilaments that influence on the performance of the pile layer[8-10], are also the geometrical dimensions of monofilaments, like profile cross section, length and thickness.
Most of the formulas for strength of materials express the relations among the form and the dimensions of a product, the loads applied thereto, and the resulting stress or deformation. Any of such formulas are only valid within certain limitations and only applicable for certain problems. Theoretically, a beam of known cross section geometry will bend under the application of a specified load and its distribution [11] (see figure 1).

![Figure 1](image)

**Figure 1.** The position of bending of a straight beam is represented schematically, equivalent with a one side fixed monofilament on artificial turf.

Deflection at specified point: \( y = \frac{Fa^2}{6EI} (3L - a)^3 \)

Deflection at the unsupported end: \( y = \frac{FL^3}{3EI} \)

And the slope measured by \( \theta \): \( \theta = \frac{F(L-a)^2}{2EI} \)

Where:
- \( E \) = Modulus of Elasticity (N/m²)
- \( I \) = Moment of Inertia (m⁴)
- \( F \) = Load (N)
- \( s \) = Stress at the cross-section being evaluated (N/m²)
- \( y \) = Deflection (m)
- \( L \) = Distance as indicated (m)
- \( a \) = Distance as indicated (m)

The moment of inertia is function of the cross section and the distance from the neutral axis to the edge of the beam geometry. The diamond shape cross section and the deflection (bended) of unsupported end are considered in this paper as the most possible deflection happening on the real conditions of artificial turf.

For diamond shape the moment of inertia is: \( I = \frac{bd^3}{48} \) or \( \frac{db^3}{48} \).
Where: b and d are the distance from centroid to extremities.

Based on a study [12], carried out in the Department of Textiles at Ghent University, the bending force shows an exponential correlation with the free pile length $F \sim 1 / L^3$.

Monofilaments, in most cases are products from polyolefin families, LLDPE, and, as a polymeric product it is likely to show poor retention, poor creasy resistance and poor shape retention.

After tufting the carpet, of artificial turf, it goes through the coating line, a process necessary to secure the position of the monofilaments. The process is performed at elevated temperatures. Even though the coating process is applied on the back of the carpets, practically, the temperatures on the upper part (part of the pile layer) rises up to the level of 75-80°C. These temperatures are higher enough to causes the dimensional change, on terms of length thickness of monofilaments.

Another important aspect is the time of exposure of the entirely system on real conditions. The temperatures on real condition will be approximately around 40°C, but higher enough to cause structural and dimensional changes. It is well known that the structural changes accurse at the crystallization temperature and below the melting temperature [13]. Therefore, in order to prevent the instability in the dimensional, physical and mechanical properties, monofilaments go through heat setting or annealing before they are tufted. In addition, heat settings or annealing is a process known to eliminate the internal stresses generated during fabrication, i.e. stretching [12]. The process itself will induce ductility, soften the material, relieve internal stress, refine the structure by making it more homogeneous and improve the properties of samples stretched on solid stage. The heat fixes the material in a relaxed state and thus avoids subsequent shrinkage as the internal stresses are relieved.

**Materials and Methods**

**Materials.** The polymer material was obtained from Dow Chemical Company DOWLEX™ 2035 [14], density 0.919 g/cm and melting index 6g/min. The monofilaments are produced on lab conditions. The extrusion line of their production is similar to the Industrial line.

**Test method.** The test method is based on the internal standard modified for polyethylene material used at Ghent University [15]. One meter yarns of monofilaments are exposed to elevated temperatures for 15 minutes at 75°C under a weight of 5g. The weight is used to minimize the possibility of monofilaments to be curled. After performing the heat treatment and conditioning the samples at normal temperatures the length is measured again under two different weights, 5g and 505g weight. After the data collection the shrinkage of the products is calculated.
Results and discussions

After performing the heat settings on different samples with different processing parameters and at different stages of production line of monofilaments, the shrinkage is calculated and the results are summarized in table 1 and, graphically presented on figure 1.

From the obtained results it is obvious that samples that didn’t pass the heat treatment (mentioned as original products) show higher values of shrinkage. In the same level are also the samples that pass the heat settings but with fixed ends. Differently from other samples that pass heat settings at 100°C on controlled shrinkage (10%) and after that goes to annealing process. The percentage of shrinkage is lowering after each of the steps of the production line.

Another important element is the inverse proportional of the stretching ratio with the percentage of shrinkage. This is something expected as the stresses induced during stretching are higher for higher stretching ratio.

Comparing the results the most stable product seem to be those that have low stretching ratio and have pass at least one time the heat setting, on controlled shrinkage.

### Table 1. Shrinkage of the monofilaments at different temperatures and measured on all the samples at different stages and with different CDR.

<table>
<thead>
<tr>
<th>CDR</th>
<th>Original product</th>
<th>10% Shrinkage at 100°C</th>
<th>Annealed at 100 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>505 g 5 g</td>
<td>505 g 5 g</td>
<td>505 g 5 g</td>
</tr>
<tr>
<td>7.2</td>
<td>9.5±0.3</td>
<td>8.9±0.2</td>
<td>9.1±0.5</td>
</tr>
<tr>
<td>6.2</td>
<td>8.3±0.4</td>
<td>6.9±0.3</td>
<td>5.8±0.3</td>
</tr>
<tr>
<td>5.5</td>
<td>9.6±0.3</td>
<td>8.3±0.6</td>
<td>5.2±2.4</td>
</tr>
<tr>
<td>3.3</td>
<td>7.6±2.2</td>
<td>5.2±1.1</td>
<td>8.4±0.9</td>
</tr>
</tbody>
</table>

Considering the shrinkage of the product, it is obvious that samples are not stable after controlled shrinkage and after heat treatment with fixed ends, but only after passing these steps and performing the annealing at elevated temperatures.
Conclusions

The dimensional stability of the monofilaments is an important aspect not only for aesthetic reasons but also because it has a direct influence on the performance of the entirely system. The loss in the length of the pile layer influences the properties of the ball roll. Performing heat settings on monofilaments prevent the instability of the monofilaments and guaranty the quality of artificial turf, as monofilaments are fixed on the back and not possible to be replaced.

References

[15] Vakgroep Textielkunde hot air retraction test voor polyester PM/214 B.
GEOTEXTILE’S PROPERTIES FOR SOME APPLICATIONS IN CIVIL ENGINEERING

I. Kola, G. Guxho

Department of Textile and Fashion, Polytechnic University of Tirana, Albania
ikola@fim.edu.al; gguxho@fim.edu.al

Keywords: geotextile, properties, test methods, applications, standards.

Abstract:

Geotextiles are permeable, planar structures made of synthetic or natural polymeric textile material, used in contact with soil and/or other materials in geotechnical and civil engineering applications. They are extremely diverse in their construction and appearance. Among the different geosynthetic products, geotextiles present the widest range of properties and can be used in a large number of earthwork applications. Because of the wide variety of products available, with their different polymers, filaments, weaving (or nonwoven) patterns, bonding mechanisms, thicknesses, masses; they have a considerable range of properties. For each application, a geotextile must perform a specific function and should be able to meet some specified properties.

The aim of this paper is to specify the particular required properties of the geotextiles, depending on the specific application and the associated function(s) the geotextile is to provide. Different functions performed in different applications require different criteria to be met. We will define the range of important criteria and properties required to evaluate geotextile’s suitability for some specific applications. Geotextile properties are generally categorized in the following groups: physical, mechanical, hydraulic, endurance, and durability. Each group encompasses testing that characterizes a different aspect of geotextiles and their performance. This paper presents the most important geotextile properties used in specific applications, and their associated test methods, according to Albanian and European Standards. These properties can be used to create a classifying system for geotextile use in Albania. This classifying system can help the Albanian engineers on using the proper geotextile for the proper application.
1. Introduction

The use of geotextiles in civil engineering is growing rapidly. Among the different geosynthetic products, geotextiles present the widest range of properties and can be used in a large number of earthwork applications. For each application, a geotextile must perform a specific function and should be able to meet some specified properties.

When designing with geotextiles it is necessary to understand the properties required to ensure an adequate design. Determining the material and construction of the geotextile to be used in a given application depends on the properties required.

The properties of a geotextile are often dependent on the properties of the fibers and the fabric construction, referred to as the structure of the geotextile [1].

Geotextile properties are generally categorized in the following groups: physical, mechanical, hydraulic, endurance, and durability. Each group encompasses testing that characterizes a different aspect of geotextiles and their performance. They are all developed from the combination of the physical form of the polymer fibres, their textile construction and the polymer chemical characteristics. In addition to these property groups, geotextile testing may be characterized as either index or performance. Index tests provide a general value from which the property of interest can be qualitatively assessed and are used for general characterization of a geotextile product and do not provide values that can be directly used for design purposes. They are performed on the geotextile alone, or in-isolation. On the other hand, a performance test requires testing of geotextile with its companion material (e.g., soil) to obtain a direct assessment of the property of interest and provides information about the expected behavior of a geotextile in an engineered system [2].

Physical properties are used to characterize the geotextile in the as-received, manufactured condition, and are obtained with index testing. Common physical properties include specific gravity, mass per unit area, thickness and stiffness.

Mechanical properties include the ability of a textile to perform work in a stressed environment and its ability to resist damage in an arduous environment. They provide an understanding of geotextile strength and/or compressibility under varying loads. Common mechanical properties include tensile strength, elongation at maximum load, creep tensile test, tear strength, puncture strength, and seam strength. A wide variety of tests are available to characterize geotextile strength, generally designed to replicate conditions encountered in field installation. Depending on the specific strength property, the testing may be described as either index or performance.

The ability of water to flow through or within a geotextile is a function of geotextile hydraulic properties, also known as filtration properties. As with mechanical properties, testing for hydraulic properties include both index and performance tests [2]. Common hydraulic properties and testing include permeability, permittivity, transmissivity, Aparent Opening Size (AOS), etc.
One major area of geotextile use is as filters in drain applications such as trench and interception drains, blanket drains, pavement edge drains, structure drains, and beneath permeable roadway bases. The filter restricts movement of soil particles as water flows into the drain structure and is collected and/or transported downstream. Geocomposites consisting of a drainage core surrounded by a geotextile filter are often used as the drain itself in these applications. Geotextiles are also used as filters beneath hard armor erosion control systems.

The performance of a given geotextile in an engineered system will vary over the geotextile’s lifetime. This is commonly due to damage of the geotextile during installation, the effects of sustained loading on the geotextile structure and strength, and/or the effects of migrating soil particles on the hydraulic properties of the geotextile [3]. Endurance testing focuses on long-term geotextile behavior.

Long-term performance or durability of geotextiles is also affected by geotextile degradation via different mechanisms including ultraviolet light (sunlight), chemical reactions with geotextile polymers, and/or thermal degradation. Degradation testing is important in determining the ultimate lifetime of a geotextile in an engineered system.

The most important properties which are required and specified for a geotextile are its mechanical responses, filtration ability and durability. These are the properties that produce the required working effect and will be discussed in this paper.

2. Mechanical properties

The mechanical response of a geotextile will depend upon the orientation and regularity of the fibres as well as the type of polymer from which it is made. As we said the geotextile must perform work in a stressed environment and be able to resist damage in an arduous environment. Usually the stressed environment is known and the textile is selected on the basis of some criteria to cope with the expected imposed stresses and its ability to absorb those stresses over the proposed lifetime of the structure without straining more than a predetermined amount. Figure 1 compares the tensile behaviors of a range of geotextiles [3]. On the other hand, damage can be caused on site during the construction period (e.g. accidental tracking from vehicles) or in situ during use (e.g. punching through geotextiles by overlying angular stone).

The ability to perform work is governed by the stiffness of the textile in tension and its ability to resist creep failure under any given load condition. The ability to resist damage is complex, being a function of the fibre’s ability to resist rupture and the construction of the fabric, which determines how stresses may be concentrated and relieved. The weight or area density of the fabric is an indicator of mechanical performance only within specific groups of textiles, but not between one type of construction and another. For example, within the range of needlepunched continuous filament polyester fabrics, weight will correlate with tensile stiffness; while a woven fabric with a given area density will be much stiffer than an equivalent weight needlepunched structure. So, the construction controls the performance. Therefore, weight cannot be used alone
as a criterion in specifying textiles for civil engineering use, but in combination with other specified factors, weight can be a useful indication of the kind of product required for a particular purpose [4].

![Fig.1](image)

**Fig.1** Typical ultimate stress–strain failure levels (a) of high strength and (b) of medium strength PES woven geotextiles used for embankment support and soil reinforcement, (c) of geogrids and lower strength polyester woven geotextiles used for soil reinforcement and (d) of low strength, highly extensible nonwoven geotextiles used for separation and filtration.

One of the most important strength properties for a geotextile is the *tensile strength*. The breaking strength of a standard width of fabric or ‘ultimate strip tensile failure strength’ is universally quoted in the manufacturers’ literature to describe the ‘strength’ of their textiles. But this is of very limited use in terms of design. Rather, a strength at a given small strain level will be the design requirement. Therefore, the tensile resistance or modulus of the textile at say, 2%, 4%, and 6% strain is much more valuable. To understand the load-strain characteristic, it is important to consider the complete stress-strain curve. It is also important to consider the nature of the test and the testing environment [2]. Ideally, continuous stress–strain curves should be provided for engineers, to enable them to design stress resisting structures properly. Geotextile tensile strength is measured by clamping two opposite ends of a geotextile specimen in a mechanical testing machine and stretching the specimen until failure occurs. Typically, both the force applied to the geotextile and the geotextile strain are measured, allowing observation of the stress-strain curve and development of associated moduli.

*Stress–strain curves*, as shown in Fig. 1 and in Fig. 2, may well comprise a high strain sector, contributed by the textile structure straightening out, and a low strain sector, contributed by the straightened polymer taking the stress. In Figure 2, geogrids (a) absorb the imposed stresses immediately, giving a high initial modulus. Later, the curve flattens. Woven fabrics (b) exhibit initial straightening of warp fibres which produces a low initial modulus. Later the modulus increases as the straightened polymer fibres take the stress directly. Nonwovens (c) give a curvilinear curve, because extension is primarily resisted by straightening and realignment of the random fibre directions [3].
Geotextiles may have different strengths in different directions. Therefore, tests should be conducted in both principal directions. The wide-width tensile test S SH EN ISO 10319 is the most commonly specified in Albanian and European Standards for testing geotextiles used in almost all the applications performing all functions [5].

![Graph](image)

**Fig. 2** Different stress–strain curve shapes exhibited by the three main types of geosynthetic construction. (a) Geogrids, (b) Woven fabrics, (c) Nonwovens

**Tensile creep** is a time-dependent mechanical property. It is strain at constant load. Creep can cause the physical failure of a geotextile if it is held under too high mechanical stress. Creep tests can be run for any of the tensile test types, but are most frequently performed on a wide strip specimen by applying a constant load for a sustained period. Short-term creep strain is strongly influenced by the geotextile structure. Woven geotextiles have the least; heat-bonded geotextiles have intermediate; and needled geotextiles have the most. Longer-term creep rates are controlled by structure and polymer type. The creep limit is the most important creep characteristic. It is the load per unit width above which the geotextile will creep to rupture. The creep limit is controlled by the polymer and for polyester it is approximately 60% of its ultimate strength, for polyethylene about 40% of its ultimate strength and for polypropylene around 20% of its ultimate strength. Therefore, for example, a polyester fabric with an ultimate tensile strength of 100kNm-1 width cannot be loaded under a long term stress of more than 60kNm-1. The higher the level of imposed stress above this point, the more rapid will be the onset of creep failure. Figure 3 shows the safe loading limits for most commonly used geotextiles [3]. The S SH ISO 13431- Determination of tensile creep rupture behavior, is the standard specified by the Albanian Standards for obtaining tensile creep for a number of specific applications [5].
Other tests for geotextile strength are focused on ensuring that a geotextile is strong enough to survive installation stresses, often the most severe stresses placed on the geotextile over its lifetime. The most commonly specified tests cover tear strength and puncture strength. Often, due to manufacturing size limitations, it is desirable to join multiple geotextile sections together when placed in an engineered system. The most common method of joining geotextiles is by sewing them. For the case in which sewing is used when installing geotextiles, characterization of the strength of a given seam type is important for ensuring the integrity of the sewn sections. This is accomplished by performing a tensile strength test on a sewn geotextile sample. The test method specified by Albanian Standards is S SH EN ISO 10321 [5].

3. Hydraulic Properties

A geotextile is similar to a soil in that it has voids (pores) and particles (filaments and fibers). However, because of the shape and arrangement of the filaments and the compressibility of the structure with geotextiles, the geometric relationships between filaments and voids are more complex than in soils. Since pore size can be directly measured, relatively simple relationships between the pore sizes and particle sizes of the soil to be retained can be developed. Three simple filtration concepts are used in the design process:

1. If the size of the largest pore in the geotextile filter is smaller than the larger particles of soil, the soil will be retained by the filter. As with graded granular filters, the larger particles of soil will form a filter bridge over the hole, which in turn, filters smaller particles of soil, which then retain the soil and prevent piping (Figure 4).

2. If the smaller openings in the geotextile are sufficiently large enough to allow smaller particles of soil to pass through the filter, then the geotextile will not blind or clog (see Figure 5).
3. A large number of openings should be present in the geotextile, so proper flow can be maintained even if some of the openings later become plugged [2].

These simple concepts are used to establish design criteria for geotextiles. Specifically, these criteria state:
- the geotextile must retain the soil (retention criterion), while
- allowing water to pass (permeability criterion), throughout
- the life of the structure (clogging resistance criterion).

To perform effectively, the geotextile must also survive the installation process (survivability criterion).

Hydraulic properties relate to the pore size distribution of the geotextile and correspondingly its ability to retain soil particles over the life of the project while allowing water to pass.

The ability of water to pass through a geotextile is determined from its hydraulic conductivity (coefficient of permeability, $k$), as measured in a permeability test. The permeability of geotextiles can vary immensely, depending upon the construction of the fabric. National and international standards have been set up for the measurement of permeability that is required, most often at right angles to the plane of the textile (crossflow), but also along the plane of the textile (in-plane flow, called transmissivity). Albanian Standards specifying those tests are S SH EN ISO 11058 - Water permeability normal to the plane and S SH EN ISO 12958 - Waterflow capacity in the plane [5].

It is important in civil engineering earthworks that water should flow freely through the geotextile, thus preventing the build-up of unnecessary water pressure. The permeability coefficient is a number whose value describes the permeability of the material concerned, taking into account its dimension in the direction of flow; the units are rationalised in metres per second. Effectively the coefficient is a velocity, indicating the flow velocity of the water through the textile.
Due to the compressibility of geotextiles, engineers also use a coefficient called the permittivity, which defines the theoretical permeability irrespective of the thickness of the fabric. The permittivity, \( \psi \) (permeability divided by thickness), is often determined from the test and used to directly evaluate flow capacity. Permittivity is defined as the cross-plane permeability of a geotextile. In other words, permittivity is a measure of the ease at which water may flow through the geotextile. Permittivity is obtained with S SH EN ISO 11058, by measuring the flow of water, under a given head, moving perpendicularly through a geotextile [5]. Values are reported in units of sec\(^{-1}\), allowing for a more traditional value of permeability to be obtained by multiplying the permittivity by the thickness of the geotextile.

**Permeability Criteria:** Depending on the critical nature and severity of the application, permeability criteria are established. For noncritical, less severe applications, the permeability of the fabric \( k_f \) is required to be at least greater than the permeability of the soil \( k_s \) the fabric is to retain, \( k_f > k_s \). For critical-severe applications the fabric permeability must be at least ten times greater than the permeability of the soil, \( k_f > 10k_s \) [2].

Permeability criteria for woven geotextiles are in terms of the Percent Open Area (POA). When the protected soil has less than 5 percent passing the No. 200 sieve, the POA should be equal to or greater than 10 percent. When the protected soil has more than 5 percent but less than 85 percent passing the No. 200 sieve, the POA should be equal to or greater than 4 percent [6].

The ability of a geotextile to retain soil particles is directly related to *its apparent opening size* (AOS) which is the apparent largest hole in the geotextile. The AOS value is equal to the size of the largest particle that can effectively pass through the geotextile in a dry sieving test. It is also called Filtration Opening Size (FOS).

The procedure for matching a textile to the soil, in order to achieve stability under difficult hydraulic conditions, is to use a textile whose largest holes are equal in diameter to the largest particles of the soil \( O_{90} = D_{90} \). Where hydraulic conditions are less demanding, the diameter of the largest textile holes can be up to five times larger than the largest soil particles \( O_{90} = 5D_{90} \). Figure 6 shows the relationship between \( O_{90} \) and \( D_{90} \). Particularly difficult hydraulic conditions exist in the soil (i) when under wave attack, (ii) where the soil is loosely packed (low bulk density), (iii) where the soil is of uniform particle size, or (iv) where the hydraulic gradients are high. Lack of these features defines undemanding conditions. Between the two extremes lies a continuum of variation which requires experience and judgment in the specification of the appropriate \( O_{90} \) size for any given application [3].

The largest whole sizes and largest particle sizes are assessed by consideration of the largest elements of the fabric and soil. Measuring the largest particles of a soil is achieved by passing the soil through standard sieves. In order to assess a realistic indication of the larger particle diameters, a notional size is adopted of the sieve size through which 90% of the soil passes. This dimension is known as the \( D_{90} \) by convention. Similarly, an indication of the largest holes in a textile is taken as the 90% of the biggest holes in the fabric, \( O_{90} \). Even under ideal conditions, if the \( O_{90} \) pore size is bigger than \( 5D_{90} \), then so called piping will take place.
4. Geotextiles Durability

Other properties that require consideration are related to durability and longevity. Geotextiles have been shown to be basically inert materials for most environments and applications. Also, they are rarely called upon to resist extremely aggressive chemical environments. Particular examples of where they are, however, include their use in the basal layers of chemical effluent containers or waste disposal sites. This can happen if and when leaks occur, permitting effluent to pass through the impermeable liner, or if the textiles have been incorporated directly in the leachate disposal system above the impermeable liner. Another example might be the use of textiles in contact with highly acidic soils, where in tropical countries; pH values down to 2 have been encountered [2]. In industrialized countries where infrastructure developments are being constructed through highly polluted and contaminated areas, geotextiles can also come into contact with adverse environments. These specific applications may expose the geotextile to chemical or biological activity that could drastically influence its filtration properties or durability. For example, in drains, geotextiles can become chemically clogged by iron or carbonate precipitates, and biologically clogged by algae, mosses, etc. Biological clogging is a potential problem when filters and drains are periodically inundated then exposed to air. Excessive chemical and biological clogging can significantly influence filter and drain performance. These conditions are present, for example, in landfills.
Biological clogging potential can be examined with S SH EN 12225, Standard Test Method for Resistance to microbiological degradation of Geotextiles [5]. If biological clogging is a concern, a higher-porosity geotextile may be used, and/or the drain design and operation can include an inspection and maintenance program to flush the drainage system.

Exposure to sunlight degrades the physical properties of polymers. Ultraviolet light will tend to cause damage to most polymers, but the inclusion of additives, in the form of antioxidant chemicals and carbon black powder, can considerably reduce but not eliminate this effect [3]. The only time when a geotextile is going to be exposed to sunlight is during the construction period. It is generally considered that contracts should specify the minimum realistic period of exposure during site installation works. However, this will vary with time of year and latitude. In brief, it can be considered that exposure in Albania type climates can be eight weeks in the summer and twelve in the winter. In tropical countries, however, exposure should be limited to seven days at any time of year before noticeable damage occurs.

Other aspects influencing the durability of geotextiles are hot asphalt that can approach the melting point of some polymers [2]. Polymer materials become brittle in very cold temperatures. Chemicals in the groundwater can react with polymers. High pH water can be harsh on polyesters while low pH water can be harsh on polyamides. Where a chemically unusual environment exists, laboratory test data on effects of exposure of the geotextile to this environment should be sought. The Standard Tests that consider resistance to weathering and resistance to chemical ageing are S SH EN ISO 12224; S SH ISO 12960 or S SH EN 12447 [5].

5. Conclusions

Geotextiles present a considerable range of properties. Determining the material and construction of the geotextile to be used in a given application depends on the properties required. The properties of a geotextile are often dependent on the properties of the fibers and the structure of the geotextile. The most important properties are mechanical, hydraulic and durability properties. Mechanical properties include the ability of a textile to perform work in a stressed environment and its ability to resist creep failure under any given load condition. They provide an understanding of geotextile strength and/or compressibility under varying loads. The most important are tensile strength and tensile creep. To understand the load-strain characteristic, it is important to consider the complete stress-strain curve. Creep can cause the physical failure of a geotextile if it is held under too high a mechanical stress.

Hydraulic properties relate to the ability of geotextile to retain soil particles over the life of the project while allowing water to pass. The ability of water to pass through a geotextile is related to characteristics such as permeability, permittivity, transmissivity, while retaining soil particles is related to the Aparent Opening Size of geotextiles and its relation to the particle soil size.

Other properties that require consideration are related to geotextile durability which includes resistance to weathering, resistance to chemical aging and resistance to microbiological degradation.
Factors such as biological and chemical agents, weathering and ultraviolet light can degrade the properties of geotextiles.

A summary of the Standard Test Methods used to consider the properties discussed in this paper, specified by the Albanian Standards, in conformity with European Standards is shown in Table 1.

**Table 1. Geotextile properties and their associated S SH EN ISO Standard Test Methods.**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Test method</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile strength</td>
<td>S SH EN ISO 10319</td>
<td>F X X X X</td>
</tr>
<tr>
<td>Elongation at maximum load</td>
<td>S SH EN ISO 10319</td>
<td>X X X X</td>
</tr>
<tr>
<td>Static puncture (CBR test) &lt;sup&gt;ab&lt;/sup&gt;</td>
<td>S SH EN ISO 12236</td>
<td>X X X X</td>
</tr>
<tr>
<td>Dynamic perforation resistance</td>
<td>S SH EN ISO 13433</td>
<td>X X X X X</td>
</tr>
<tr>
<td>Water permeability normal to the plane</td>
<td>S SH EN ISO 11058</td>
<td>X</td>
</tr>
<tr>
<td>Characteristic opening size</td>
<td>S SH EN ISO 12956</td>
<td>X</td>
</tr>
<tr>
<td>Waterflow capacity in the plane</td>
<td>S SH EN ISO 12958</td>
<td>X</td>
</tr>
<tr>
<td>Durability</td>
<td>S SH EN ISO 12224 or S SH EN ISO 12960 or S SH EN 12447 or S SH EN 12225</td>
<td>X X X X X</td>
</tr>
</tbody>
</table>

The properties mentioned in this paper can be used to develop a system to classify and specify geotextiles for routine applications in Albania. It is believed that by separating into classes certain important geotextile properties, a useful systematic method of specifying geotextiles can be established. The French Committee of Geotextiles and Geomembranes was the first to set up a system to classify geotextiles, based on five geotextile properties, necessary for the design of a number of routine geotextile applications. This system has been used by other countries around the World to develop their proper systems and could be a good example to follow. This classifying system can help the Albanian engineers on using the proper geotextile for the proper application.

**References**


INFLUENCE OF MULTIPLE LAUNDERING ON COTTON SHIRT'S PROPERTIES

E. Toshikj, I. Jordanov, G. Demboski, B. Mangovska

Sts. Cyril & Methodius University, Faculty of Technology and Metallurgy, Department of Textile Technology, R. Boskovic 16, 1000 Skopje, Macedonia
tosic_emilija@tmf.ukim.edu.mk

Keywords: cotton shirt, different detergents, multiple laundering, ash residues, mechanical properties, graying and yellowing

Abstract

Cotton men's shirt all in plain wave in white and light color were submitted to multiple laundering with two different detergents under the same washing conditions. Powder detergent was with oxygen bleaching and optical brightening ageneses and liquid without them. Changes after 25-th washing cycle were analyzed through ash content, mechanical (tensile strength, elongation, work of rupture, fabric stiffness), comfort (air permeability) and aesthetic (whiteness index and CIELab coordinates) properties.

Shirts laundered with powder detergent had higher tensile strength, elongation, work of rupture, and lower air permeability and stiffness compared to shirts laundered with liquid one. They also contained higher ash content. White shirts laundered with powder detergent have higher whiteness index and lower $b^*$ values, while colored shirts showed higher fading and lower yellowing compared to shirts washed with liquid detergent.

Introduction

For many people, a dress shirt is a comfortable and stylish way to look decent every day of the week. Everyone wearing a sharp looking shirt looks fabulous. Man’s dress shirt includes a diversity of styles, types, volume of production, colors and designs as well as constructions and they are usually made of cotton or blends of polyester and cotton, sometimes with lycra. The reasons for development of blends are economy, durability, environmental impact, comfort, style and ease of use and care [1].

Determining how long a shirt should last is difficult due to the variances in frequency of wear. Industry experience shows that, on average, shirts have a two year wear life expectancy. The
number of launderings is a better measuring method for lifetime of the dress shirt. The average shirt should have a wear life of 35 to 50 washings. This will fluctuate depending on the degree of abrasion during wear, the fiber content, the type of fabric, and the laundering conditions. Generally, the washing processes are more damaging to shirt than its usage or wear [2]. Laundering process includes textile materials, soil, water, detergents and washing machine. It is known that the laundering conditions such as temperature, the number of laundering cycles, type of detergent and content of washing products has influence on the changes in textile hand, hydro properties, surface friction and other properties [3-5]. Detergents and washing processes should not only be tested for their cleaning efficiency, but also on their gentleness to dress shirts during laundering. Detergents come in liquid or powder forms, the liquid form being the most popular because it can be formulated more readily without phosphates. Household commercial detergents are complex formulations containing different components among which surfactant is the major constituent and contributor; builders, alkali/pH controller, chelating agents, ion exchangers, softeners, corrosion inhibitors, and foam controlling agents, bleaching agents/activators, fluorescent brighteners/whitening agents, enzymes, fragrances/perfumes, fillers and other additives as specific property builder/washing efficiency improver [6,7].

Correct washing can make your shirt look much more spectacular. On the flip side, a poorly washed dress shirt looks very tacky. For most shirts laundering temperature ranges between 40 ºC to 60 ºC depending on the color. The dyes used are mainly reactive dyes. Understanding the preferred methods of cleaning fabrics made of different fibers, consumers can understand how to follow the care label instructions and prolong the life of their garments. These labels may signal machine wash, tumble dry, but the type of detergent and drying temperature are not stated. A care label should recommend the use of detergents and bleaches to assist in the removal of soil and stains [8].

The aim of this investigation is to analyze the influence of multiple laundering on cotton shirts in white and light colors with two different detergents under the same washing conditions. In the experiment two detergents were used, powder with oxygen bleaching and optical brightening agenesis and liquid without them. Changes after 25-th washing cycle were analyzed through aesthetic, ash content, comfort and mechanical properties.

Experimental

Material

Commercially available, cotton and cotton/elastane woven fabrics in white and light colors for production men's dress shirts, all in plain weave, were seamed using the industrial sewing machine under sewing parameters adopted by apparel manufacturers. The sewing parameters and machine settings were constant during sewing shirts. The characteristics of the woven fabrics used for production of man's shirts are shown in Table 1.
Table 1. The characteristics of the woven fabrics used for production of men's dress shirts

<table>
<thead>
<tr>
<th>No</th>
<th>Color</th>
<th>Fabric composition [%]</th>
<th>Q [g/m²]</th>
<th>d [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>White</td>
<td>Cotton</td>
<td>72.64</td>
<td>0.22</td>
</tr>
<tr>
<td>2</td>
<td>White</td>
<td>Cotton</td>
<td>112.15</td>
<td>0.24</td>
</tr>
<tr>
<td>3</td>
<td>White</td>
<td>Cotton</td>
<td>115.99</td>
<td>0.22</td>
</tr>
<tr>
<td>4</td>
<td>White</td>
<td>Cotton/Lycra</td>
<td>125.83</td>
<td>0.29</td>
</tr>
<tr>
<td>5</td>
<td>White</td>
<td>Cotton/Lycra</td>
<td>123.21</td>
<td>0.35</td>
</tr>
<tr>
<td>6</td>
<td>light color</td>
<td>Cotton</td>
<td>106.69</td>
<td>0.26</td>
</tr>
<tr>
<td>7</td>
<td>light color</td>
<td>Cotton</td>
<td>125.83</td>
<td>0.22</td>
</tr>
<tr>
<td>8</td>
<td>light color</td>
<td>Cotton</td>
<td>123.21</td>
<td>0.33</td>
</tr>
</tbody>
</table>

Laundering procedures
The shirts were washed 3 and 25 times in an automatic washing machine with two commercially available detergents: powdered Ariel 3D actives (A) and liquid Eco Gloss (G) with very different formulations. Detergent A contains 5-15 % anionic surfactants, 5 % nonionic surfactants, phosphate, oxygen bleaching agent, enzymes, polycarbonates, soap, zeolites, optical brighteners and fragrances. Detergent G contains 15-30 % anionic surfactant, formaldehyde, fragrance, benzyl benzoate, 2-(4-tetra-butylbenzyl) propyl aldehyde, coumarin, gina-hexyl aldehyde and linalool. After laundering the shirts are dried in vertical direction at room temperature. The washing machine was set as followed: total weight to 1.8 kg, water level high, 60 ºC for washing, 106 min washing time, 34 l water content.

Testing and Analysis
Different methods were applied in order to assess the influence of multiple launderings on cotton shirt's properties.

Aesthetic properties: Whiteness index, CIE Lab coordinates and Colour differences were measured on X-Rite spectrophotometer with Colour Match colour formulation software v7.0 (D65/10o).

Ash content according to DIN 53 919, part 2. 3 g of sample material is taken from the unwashed and washed shirt cut, weighed, incinerated in a porcelain crucible, annealed during 60 min at 800 ºC in a muffle furnace, cooled in a desiccators and weighed again. The ash residues are calculated in percent of the fabric's weight.

Comfort characteristics were analyzed through:
- Air permeability AP (l/m²/s) according to BS EN ISO 9237:1995 on M021A Air Permeability Tester using a test area 20 cm² and pressure 100 Pa.
Mechanical properties were analyzed through:
- tensile strength $F$ (N), elongation $\varepsilon$ (%) and work of rupture in the warp direction according the strip method (BS EN ISO 13934:1-1999) using dynamometer (Tinus Olsen). The loss in the tensile strength, $F_a$ (%) was calculated as a percent of the differences between shirt's tensile strengths washed 3 and 25 times.
- Fabric stiffness $B$ (N) according to ASTM circular bend test method ASTM D 4032-94 on M003F Digital pneumatic stiffness tester.

Results and discussion

Multiple laundering may cause considerable reduction of aesthetic properties of shirts, shortening their wear life. Whiteness index and CIELab coordinates especially color differences are important criterions for evaluation of changes in aesthetic properties of multiple laundered shirts. Detergent A contains bleaching and optical brightening agents with specific action. They should give brilliance and freshness of white washed shirts. Laundering yellowing and graying of shirts might occur due to improper washing process, poor water quality, lack of certain quantities of components in detergents, such as builders, inhibitors against redeposition of soils, insufficient rinsing etc. Whiteness index and CIELab color coordinates of the referent and laundered shirts after 25-th washing cycle with detergent A and G are given in Table 2. Shirts after multiple laundering had lost their crispness compared to unlaundered. Laundering of white shirts with detergent A resulted in lower reduction of whiteness index (less graying) and less yellowing compared with detergent G. Laundering of light colored shirts with detergent A resulted in higher increase in $L^*$ values (fading) and yellowing compared with detergent G.

Table 2. Whiteness index and CIELab color coordinates of laundered shirts after 25-th washing cycle

<table>
<thead>
<tr>
<th>No.</th>
<th>WI R</th>
<th>A</th>
<th>G</th>
<th>L* R</th>
<th>A</th>
<th>G</th>
<th>b* R</th>
<th>A</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>126.04</td>
<td>124.05</td>
<td>106.14</td>
<td>95.24</td>
<td>94.2</td>
<td>92.34</td>
<td>-8.12</td>
<td>-8.45</td>
<td>-5.34</td>
</tr>
<tr>
<td>2</td>
<td>143.38</td>
<td>131.94</td>
<td>122.95</td>
<td>95.69</td>
<td>95.15</td>
<td>93.68</td>
<td>-12.16</td>
<td>-9.79</td>
<td>-8.44</td>
</tr>
<tr>
<td>3</td>
<td>132.3</td>
<td>120.63</td>
<td>114.58</td>
<td>94.82</td>
<td>95.31</td>
<td>93.71</td>
<td>-10.02</td>
<td>-7.18</td>
<td>-6.58</td>
</tr>
<tr>
<td>4</td>
<td>132.99</td>
<td>121.58</td>
<td>105.78</td>
<td>95.1</td>
<td>93.67</td>
<td>91.38</td>
<td>-10.12</td>
<td>-8.13</td>
<td>-5.68</td>
</tr>
<tr>
<td>5</td>
<td>124.61</td>
<td>121.25</td>
<td>105.23</td>
<td>95.64</td>
<td>93.22</td>
<td>90.48</td>
<td>-7.92</td>
<td>-8.26</td>
<td>-5.93</td>
</tr>
<tr>
<td>6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>83.37</td>
<td>85.79</td>
<td>81.92</td>
<td>-20.21</td>
<td>-17.25</td>
<td>-15.15</td>
</tr>
<tr>
<td>7</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>85.21</td>
<td>85.96</td>
<td>83.32</td>
<td>-9.34</td>
<td>-10.12</td>
<td>-8.32</td>
</tr>
<tr>
<td>8</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>78.44</td>
<td>83.21</td>
<td>79.24</td>
<td>-22.67</td>
<td>-19.45</td>
<td>-19.15</td>
</tr>
</tbody>
</table>

R-referent shirts, A- laundered with detergents A and G
Detergent G laundered shirts showed “older look” than laundered with detergent A, ΔE >1 Fig. 1. Fading of colored shirts laundered with detergent A can be due to the presence of bleaching agent, while graying of fabrics laundered with detergent G can be due to lack of inhibitors for redeposition of soils or residual soaps from detergents. It can be concluded, that laundering with detergent A was more successful and caused less deteriorated aesthetic properties of shirts.

Water used for washing cotton shirts has high hardness, °DH 17 to 18. It has long been recognized that calcium and magnesium hardness ions, present in supply waters are deleterious to textile washing process. These salts are often also deposited on and bound by textile fibers, where they build up to cause greying or yellowing, and the development of rancid, fatty odours on the fabric. Detergent A contains phosphates and zeolites. Phosphate forms a soluble 1:1 complex which is responsible for its excellent sequestrate building performance and zeolites act as ion exchange components. Where there is a molar excess of phosphates over hardness ions, no insoluble phosphates are precipitated, but in marginally build conditions insoluble calcium ortho- and pyro-phosphates occur. These phosphates are referred as ash because their levels are readily determined by burning off the fiber and weighing the residual ash. Laundered shirts after 25-th washing cycle with both detergents have higher ash content compared to referent shirts. Ash content of the tested shirts is given on Fig. 2. The higher ash content was found on laundered shirts with detergent A (1.2 to 4.43 %) compared to laundered with detergent G (0.25 to 0.68 %).

Ash contents on white and colored shirts laundered with detergent A have similar values. Ash content was slightly higher on colored shirts laundered with detergent G compared to white ones. The higher ash content on shirts laundered with detergent A may suggest that the amount of sequestering agent in A is not enough to bind all ions from water used for washing of tested shirts, and therefore can not prevent the formation of inorganic salts and their deposition on shirts. The hardness ions present in washed textiles provide potential sites for the attachment of anionic soils during the next use, wear and subsequent wash cycle. They also provide potential sites for the attachment of anionic soils during use.
The fatty acid components of sebum are often tenaciously held, especially when they are able to diffuse into the interior of fibers such as cotton during warm, moist use conditions. Detergent G contains sufficient quantity of sequesters in combination with anion active agent. Inorganic salts deposits could affect the stiffness, air permeability or mechanical properties. The changes in air flow also gave information of the changes of the fabric quality after washing. Air permeability of referent and laundered shirts after 25-th washing cycle with detergent A and G are given in Fig. 3. Multiple laundering decreased the air permeability of shirts. Shirts laundered with detergent G were more comfortable, had higher air permeability, than laundered with the detergent A suggesting less intensive changes of the shape and dimensions of the pores.

Tested shirts after multiple laundering became stiffer. The results of measuring the stiffness of referent and laundered shirts are given in Fig. 4. White shirts laundered with detergent A were stiffer than laundered with detergent G.

As a result of mechanical and chemical damages during multiple washing changes in mechanical properties can occur. The loss of tensile strength after multiple washing is due to the action of the bleaching agent and/or the abrasion and creasing in the washing machine.
The higher loss of the tensile strength can indicate that it is necessary to correct the concentration of bleaching agent or to control the presence of heavy ions in water [9]. Tensile strength, elongation and work of rupture of referent and laundered shirts after 25-th washing cycle with detergent A and G are given in Table 3. Changes after the 25-th washing cycle may be due to mechanical action during washing, detergent and its individual components, and water hardness. It was found that tensile strength of laundered shirts after 25-th washing cycle was not considerably reduced. As the tensile strength lost with both detergents did not exceed 10.02 % to 16.66 % (only on shirts 6 and 7) (Fig 5.), the degree of polymerization was not measured. Shirts laundered with detergent G showed higher reduction of tensile strength than laundered with detergent A (Fig.5). Elongation and work of rupture of laundered shirts with detergent G were lower than with A. Loss in strength to 20 % indicated that the mechanical properties of the fabrics sustained from deterioration from the multiple laundering of the shirts [10].

<table>
<thead>
<tr>
<th>No.</th>
<th>Fa [N]</th>
<th>ε [%]</th>
<th>A [J]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ref</td>
<td>Detergent A</td>
<td>Detergent G</td>
</tr>
<tr>
<td>1</td>
<td>462.83</td>
<td>469.33</td>
<td>468.75</td>
</tr>
<tr>
<td>2</td>
<td>534.5</td>
<td>528.5</td>
<td>562</td>
</tr>
<tr>
<td>3</td>
<td>639</td>
<td>596</td>
<td>641</td>
</tr>
<tr>
<td>4</td>
<td>990</td>
<td>893</td>
<td>904</td>
</tr>
<tr>
<td>5</td>
<td>600</td>
<td>577.33</td>
<td>602.33</td>
</tr>
<tr>
<td>6</td>
<td>504</td>
<td>441.5</td>
<td>524</td>
</tr>
<tr>
<td>7</td>
<td>680</td>
<td>568</td>
<td>632</td>
</tr>
<tr>
<td>8</td>
<td>683.33</td>
<td>679</td>
<td>667.3</td>
</tr>
</tbody>
</table>

*Tensile strength after 3-th washing cycle is used to calculate tensile strength loss, Fa (%).
Detergent A is a powder detergent containing oxidizing bleaching and sequestering agents and is used for washing white clothes. The most commonly used bleaching agent is perborate. It is activated at 90 °C or in the presence of activator TEAD. As detergent A did not contain TEAD, and the washing temperature did not exceed 60 °C, the conditions for full activation of the bleaching agent were not reached. Bleaching agent (perborate) at 60 °C may have some effect, but it is insignificant to compare with the effect at 90 °C. Detergent G contains 15-30% anion active agent, soap or sequestering agent and is intended for washing colored clothes. The differences in mechanical properties on fabrics after the 25-th washing cycle may be due to the different formulations of detergent.

Conclusions

Cotton based woven fabrics are the most commonly used shirting items due to comfortable soft hand, good absorbency, good strength, easy to handle, sew and care. Multiple laundering with both detergents, A and G was appropriate with some deterioration of aesthetic, comport and mechanical properties. Thus, laundered shirts with detergent A compared to detergent G retained aesthetic properties (especially white ones) and mechanical properties but they are less comfortable have higher ash content compared to launder with detergent G.
References


SECTION III:
Smart Textiles & Advanced Technology
EXTRACTING BODY DIMENSIONS FROM 3D BODY SCANNING

T. Spahiu¹, E. Shehi¹ and E. Piperi²

¹Faculty of Mechanical Engineering, Textile and Fashion Department in Polytechnic University of Tirana
²Faculty of Mechanical Engineering, Department of Production and Management in Polytechnic University of Tirana
tspahiu@fim.edu.al

Keywords: Clothing, human body, 3D body scanning, anthropometric data.

Abstract

Nowadays different attitudes and habits in everybody way of living, has bring out the necessity for different sizes and shapes in clothing. Creating better fitting clothing for different human bodies is a critical issue for any designer and manufacture of clothing industry. Fit of clothing is one of the main factors indicating the clothing purchasing behavior of consumers. Clothing manufactures needs accurate body dimensions for clothing production. The advancement of 3D body scanning technology has gained importance as clothing industry has raised its demands for good quality, short production times, low manufacturing costs and the overall product quality meaning clothing fit. Using the 3D body scanning technology is helping a lot of manufactures around the word obtaining accurate body dimensions. This new technology is changing the future of the apparel industry.

In this paper we are going to present the implementation of the 3D laser scanning system Konica Minolta VIVID 910 for body scanning. The purpose was extracting anthropometric data from 3D body models. In our work took part a 16 students, from 20-25 years old. Different package software are used for 3D data analyze.

1 Introduction

Creating better fitting clothing for different human bodies is a critical issue for any designer and manufacture operating in clothing industry. Since the advent of 3D image capture technology, there has been a great deal of interest in the application of that technology to the measurement of the human body [1]. 3D scanning technologies are applied for capturing different parts of the human body. Recently, 3D body scanners have been more and more used in anthropometric surveys [2].
Measuring the human body from 3D data is gaining increasing importance in applications such as virtual try-on solutions, online shopping, etc. Extracting tailoring measurements directly from 3D scans of people, could accelerate the tedious and time consuming process of custom tailoring [3].

Extracting anthropometric data from 3D body models is one of the main applications of this technology in the garment industry. The 3D scanning technologies used for body measurement extraction on today’s market are based on various systems. Although there are variability and incomparability of measurements between them, their common aim is to scientifically extract anthropometric data in a valid and reliable manner [4].

Technologies used commercially for the digital measurement of the human body can be divided into four major groups: (a) laser scanning, (b) white light scanning, (c) passive methods (as photogrammetric, silhouette, visual hull), (d) technologies based on other active sensors (as millimeter-wave radar, TOF 3D cameras) or touch sensors [5]. The main approaches to illumination control are: (a) continuous wave modulation, (b) time-of-flight (TOF) and (c) structured light triangulation [6].

2 3D scanning technologies

Before the turn of the nineteenth century, surveyors were using non-contact measurement from e distance to determine the shape of the Earth’s surface. Their system of triangulation would become the basis of modern methods where a light-sensing device would replace the theodolite, an ancient surveyor’s instrument [7].

Body scanning technology is becoming more widely used throughout fashion industry in garment design and body shape analysis [8]. There are various scanning systems used for body scanning. Their main scope is creating a replica of the real body. By scanning through the human body, 3D point clouds on the body surface can be captured, and further applications such as body dimension collection can be performed [9].

The use of 3D surface scanning technology to produce digitized representations of the human anatomy has the potential to help change the way a wide range of products are designed and fabricated [10].

3 Methodology

The system used in our work is a 3D laser scanning system Konica Minolta VIVIVD 910. The objective of this work was the extraction and evaluation of anthropometric data taken with this scanning system. A small group of students (16) was choosing for scanning and extracting anthropometric data. The main criterion used for selecting the group of people to be scanned was their age, from 20 – 25 years old. Ethical explanation was done to ensure data privacy only for this study purpose. The scanning process was done in the Laboratory of CAD/CAM and
Technology of Garment Production in Polytechnic University of Tirana. Workflow of the system for full body scanning and data manipulation for extracting body dimensions as shown in Fig. 1.

![3D scanning and Extracting Body Dimensions workflow](image)

**Fig. 1** Workflow from 3D full body scanning till the extraction of body dimensions

4 Experimental work

4.1 Pre-test methods and system setup

Since the scanner is an optical measurements equipment, meaning that is very sensitive to lighting conditions and the texture of the object being scanned, we have done some pre-tests. Initially before starting the scanning process of body scanning, we have done testing of this scanning system. The scope was to test the scanner in different environmental conditions as temperature, humidity and lighting. This was necessary to define the right scanning parameters and time of the scanning process. During the testing procedure were recorded various objects scanned. The preliminary results of scanned objects showed different feature, which were taken into account during the body scanning. During the scanning process, the models wore fitted garments, polyamide composition with black color. This was done to provide comfort and avoiding unsuccessful results during the scanning process. Breathing and human body movements were two criteria, taken into account for the scanning process.

4.2 3D Laser Scanner System Konica Minolta VIVID 910

3D Laser Scanner Konica Minolta VIVID 910 (2002) is a portable scanner which captures the surface of an object from a single position. During the scanning process, the 3D scanner is
mounted on an adjustable tripod. The lens of the scanner needs focusing on the object being scanned. The laser beam moves across the object and the light is reflected back to the scanner, which captures the surface data of the shape and records the measurements of the object at a certain distance. VIVID 910 are equipped with three types of lens, which are suitable for the size of the object and distance must be used. In our work we used a WIDE Lens for object distance Horizontal 725.8 mm and Vertical 544.4 mm. We scanned the objects using Polygon Editing Tool Ver. 2.3 and saved the scans as .vvd format. The scanner is equipped with a 360° rotary turntable permitting a full object scan. Different angles of the turntable can be used permitting different view of the object. The first step before starting the scanning process is chart calibration. The schematic view of the 3D Laser Scanner VIVID 910 Konica Minolta is shown in Fig.2 [11].

![Fig.2 Laser scanning VIVID 910 schematic view](image)

The basic principle of VIVID 910 uses LASER triangulation. The object is scanned by a plane of laser light coming from the VIVID’s source aperture. The plane of light is swept across the field of view by a mirror, rotated by a precise galvanometer. This laser light is reflected from the surface of the scanned object. Each scan line is observed by a single frame captured by the CCD camera. In Fig. 3 is shown the principle of triangulation for laser scanning.
Fig. 3 Triangulation principle: single camera solution [12]

The scanning process included different phases as follows:

- Calibration process
- Scanning of the object
- Modification of the scan data
- Exporting the 3D model in different formats

Taking into account the object dimensions to be scanned, in our case body scanning, we have used wide lens, which is suitable for object size Horizontal 1204.2 mm and Vertical 903.2 mm. For body scanning we have used Polygon Editing Tool Ver. 2.3 and the data captured are saved as vvd. The surface shape is converted to a lattice of over 300,000 vertices (connected points). In Fig. 4 are shown the model during the scanning process and the body data captured during for one single scan.

Fig. 5 The model in the scanning position and with b) data captured of one single scan
During the scanning process we scanned the model in 8 positions, meaning 8 different single scans. This was done only for the upper part of the body and other 8 single scans in different positions for the lower part of the body. So, in total we have done 16 single scans of the human body. The total time of body scanning was 6 min. The distance between the scanner and turning table was 1.5 m.

5 Data manipulation and extracting body dimensions

An important phase in creating an accurate 3D body model is post processing of the scanned data. In most cases the 3D point cloud data generated from 3D scanning, needs cleaning all the distortions or unwanted data and alignment of all the single scans, in order to create an accurate 3D body model or as is called a geometric variant from the scanned data. Advanced data manipulation of the 3D models taken from body scanning is done using the software Geomagic Studio™ software [13]. The captured data meaning the point cloud need cleaning of all the unnecessary point or distortion during the scanning process. Also during this phase is done filling of the holes (small gaps in the scan data), smoothness. In the Fig. 6 is shown one of the steps during the process of advanced data manipulation.

![Fig. 6 Scan data manipulation in Geomagic Studio software](image)

The procedure followed for calculating circumferences is shown in Fig. 7. With numbers from 1 to 3 are shown the main steps for calculating the circumferences. By knowing the number of points and the distance between them we calculate the circumferences of each section [14].
Fig. 7 Extracting circumferences

Fig. 8 Bodies with section planes at different parts and the number of points generated
6 Comparing body dimensions taken manually versus digital

In our work took part a 16 students, from 20-25 years old. Assessing the accuracy of the body dimensions extracted following the steps explained above, we have done manual measurements of the same body dimensions extracted virtually. In Fig. 9 are shown the charts of the main measurements taken with both methods, such as:

- bust circumferences digital & manual (BCD & BCM),
- waist circumferences digital & manual (WCD & WCM),
- hip circumferences digital & manual (HCD & HCM),
- shoulder circumferences digital & manual (SHCD & SHCM),
- breast distance digital & manual (BDD & BDM),
We tested the accuracy of body dimensions extracting from 3D body model using one set of body dimensions to produce a suit. This, for evaluating the fit of the garment realized using body dimensions taken from 3D model and extracted following the procedure showed in Fig. 7. In the Fig. 10 is shown the selected model, wearing the suit produced with her body dimensions [11].
Fig. 10 3D scanning of garment fit on the real body

7 Results and discussion

This study involved the implementation of a 3D laser scanning system Konica Minolta VIVID 910 for full body scanning. 3D body models were exported in software for making advanced data manipulation. The main scope for capturing 3D human body and extracting body dimensions. As this is not an automatic procedure for extracting body measurements, we tested the accuracy of this procedure by manually measuring the same body measurements. By choosing one set of body dimensions extracted virtually, we designed and produced a suit. This, to evaluate the fit of the garment realized with those body dimensions.

The 3D body model will be exported in 3D garment design software for custom garment design. This is part of another work made by authors.

During our work were encountered different issues. One of them was the instability of models during the scanning procedure. In some cases we have done the body scanning of three parts because of the height of the model.

8 Conclusion

Creating better fitting clothing for different human bodies is a critical issue for any designer and manufacture of clothing industry. Clothing manufactures needs accurate body dimensions for clothing production. The advancement of 3D body scanning technology has gained importance as clothing industry has raised its demands for good quality, short production times, low manufacturing costs and the overall product quality meaning clothing fit. Using the 3D body scanning technology is helping a lot of manufactures around the world obtaining accurate body dimensions. The scope of our work was the implementation of the laser scanning system Konica Minolta VIVID 910 for full body scanning and extracting body dimensions from the 3D body model. Following different steps we have done the calculation of main body dimensions.
This work is part of a largest work about using 3D scanning technology for digitizing 3D body models, designing patterns on personalized body using anthropometric data extracted from 3D body models. So we tested the implementation of this scanning system and using different software for data manipulation and extracting body dimensions. This body dimensions were measured manually to test the accuracy of body dimensions extracted from the 3D body models. Comparing the results taken by both ways of body measuring was shown that the method is accurate for extracting body dimensions.

References

THE POTENTIAL OF SCREEN PRINTED CONDUCTIVE TEXTILES

I. Kazani¹, C. Hertleer², G. De Mey³, F. Declercq⁴, H. Rogier⁴, G. Guxho¹, L. Van Langenhove²

¹Polytechnic University of Tirana, Department of Textile and Fashion, Square ‘Mother Teresa’, No.4, Tirana, Albania
ikazani@fim.edu.al;
²Ghent University, Department of Textiles, Technologiepark 907, 9052 Zwijnaarde, Belgium
³Ghent University, Department of Electronics and Information Systems, Sint-Pietersnieuwstraat 41, 9000 Ghent, Belgium
⁴Ghent University, Department of Information Technology, Sint-Pietersnieuwstraat 41, 9000 Ghent, Belgium

Abstract

During the last decade a lot of research is performed on developing smart textiles. They contain different components such as sensors, actuators, data processing components, energy and communication systems. Over the last years a lot of work is done on making these components out of textiles and to manufacture these wearable textile systems, electroconductive textiles are needed.

The paper will give an overview on the applications of screen printed electroconductive textiles. This method offers flexible and lightweight conductive textiles with excellent electroconductive properties, which can find use in different applications such as circuits, textile antennas, feed lines or simple one-layer routing structures, and electrodes.

Introduction

Textiles are among the oldest materials that are known to humankind. But evolution in technology has made it possible to apply different materials and to integrate electronic devices into these textiles in order to make them smart or intelligent [1].

Today, terms such as “Smart Textiles”, “Intelligent Textiles” and “Wearable Electronics” are commonly used in every textile environment. These terms refer to textiles that are able to sense stimuli from the environment around them and react and/or adapt to these stimuli [2 - 4].
Research on smart textiles from different groups with different backgrounds was carried out (designers, engineers, chemists, doctors, etc) aiming at developing applications for the military, fire-fighters and first responders to medical garments and also casual garments. Most of this research is supported by projects and in the last decade the research in smart and wearable textiles is done through different European projects [5-16].

To manufacture these wearable textile systems, electroconductive textiles are needed. Electroconductive textiles are materials which can conduct an electrical current [17]. These textiles can be achieved by using conductive fibres, yarns, coatings, polymers or inks [18-21].

In the research presented in this paper the screen printing method was specifically selected because it is an economical, flexible and fast way to obtain lightweight electroconductive textiles. With this method we can have a flexible and low cost material, diversity of patterns, which cannot easily be achieved with other methods. They can be used in different applications such as electrodes for monitoring heart rate and textile-based antennas for off-body communication.

The only problem this method was facing was the maintenance of the printed textile in daily life, but a solution is presented in order to make these electroconductive flexible substrates washable or dry-cleaned up to 60 times [22-23].

**Screen-printed electrodes**

One of the main applications of conductive textiles is in the medical field for sensors and electrodes [24 - 28]. Many groups have investigated the integration of textile electrodes in garments. Catrysse et al. [26] have integrated knitted electrodes into a belt for the recording of electrocardiogram (ECG) and respiration rate for children in the hospital. Linz et al., in the framework of the ConText project, [27] have embroidered sensors, integrating them into garments, for monitoring health parameters on the human body. Schwarz et al. [28] have integrated electrodes in socks for electro stimulation, based on conductive silicones and elastic conductive yarns in order to prevent or heal the decubitus wounds and support patients with Parkinson disease. Merritt *et al.* [29] have screen-printed on nonwoven textile substrates electrodes for potential use in health monitoring garments. Other groups have developed woven or knitted electrodes [27, 33 and 34].

When using screen-printed fabrics as electrodes it is important to investigate their behaviour in combination with sweat because the textile electrodes will be in close contact with the human body. Electrochemical Impedance Spectroscopy (EIS) is the appropriate method to investigate and analyze these screen-printed textile electrodes combined with (artificial) sweat. Since these electroconductive textiles with two silver-inks used show to have good conductivity after 20 washing cycles, confirming that these electrodes can be easily maintain. The resistivity was investigated when they are in contact with the human sweat. These textile electrodes may be used for measuring biomedical parameters or for giving therapeutic treatments.
Screen-printed textile antennas for off-body communication

The second application of screen printed electroconductive textiles is for antennas for off-body communications. In the last decade research has started into the development of flexible textile antennas to be integrated into garments in order to have a wearable textile system that can wirelessly communicate with a nearby base-station. A lot of research effort has been put in obtaining antennas with smaller dimensions and with better performance [35]. The textile antennas can find use in the medical and military sector or in personal protective clothing e.g. to monitor first responders [36 - 38]. The antenna patch is made out of conductive material, for which in the case of a textile antenna, commercially available conductive coated textile materials, conductive threads for embroidery or conductive inks can be used [35 - 40].

Many papers have been published on design, fabrication and applications of textile antennas. Hertleer et al. [39] proposed a truncated corner microstrip patch antenna on a flexible pad foam substrate; in [43] she describes a rectangular ring microstrip patch antenna. In [44] Kennedy presented an eight-element microstrip patch antenna and Subramaniam et al. [45] have developed a circular microstrip patch antenna, all made out of textile materials.

When using conductive coated textile it is necessary to cut the patch in the desired pattern by means of a simple cutting tool which sometimes is not very precise and accurate. Therefore, in this chapter we will describe one application of electroconductive textiles through screen-printing. It was decided to continue what was started by Hertleer et al. [46]. They screen-printed silver-based ink on aramid fabric and concluded that the screen printing with conductive inks has powerful potential and fulfils the requirements. However, the properties of the antenna were not tested after a washing process, which is inevitable when the garment with incorporated antenna is cleaned. Earlier was explored with other textile substrates and another antenna type, a microstrip inset-fed patch antenna [47] (Figure 1). It was compared between two different conductive materials, one electroconductive textile, manually cut and glued onto the substrate, and the other screen-printed electroconductive textile. The antennas made with conductive ink exhibit a stable resonance frequency, good matching, and stable radiation efficiency as the number of washing cycles increases up to six. Instead, the antennas made with the electrotextile tend to lose some matching, and the radiation efficiency drops with the number of the washing cycles. Et. al. [48] was shown that covering the antennas with the TPU (thermoplastic polyurethane layer) not only protects the screen-printed conductive area but also prevents delamination of the multilayered textile fabric substrates, making the antennas washable for up to 20 cycles. Furthermore, it is proven that coating is not necessary for maintaining antenna operation and this up to 20 washing cycles. The main problem of antenna performance degradation during the washing process was the connector detachment, caused by friction. Hence, other flexible, durable methods should be developed for establishing a stable electrical connection.
Materials and methods

Textile materials
In this study four textile substrates were used for the screen-printed electrodes (PES 1, PES 2, CO/PES 1 and CO/PES 2) and two for the screen-printed antennas (PES 3 and CO/PES 3).

Conductive inks
The electrodes samples were screen-printed with two silver conductive inks, (Ink 1 and Ink 2) provided by Sun Chemical Company and the antennas were print with Ink 3 from Acheson (Electrodag PF 410).

Impedance measurement
Here, the impedance of the complex system textile-human skin is required as it is evident that the electroconductive textile will be in contact with the skin. So with EIS it is possible to study the properties of electroconductive textiles for medical application. Electrochemical impedance is measured by applying an AC potential to an electrochemical cell and then measuring the current through the cell.

Measurement set-up
The measurement set-up comprises two main components, an electrochemical cell and a potentiostat.

Antenna design and performance
The planar textile antennas used in this research consist of three layers: a patch, a substrate and a ground plane. Two of the layers, the patch and the ground plane, consist of conductive materials, whereas the substrate is nonconductive.

The antenna was designed by means of a 2.5-D EM field simulator Momentum of Agilent’s Advanced Design System (ADS). Because of the thickness of textile substrates used and the frequency band to be covered by the antenna (2.45 GHz ISM band), it was decided to have a multiple layer antenna, meaning that several layers of nonconductive textile material are used to form the substrate layer. So each antenna is assembled by applying 4 or 6 layers, where the antenna patch was screen-printed on the top layer and the ground plane on the bottom layer.

The maintenance of antennas was done according to the international standard, ISO 6330:2000.
Results and discussion

Electrodes application - Different textiles printed with silver conductive inks

In the figures below the Nyquist and Bode plots of all textiles printed with ink 1 and with ink 2 are shown.

**Figure 2.** Nyquist plot of impedance for printed samples with conductive inks 1 and 2

Figure 2 reveals that the maximum impedance varies between 1250 and 2500 Ω. Rattfält et al. [22] reported that the impedance of an electrode is acceptable when it is lower than 50 kΩ at 50 Hz. Our results show that the impedance of the printed electrodes (both with ink 1 and ink 2) remains under 2500 Ω for frequencies between 0.5 Hz and 500 kHz.

From the Nyquist plot we observe that printing with a different ink results in a change of impedance, as could be expected because also the DC resistance varied when applying a different ink. Every textile printed with ink 2 shows to have lower impedance compared with ink 1. The same result was obtained when measuring the square resistance with a four-point probe using DC (direct current). As can be seen from the table below (Table 1) the samples printed with ink 2 show to have lower square resistances than those with ink 1.

**Table 1.** Square resistance of the samples before washing

<table>
<thead>
<tr>
<th>Screen-printed textile</th>
<th>Square resistance $R_{sq}$ (Ω/□)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ink 1</td>
</tr>
<tr>
<td>Polyester 1</td>
<td>0.019</td>
</tr>
<tr>
<td>Polyester 2</td>
<td>0.009</td>
</tr>
<tr>
<td>Cotton/Polyester 1</td>
<td>0.012</td>
</tr>
<tr>
<td>Cotton/Polyester 2</td>
<td>0.019</td>
</tr>
</tbody>
</table>
Antennas application - Measurements results before and after washing

The antenna characteristics such as the reflection coefficient ($|S_{11}|$) and the radiation efficiency ($\eta$) were measured and calculated before and after washing. In total 5 washing cycles were completed and the measurements were done after each washing cycle. After being dried the antennas were put in the climatic test cabinet for 24 h. In order to calculate the radiation efficiency, the Generalized Wheeler cap method with Matlab was used [49].

**Cotton/polyester antennas printed with Electrodag ink**

From Figure 3, we observe an increase in ohmic losses (broadening resonance peak, decrease $|S_{11}|$ at higher frequencies) after the 15th and 20th washing cycles. Nevertheless, these results show that even after 20 laundering cycles, the unprotected antenna presents acceptable antenna characteristics. For the coated cotton/polyester antenna with Electrodag ink, the reflection coefficient behaviour as a function of increasing washing cycles, given in Figure 4, is relatively constant up to 10 washings. Hereafter, a large degradation in $|S_{11}|$ is observed. Since the antenna is coated, the abrupt change in antenna reflection coefficient behaviour results from connector detachment and not from a degradation of antenna patches and ground plane conductivity.

![Figure 3. Free-space reflection coefficient before and after each 5$^{\text{th}}$ and up to 20 washing cycles of the CO/PES antennas with Electrodag ink and without TPU layer](image1)

![Figure 4. Free-space reflection coefficient before and after each 5$^{\text{th}}$ and up to 20 washing cycles of the CO/PES antennas with Electrodag ink and with TPU layer](image2)

**Polyester antennas printed with Electrodag ink**

The free-space $|S_{11}|$ measurement depicted in Figure 5 of the uncoated PES antenna using Electrodag as conductive ink shows a relatively constant behaviour and this up to the 10$^{\text{th}}$ washing cycle. Also, the results of the coated counterpart, depicted in Figure 6, show a stable reflection coefficient as a function of an increasing number of washing cycles. Hence, we can conclude that the conductive ink is not degraded due to washing and that the SMA connections of these antennas did not detach.
Conclusions

In this paper an overview on the applications of screen printed electroconductive textiles was given. One application of these conductive textiles with excellent electroconductive properties is as electrodes. A lot of research was done in textile electrodes for biomedical monitoring. Here it was introduce another type of electroconductive textile by means of screen printing. In this paper the results of electrochemical impedance spectroscopy have shown to be promising as the values of the impedance, of the printed electrodes, have shown to be lower than 50 kΩ at 50 Hz.

The other application of screen-printed conductive textiles shown here was the microstrip inset-fed patch antenna, where the influence of laundering of these antennas was studied. The performance of the antennas, by measuring the reflection coefficient, was studied before and after coating with a TPU layer. The antennas were protected with TPU because degradation of the conductive ink layer was expected after repeated washing cycles. In conclusion, coating the antenna effectively protects the conductive ink from degradation and avoids delamination due to washing. The coating remains effective up to at least 20 washing cycles. However, some uncoated antennas still performed well after 20 washing cycles, which implies that the washing process does not significantly degrade the conductive ink. Nevertheless, coating with a protective layer prevents any degradation of the ink layer, but even more, avoids delamination of the multilayer antenna substrate.

References


AN INNOVATIVE ELECTRO-CONDUCTIVE TEXTILE PROTOTYPE SWEATER

A. Shabani\textsuperscript{1}, I. Kazani\textsuperscript{2}, O. Zavalani\textsuperscript{3}, G. Guxho\textsuperscript{2}, S. Kasmi\textsuperscript{2}

\textsuperscript{1} Polytechnic University of Tirana, Department of Electrotechnics, Square ‘Mother Teresa’, No.4, Tirana, Albania
aulonshabani@yahoo.com

\textsuperscript{2} Polytechnic University of Tirana, Department of Textile and Fashion, Square ‘Mother Teresa’, No.4, Tirana, Albania

\textsuperscript{3} Polytechnic University of Tirana, Department of Automation Industry, Square ‘Mother Teresa’, No.4, Tirana, Albania

Keywords: heating sweater, copper yarn, thermal comfort, knitting

Abstract

In the last years the wearable electronics have been an emerging transdisciplinary field. They have brought together concepts and expertise from a variety of disciplines, ranging from textile materials science, through electrical and electronic engineering to design. The aim of this paper was to investigate through the prototype the potentials of the cooper yarn stitched into a knitted sweater for a better comfort in a cold climate. A woollen sweater was knitted and a heating element was stitched at the lumbar region. The heating element is an electrically conductive copper yarn, which is winded around a non conductive core yarn. The thermo graphic analysis of the field temperature of the prototype has result to be uniform and within recommended values of literature. The sweater was connected to a controlled power source which provides different temperature ranges for a better comfort.

Introduction

Recent innovations in engineering have significantly broadened the scope for the uses of textiles. They have moved our understanding of textiles, from being passive, simply serving their design purposes of being beautiful, hard wearing or high performance, to becoming active or interactive\cite{1}. The most commonly types of active textiles are electrically heated garments. They help wearers to manage specific situations by improving the functionality of traditional garments. The personal heating garment widens the operating temperature range of garment and
improves the protection against cold [2-7]. Moreover they can find numerous applications in health care, military applications, sports, leisure, automotive and in the aircraft industry as an antifreezing agent [8-14].

The built-in heating elements can be flexible electrical element wires, graphite elements, electrically conductive rubber, textile fabrics treated in metallic salt solutions, polyethylene mixed with carbon black, or printed circuit heaters [15]. Not so long ago, a new carbon polymer heating element made from bio-thermal carbon fibres was successfully developed and launched on the market. This heating element is slim, light and washable, and most importantly, there is no limit to human movement [8].

In this paper we propose a heating woollen sweater, which is flexible, washable and not very expensive. The knitted sweater, made out of wool fibres, has a heating element positioned at the lumbar region. The built-in heating element is an electrically conductive copper yarn, which is wounded around a non-conductive core yarn. This heating element is connected to a controlled power source which provides different temperature ranges for a better comfort of the wearer in specific situations.

The attempts of incorporating electric heating elements such as heating wires to clothing are not new [16]. Our proposed prototype compare to other products on the market is cheaper and easier to install. The target groups for our proposed prototype are the elderly people and those who work in an office spending most of their time in one place. We believe that the use of heating woollen sweater by this target group shall increase not only their comfort but also the heating efficiency of the building. This is a very sensitive issue in our day [15-16]. Our investigation is in progress and the results shall be published in another paper. Another field of our ongoing work is the simulation of the heating process in MATLAB. This is a very important issue connected to further development of the prototype and the use of it for education purposes. Research literature [17] underlines that in our days mathematical modelling and simulation in engineering education is a comprehensive issue.

Methodology

Prototype preparation

Textile material.

In this study a 100 % woollen sweater is knitted in flat knitwear “Universal V” machine. Wool is the best natural occurring heat generating fibre that has been used to warm up the body in colder environments since ancient ages [18]. This is the reason that wool is selected as the textile material for the sweater.

Heat is released from the wool as soon as it absorbs moisture. Stuart et.al [18] declared that if 1kg of dry wool is allowed to get saturated in humid air, 960 kJ of heat will be generated that is equal to the heat produced by an electric blanket running for eight hours [13].
Heating element
The heating element is an electrically conductive winding copper yarn with a diameter of 160 µm, which is winded around a non conductive core yarn. It is stitched at the lumbar region in the area of kidneys. Figure 1 shows the design and the place of the conductive yarn inside the prototype textile garment. The shape of the heating element prototype is selected rectangular 10 cm x 37 cm due to available place inside the garment. The heating element of the sweater is designed to operate with a controllable power source (10-25 V).

![Figure 1. The design of the heated circuit](image)

Experiment
Adjustable power supply PS 23023 was used to supply with DC voltage the heating element of the prototype, where the voltage and current were monitored. Temperature level is controlled through voltage level control. This means that the thermal energy inside the garment can be controlled through the level of the voltage. Moreover the temperature measurement is realized using a thermocouple type NI USB-TC01 in five different points of prototype (Figure 2). Measurements were repeated every 5 minutes, because this is the measured time of temperature stabilization.

Table 1 presents the electrical resistance values for each level of the voltage used during the test.

<table>
<thead>
<tr>
<th>Voltage (V)</th>
<th>Current (A)</th>
<th>Power (W)</th>
<th>Resistance (Ω)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>0.25</td>
<td>2.5</td>
<td>40.000</td>
</tr>
<tr>
<td>15</td>
<td>0.37</td>
<td>5.55</td>
<td>40.540</td>
</tr>
<tr>
<td>20</td>
<td>0.48</td>
<td>9.6</td>
<td>41.667</td>
</tr>
<tr>
<td>25</td>
<td>0.59</td>
<td>14.75</td>
<td>42.372</td>
</tr>
</tbody>
</table>
The temperature field of heating element after 20 minutes of the test is presented in Figure 3. The image is taken with a Thermo Visio V1.4 thermal camera and elaborated in dedicated software.

Figure 4 shows the transitional values of temperature in each point of measurement for an increase of voltage level from 10 to 25V, with 5V step each 5 minutes.
Researchers have shown that different textile and heating materials change their resistance after laundering [7, 21-23]. For this reason, the laundering behaviour of our prototype was tested by being subjected to a maximum of 10 washing cycles. The electrical resistance values after the washing circles for each level of the voltage are presented in Table 2.

**Table 2. Electrical measurements of the electro-conductive prototype after washing cycles**

<table>
<thead>
<tr>
<th>Voltage (V)</th>
<th>Current (A)</th>
<th>Resistance (Ω) R=V/I</th>
<th>Current (A)</th>
<th>Resistance (Ω) R=V/I</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>0.25</td>
<td>40.000</td>
<td>0.25</td>
<td>40.000</td>
</tr>
<tr>
<td>15</td>
<td>0.37</td>
<td>40.540</td>
<td>0.37</td>
<td>40.540</td>
</tr>
<tr>
<td>20</td>
<td>0.48</td>
<td>41.666</td>
<td>0.48</td>
<td>41.666</td>
</tr>
<tr>
<td>25</td>
<td>0.59</td>
<td>42.372</td>
<td>0.59</td>
<td>42.372</td>
</tr>
</tbody>
</table>

**Results and discussions**

Experimental results shows that the temperature field of the heating element is uniform (Figure 3 and 4), which means that one of the comfort requirements is satisfied. Furthermore the level of temperature inside the garment is also in accordance with comfort requirements. Literature reference requires that the heating element has to increase the temperature inside the garment until maximum temperature of 15°C over the environment temperature [24-25]. The electric proprieties of heating element such as electric power absorbed, have been selected and calculated based on the requirements. Temperature control realized by using different level of voltage
supply and an on-off control allows the wearer to select a wide range of temperature level to feel the comfort. The results of Table 1 and 2 are compared graphically in the Figure 5. Analyze of these results shows that the electrical resistance values of the selected heated circuit material material do not change significantly after the washing tests. Moreover this means that the heating properties of this element do not change after 10 washing cycles. This is a very crucial technological requirement satisfied by our electro-conductive textile prototype sweater.

![Figure 5. Temperature distribution before and after washing cycles](image)

The prototype presented in this paper is the first prototype development. The heating efficiency of the heating element the use of this type of garment for the selected tagged groups in the building efficiency will be investigated in the future. To realize this we are working for modelling and simulation of the prototype, to study its performance in MATLAB environment, which is very flexible also for the further investigation of the temperature control system of the prototype.

Modelling and simulation will allow the use of the prototype development also in the education process during student laboratories or during the teaching process as a real example of an electro heating system used in textile industry.

Another future work will be the investigation of electric and structural properties of the material used for heating in different chemical environments during the washing process.

**Conclusions**

In this paper the potentials of an innovative electro-conductive textile prototype sweater; in order to increase the comfort of the wearer in a cold environment is presented. The woollen sweater
was knitted and a heating element was stitched at the lumbar region. The heating element is an electrically conductive copper yarn, which is wounded around a non conductive core yarn.

The thermo graphic analysis of the electro-conductive prototype has result to be uniform and within recommended values. The sweater was connected to a controlled power source which provides different temperature ranges for a better comfort.

The prototype presented in this paper is the first prototype developed. The ongoing study will be focused in the heating efficiency of the prototype and investigation of electric and structural properties of the material used for heating in different chemical environments during the washing process.

During the improvement of the prototype the modelling and simulation will be study, in order to observe the performance in MATLAB environment. It is expected that by simulation in MATLAB environment the temperature control system of the prototype will be improved.

The study of modelling and simulation of the electro-conductive textile prototype sweater will be integrated in the in the education process as a real example of an electro heating system used in textile industry.

References


[24]. Human Comfort and Health Requirements.

FROM 3D FOOT SCANS TO FOOTWEAR DESIGNING & PRODUCTION

E. Piperi¹, L. M. Galantucci², J. Kaçani¹, E. Shehi³, T. Spahiu³

¹ Faculty of Mechanical Engineering, Department of Production and Management, Polytechnic University of Tirana, Tirana
epiperi@fim.edu.al

² Department of Mechanical, Matematical and Management– Polytechnic of Bari, Italy

³ Faculty of Mechanical Engineering, Textile and Fashion Department, Polytechnic University of Tirana

Keywords: 3D foot scans, footwear designing, custom shoes, reverse engineering, 3D printing.

Abstract

3D scanning is a potential technology for creating individualized products. It is used in various fields such as medicine, clothing manufacture, footwear manufacture, etc. The last mentioned field has gained a growing interest in recent years. The foot is regarded as an important part of human body. Footwear fit, is one of the main factors for consumer on purchasing shoes in the daily life decisions. Designing footwear is a very complex process. Traditional footwear design begins with a plan to sketch patterns and designs in scale drawings. The paper sketches are done by hand, or on computer-aided software, but it can be a mix of both technologies.

In this paper we are going to present a full cycle of footwear production, starting from 3D foot scanning, to 3D shoes designing, 2D patterns extraction, till the production of the custom shoes. The system, explained in these work will give the opportunity to individual clients to produce their own shoes prototype. We are going to use the 3D printing technology to produce custom shoes. These will help people, which have feet problems with standard shoes available in the market creating their own shoe last. Also, it will be possible to create sample prototypes and refining the same for both functionality and aesthetics.

1 Introduction

Footwear can be defined as a garment worn by feet. The main scope is protecting the feet of the wearer, which is a very important part of the human being. The foot is regarded as the second heart of the human beings in traditional Chinese medicine, transmitting and attenuating the impact forces between the ground and the human skeletal system [1].
Feet have a rough time of it; they carry us the equivalent of five times around the earth in an average lifetime, yet we give them less attention than they deserve and we rarely wear the best shoes for our feet [2].

The main factors indicating the purchasing decision of consumers are two: footwear appearance and footwear fit. Fit is one of the most important functional aspects in footwear comfort and together with appearance and price, is one of the most important considerations for users when purchasing new footwear [3]. The foot provides a crucial contribution to the balance and stability of the musculoskeletal system. Foot problems are common among a wide group of people, ranging from simple disorders through to complex diseases and joint deformities [4].

Footwear shape and dimensions are influenced by the last’s shape and dimensions. The most important component of the shoemaking is a shoe last, a 3D mold around which a shoe is made. A shoe last is closely related to the foot and its design is based on many factors such as the foot shape/size, comfort parameters, shoe fashion/style, type of construction, etc [5].

Manufacturers attempt to design and develop footwear so that provide a covering for the foot while exhibiting fashion or style. Product performance on the other hand, can be broadly evaluated based on its function, form, and fit. It is well known that fit or product compatibility is necessary for a person to experience comfort, safety and satisfaction during use [6].

Various methods of designing and manufacturing software, along with fashion trends do not always respect structural and functional requirements of the feet. Because of this, in time, muscles, bones and joints are over stretched, resulting in a change of morphological and structural characteristics of the feet [7].

2 3D technology

3D technology has gained a lot of importance in recent years. It is used in various fields of application, such as medicine, science, engineering, military, entertainment and now in the apparel industry. In the world of fashion, 3D technology offers the potential for creating made-to-measure apparel meaning clothing and footwear. The human fit are complex 3D objects having a wide diversity in their shapes depending upon locality, age, sex, etc [8].

The use of 3D scanning technology to produce digitized representations of parts of the human anatomy has the potential to help change the way a wide range of products are designed and fabricated [9]. There are a lot of applications of 3D scanning technology for digitizing different part of human body. Their scope it is more than product interaction. With the research field shifting to more information and better accuracy, 3D scanning has quickly become the standard in capturing foot geometry. Analysis into the capability of 3D scanning for foot modeling showed that 3D scans were very reliable and repeatable [10].

3D printing technology is widely used recently for manufacturing of footwear products. 3D printing is a form of additive manufacturing (AM) technology where a three dimensional object is created by laying down successive layers of materials.
Additive manufacturing (AM), also known as 3D printing, rapid prototyping or solid freeform manufacture. Additive manufacturing is an umbrella term which covers a range of technologies that utilize layer manufacturing to fabricate items.

3 Methodology

Designing footwear products is a complex process. Designing the footwear on the scanned foot, meaning the custom last will provide a good fit. The scope of our work was implementation of a low cost structured light scanning system for 3D foot scan. In Error! Reference source not found. re shown the main steps used in these work. They include:

1. 3D foot scanning,
2. Creation of the 3D foot model,
3. Converting in 3D foot last,
4. Comparing the converted 3D foot last with 3D scanned foot model,
5. Shoes design,
6. Different possibilities for producing custom shoes.

Fig 1. From 3D foot scans to footwear designing & production
4 Experimental work

4.1 Structured light scanning system

The 3D shape of the foot used for designing custom footwear was taken from the 3D Structured Light Scanning Systems David Laser-Scan. The system created for the foot scan is based on low cost 3D structured light system (SLS) based on the software platform of the DAVID Vision Systems GmbH's DAVID-Laser Scanner. On the shelf hardware and equipment’s as light projector, web camera and also open source software can be used for 3D scanning systems [11]. The schematic view of the system is show in Fig 3. Schematic view of foot Structured light scanning system

SLS use a video projector instead of the laser. The video projector Acer X110(1920x1080 pixels) was used to project a number of stripe patterns onto the object. To have a higher resolution of single scans, the pattern parameter used was “Quality” with 58 numbers of patterns. The camera used has aCMOS sensor model uEye UI-1480-C (5MPixel, 6f/s, CE class A of regulation) and the optic lenses used is Fujinon 1: 1.2/6 mm DF6HA–1B. Camera and structured light emitter (projector) calibration is based on triangulation calculation. The field of view of the sensor is fixed by maintaining constant the D distance. This range will be always in the depth of field of the sensor. Using conventional geometry, the field of view of the sensor is [12]:

\[
\Phi = 2 \cdot \tan^{-1} \left( \frac{P}{D \cdot f} \right) \quad \text{Eq. (1)}
\]

Where:
- f- is the focal length of the lens
- D- is the triangulation base [(A-B)=const, Fig. 2]
- P- is the dimension of the CMOS

Fig 2. Setup of the scanning systems
To improve measurement accuracy, the baseline (D) can be increased, or a larger sensor (P) should be used. These modifications sometimes are not possible, due to the optical system setup, in which the stability of the system decreases with the increase of (D), and for the shadow effect (self-occlusion problems increase with (D)). Based on the deformations of the stripe patterns in these images, DAVID will compute a precise 3D point cloud of the object surface.

![Fig 3. Schematic view of foot Structured light scanning system](image)

After different tests have done, the best scans quality occurs when triangulation angle was from 15 to 20 degree. For an optimal 3D fuse foot scanned object, the minimum number of single scans was 6 scans [13]. The total time of single acquisition was 1.3 min with a 5Mp of resolution. Regarding the hardware used in these work (a workstation laptop Fujitsu H 700 series) the frame per seconds (fps) parameters ranged from 2 to 6 fps. In Fig 4. Scanning process: a) setup; (b, c) calibration succeeded; (d,e) during scans; f) fusion of single step scans. are shown the steps needed for the reverse process, from optical setup till the creation of the 3D foot scan model.
4.2 3D data analyzing (Geomagic studio™)

In the reversed engineering processes, especially in the 3D scanning processes there will be always some imperfection during data capture. Even in the most advanced commercial 3D scanners a big effort is made by software developers to include the data clean-up process. David software include data manipulation, however, to perform deep analyze of our scans we used Geomagic Studio™ software [14]. Workflow (Fig 5. Workflow from 3D foot scanning to custom shoes design) in this paper will return twice to data manipulation by Geomagic. The first part will include data manipulation as fill holes, surface smoothness, scans overlap, spike etc. These procedures will help for better last identification in the following procedure (Fig 6).

Fig 4. Scanning process: a) setup; (b, c) calibration succeeded; (d,e) during scans; f) fusion of single step scans.
5 Last identification and custom shoes design

After modification and optimization of data scan, our 3D foot model is ready for last converting and custom shoes design. The software used for these reason is ShoeMaker 2014[14]. The steps followed for the last identification are shown in Fig 7. The program permits to import a STL file for last identification wizard. After different point and curves identification are selected the final attribution of last as: standard, size group and size need to be specified. Flattened last (2D) and 3D last will show up if everything was done correctly. To check the error occurred by the last
identification wizard we will compare step 1 with step 7 (Fig 7) back in Geomagic software. This procedure will be shown in coming sections of this work.

Fig 7. Last identification from 3D foot model

5.1 Shoes design

After the confirmation from data comparison (see coming section) that the converting procedure of last wizard, give accepted deviations between 3D foot scan and last converted (step 7, Fig 7) everything is ready for she design. We will use the same software ShoeMaker for shoes design. We designed a pump shoes model. The software is user friendly and easy to use for everyone. The main steps for designing the custom shoes are shortly presented in Fig 8.

Fig 8. The process of pump shoes model designing till the exporting of the shoes pattern

In Fig 8, step 6 shows the 3D file exported and being ready for 3D production, meanwhile, step 7 shows the 2D pattern extraction for custom shoes production.
6 3D data comparison

In this section we are going to show the data comparison between 3D foot scanned versus 3D last converted. This analyze is needed to check the errors occurred during conversion process of the last. As shown by the results () generated from 3D Comparison Results, the value of standard deviation is 1.14 mm and the RMS error is 1.45 mm. These low values show that, the last identification wizard has been successfully and the 3D last converted represents the real scanned foot.

Table 1. Comparison result I

<table>
<thead>
<tr>
<th>Reference Model</th>
<th>Foot_converted_right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Model</td>
<td>3D scan FusionResult</td>
</tr>
<tr>
<td>No. of Data Points</td>
<td>27148</td>
</tr>
<tr>
<td>Tolerance Type</td>
<td>3D Deviation</td>
</tr>
<tr>
<td>Units</td>
<td>mm</td>
</tr>
<tr>
<td>Max. Critical</td>
<td>0.9299</td>
</tr>
<tr>
<td>Min. Critical</td>
<td>-0.9299</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>1.14</td>
</tr>
<tr>
<td>Average Deviation</td>
<td>0.7841 / -0.7635</td>
</tr>
<tr>
<td>RMS error</td>
<td>1.45</td>
</tr>
</tbody>
</table>

Fig 9. 3D comparison results I

7 Conclusions

Designing footwear is a very complex process. The work presented in this paper showed a full cycle of footwear production, starting from 3D foot scanning, to 3D shoes designing, 2D patterns extraction, till the production of the custom shoes. The implementation of different software/hardware (part of CAD/CAM Laboratory in Faculty of Mechanical Engineering in Tirane) is very crucial in the realization of custom shoes design. Different technologies can be applied after shoes designing as 3D printing (exporting as STL file), traditional ones (exporting as 2D pattern file) for made to measure shoes. These will help people, which have feet problems with standard shoes available in the market creating their own shoe last. Also, it will be possible to create sample prototypes and refining the same for both functionality and aesthetics.
References

SECTION IV:
Garment Manufacturing & Design
COMFORT PERFORMANCE OF THE ACTIVE SPORTSWEAR

E. Shehi, B. Kolgjini, M. Hylli

Textile and Fashion Department, Polytechnic University of Tirana, Sheshi. Nënë Tereza. N.4
ermira.shehi@upt-tekstilmoda.org

Keywords: Comfort, performance, objective and subjective assessment, protective clothing, total wear comfort index

Abstract

The complex interactions between fabric and garment design, climate, physiological, and psychological variables that define comfort performance make it one of the most important qualities influencing product acceptance by the end user. With both objective and subjective measurement techniques, specialists might have the tool that can inform the textile producer whether their efforts have potential for improving comfort while in the research and development stage.

Comfort performance has obvious importance for daily fashion wear, specialized medical applications, varying types of athletic gear, and protective ensembles for military, industrial, and first responder personnel. Protective clothing has a unique and often contradictory set of properties. The essential requirements for protection against the penetration of environmental threats such as toxic chemicals, or hazardous heat exposures, results in a protective garment which itself contributes to the thermal discomfort, or worse, heat illness (exhaustion, hyperthermia, etc.). Combination of research and testing approaches may be the only way to define the optimum balance between protection and wearer comfort.

In this paper we try to give a full summary of the necessary testing standards from fabric level analysis to garment ensemble comfort evaluation. We will use the total wear comfort index as a combination of three important properties of fabric for the objective evaluation of comfort performance of clothing.

According to Oxford English Dictionary, comfort means “a state of physical ease and freedom being free from pain or constraint”.

Introduction

Comfort performance is one of the most important characteristics affecting the acceptance level of the product from consumer. This is because of the interaction between skin and fabric/garment and that many climatic, psychological and physiological variables determine comfort performance. Of special importance is for the uniforms, medical clothing, sportswear, military wear and emergency care.

Sportswear is typically designed to be light weight so as not to encumber the wearer. The best athletic wear for some forms of exercise, for example cycling, should not create drag or be too bulky.

Sportswear or active wear is clothing, including footwear, worn for sport or physical exercise. Sport-specific clothing is worn for most sports and physical exercise, for practical, comfort or safety reasons. (1)

Typical sport-specific garments include shorts, tracksuits, T-shirts, tennis shirts and polo shirts. There are also specialized garments for swimming, diving or surfing, skiing, gymnastics. Sports footwear includes trainers. It also includes some underwear, such as the jockstrap and sports bra. Sportswear is also at times worn as casual fashion clothing. For most sports the athletes wear a combination of different items of clothing, e.g. sport shoes, pants and shirts. In some sports, protective gear may need to be worn, such as helmets or American football body armor. On the other hand, sportswear should be loose enough so as not to restrict movement. (1)

Sportswear design must consider the thermal insulation needs of the wearer. In hot situations, sportswear should allow the wearer to stay cool; while in cold situations, sportswear should help the wearer to stay warm. Sportswear should also be able to transfer sweat away from the skin, using, for example, moisture transferring fabric. (1)

Same as the trend of other sportswear, function performance becomes a more important factor to be concerned in the selection of golf wears nowadays. In order to maintain the proper human body temperature to avoid people suffered from the generation of huge metabolic heat or the heat/cold stress from surrounding environment, an ideal golf wear should provide a good thermal comfort performance. Also, good moisture transmission and breathability are required. (2) - PhD

Thermic Comfort

With reference to the British Standard BS EN ISO 7730 (2005), thermal comfort is defined as “the condition of mind which expresses satisfaction with the thermal environment.”

Thermal comfort is an important issue in clothing design because one of the main and basic purposes for us to wearing garment is that it satisfies our physical needs. For example, Cheng and Cheng (1994) stated that “the purpose of clothing is to maintain a uniform body temperature under adverse conditions”. This clothing function is especially important and being investigated for many years in sportswear application.
This is an important and measurable factor, but before evaluating and measuring it one should keep into consideration the body balance. Comfort performance according to Fuzek and Ammons (1977) is a result of many objective factors:

1. **Thermoregulation of human body**
   
   a. Heat balance of human body
   b. exchange with clothing system

2. **Moisture Comfort**
   
   a. Skin Wetness
   b. Moisture Comfort in Clothing system
      i. Diffusion
      ii. Migration
      iii. Absorption and desorption
      iv. Capillary action

3. **Air permeability**

4. **Fabric Characteristics (structure, handling, n gestión, smoothness)**

5. **Fibres characteristics**

**Measuring body factors**

1. *Core temperature*
2. *Skin temperature*
3. *Skin relative humidity*

Generally, skin relative humidity reaches around 70% means the beginning of insensible sweat production. If skin relative humidity reaches 100%, condensation of sweat occurs. Besides, most people are not capable of sensing relative humidity fluctuations within the range of 25 percent to 60 percent. Thus, this relative humidity range can be defined as the comfort range, although there must be some variation to different people.

4. **Heart rate** - there is a fairly straightforward relationship between heart rate and exercise intensity. There is a positive relationship between heart rate and exercise so this is one of the factors to be measured during trials. Usually, heart rate increases with the intensity of an activity in order to supply the necessary oxygen to the muscles.

**Measuring Points**

According to International Standard ISO 9886 (2004), 14 points are suggested for the measurement of skin temperature. Their list is listed in the following table:
Skin temperature sites proposed by ISO 9886:2004

<table>
<thead>
<tr>
<th>Point</th>
<th>Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Forehead</td>
</tr>
<tr>
<td>2</td>
<td>Neck (back)</td>
</tr>
<tr>
<td>3</td>
<td>Right scapula</td>
</tr>
<tr>
<td>4</td>
<td>Left upper chest</td>
</tr>
<tr>
<td>5</td>
<td>Right arm in upper location</td>
</tr>
<tr>
<td>6</td>
<td>Left arm in lower location</td>
</tr>
<tr>
<td>7</td>
<td>Left hand</td>
</tr>
<tr>
<td>8</td>
<td>Right abdomen</td>
</tr>
<tr>
<td>9</td>
<td>Left Para vertebral</td>
</tr>
<tr>
<td>10</td>
<td>Right anterior thigh</td>
</tr>
<tr>
<td>11</td>
<td>Left posterior thigh</td>
</tr>
<tr>
<td>12</td>
<td>Right shin</td>
</tr>
<tr>
<td>13</td>
<td>Left calf</td>
</tr>
<tr>
<td>14</td>
<td>Right instep</td>
</tr>
</tbody>
</table>

Research design

The research design was meant to be conducted for the national football teams but because of some objective difficulties in completing the research the focus was moved to the sportswear (uniforms) in our market for young boys playing organized football matches as free time sports. The market showed that there is a variety of sports uniforms. We have selected one model used mainly for non professional football games for children and adults:

Materials and methods

Fabric thermal resistance, thermal conductivity and absorptivity, heat flow, water vapor permeability and air permeability are the physical properties to be measured for a good view of heat and water transportation through the fabric.

Two types of fabrics used for sportswear in the home market are analyzed for this work, respectively 100% cotton and 100% PES.

General characteristics:

<table>
<thead>
<tr>
<th>Fabric #.</th>
<th>Content</th>
<th>Structure</th>
<th>Weight gr/m2</th>
<th>Thickness, mm</th>
<th>Fabric porosity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100%CO</td>
<td>Knit</td>
<td>182</td>
<td>0,725</td>
<td>0,86</td>
</tr>
<tr>
<td>2</td>
<td>100%PES</td>
<td>Knit</td>
<td>175</td>
<td>0,739</td>
<td>0,81</td>
</tr>
</tbody>
</table>
Fabric density can be calculated using the relationship:

\[
\text{Fabric density (Fd)} = \frac{\text{Fabric weight (g/cm}^2\text{)}}{\text{Thickness (cm)}}
\]

\[
\text{Fabric porosity (Fp)} = 1 - \frac{\text{Fabric density}}{\text{Fibre density}}
\]

**Physical Testing Method**

1. **Water vapor permeability (WVP)**

Water vapor permeability is calculated as below:

\[
\text{WVP} = \frac{M}{A \times T} \text{ (gr/m}^2\text{/24h)}
\]

Where:
- \(M\) – Weight loss
- \(T\) – Time interval (24 hrs)
- \(A\) – Surface of sample (internal surface of the cup)

\[A = \pi d^2 / 4 \times 10^{-6}\]

The water vapor permeability test was conducted according to S SH 1150-5:1989 (ASTM 96) cup method; This includes the measurement of the weight loss of the sample with evaporation time (1 day). The results for the two samples (CO and PES) were respectively 770 and 847 gr/cm\(^2\)/24hrs.

Amongst many methods and characteristics of textiles vapor permeability it is difficult to select the best one for determining the breathability of fabrics. It is important to see the impact of fabric characteristics to the health and performance of real persons.

**Wear Trial**

The second part of the research was conducted to directly assess the subjective human thermoregulation responses. During the wear trial, two men at the same age (24, 25) were asked to wear both models of sports blouses (model 1 and 2).

Concerning the time, equipment and convenience 2 points were measured for the skin temperature: chest and upper arm.

**Procedure**

The normal procedure was taking notes on the general data of wears:

1. **General data of wears**

Each wear was interviewed for major medical problems or prescription medication via a oral interview. They didn’t eat anything 2 hours before the exercise sessions. They both performed the 12 minutes fitness run test that developed by Dr. Ken Cooper in 1968 as an easy way to measure aerobic fitness and provide and estimate of VO2 max for military personnel.
During the exercise sessions each wear was monitored through a heart rate monitor (beats/min). Both of them held one type of blouse one day at the same time. So, the exercise sessions were completed in two days. The running test requires that the runner walks or run as fast as possible and at the end of 12 minutes he measures the maximum distance.

The calculation is done as below:

\[ \text{VO2max} = (22.351 \times \text{kilometers}) - 11.288 \]

The results of the two men were put in the table below:

<table>
<thead>
<tr>
<th>Subject #</th>
<th>Heart rate</th>
<th>VO2 MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Man 1 Blouse CO</td>
<td>170</td>
<td>1694</td>
</tr>
<tr>
<td>Man 2 Blouse CO</td>
<td>178</td>
<td>1936</td>
</tr>
<tr>
<td>Man 1 Blouse PES</td>
<td>188</td>
<td>2028</td>
</tr>
<tr>
<td>Man 1 Blouse PES</td>
<td>181</td>
<td>2180</td>
</tr>
</tbody>
</table>

Results show that subjects with PES blouse perform better although the heart rate is higher in the PES sportswear.

Conclusions and recommendation for future research

The results are considered a original work of a wider research work. These results showed that the 100%PES fabric had better physiological response compared to the 100% Cotton. Although the perspiration is well absorbed in the cotton fabric it is not transported out of the body but remains close to it. The correlation between water vapor permeability and subject performance was positive. The 100% PES fabric perspires more quickly the sweat from the body.

References

3. Moisture vapor transmission behavior of cotton fabrics – Subhasis Das and V K Kothari
ASSESSMENT OF ENERGY CONSUMPTION IN THE GARMENT PRODUCTION

E. Dumishllari, G. Guxho

Polytechnic University of Tirana, Department of Textile and Fashion, Square ‘Mother Teresa’, No.4, Tirana, Albania
edumishllari@fim.edu.al

Keywords: energy, working time, garment, process

Abstract

Energy is a major cost factor in the textile industry. Improving energy efficiency should be a major concern for the industry. As a manufacturer, textile industry faced with increasingly competitive global environment, always sought opportunities to reduce production costs, without adversely affecting its quality [1, 6].

This study was conducted in a garment production company which is located in Tirana. This company produces sports clothing for different disciplines and operates Full Package (realizes complete production package from the purchase of raw and auxiliary materials to send to the client) [13, 14].

The methodology used in the study consists in measurement of working time with stopwatch for each operation. Then starting from the known energy consumption of each machine per hour is defined how much energy we needed for the resulting time. The actual cost of energy and fuel in the market helped us to determine the most economic option for producing the required product.

Introduction

Textile industry is one of the most complicated manufacturing industries because it is a fragmented and heterogeneous sector dominated by small and medium enterprises (SMEs). Energy is one of the main cost factors in the textile industry, especially at a time when the price of energy is a high volatility; improving energy efficiency should be a primary concern for textile industry [1]. As a manufacturer, textile industry is facing more and more with a global competitive environment, increasingly sought opportunities to reduce production costs without negatively affecting production or product quality.
Methodology

The methodology used in the study includes a measure of working time with stopwatch for each process and then calculating the energy consumption in each process, starting from the energy’s known consumption of each machinery/equipment per hour. The study is focused in the realization of the ten so-called TSC model sport shirts.

Types of energy used in garment production, machinery and their energy

In general, energy in garment production industry is mostly used in the form of electricity as a common power source for machinery, lighting and office equipment [3, 8]. Fuel as a source of energy is predominantly consumed by dying and finishing [2], only in case of shortage of energy in garment production, due to its cost. In garment production industry are used a large number of machines. All these machines consume electricity. The amount of energy they consume is different (Table 1).

<table>
<thead>
<tr>
<th>No</th>
<th>Equipment/Machinery</th>
<th>Consumption [kW/hr]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Computer</td>
<td>0.422</td>
</tr>
<tr>
<td>2</td>
<td>Printer</td>
<td>0.15</td>
</tr>
<tr>
<td>3</td>
<td>Printing machinery</td>
<td>2.4</td>
</tr>
<tr>
<td>4</td>
<td>Saw</td>
<td>0.1</td>
</tr>
<tr>
<td>5</td>
<td>Lockstitch sewing machine</td>
<td>0.5</td>
</tr>
<tr>
<td>6</td>
<td>Labelling machine</td>
<td>2.0</td>
</tr>
<tr>
<td>7</td>
<td>An iron</td>
<td>1.2</td>
</tr>
<tr>
<td>8</td>
<td>Straight Stitch Sewing machine</td>
<td>0.5</td>
</tr>
<tr>
<td>9</td>
<td>Ornamental stitching machine</td>
<td>0.5</td>
</tr>
<tr>
<td>10</td>
<td>Machines for the realization of bottom/sleeves folding</td>
<td>0.5</td>
</tr>
<tr>
<td>11</td>
<td>Bulb Lights</td>
<td>0.04</td>
</tr>
</tbody>
</table>

The energy needed for each process

For determine the energy consumption of different processes in the apparel industry, must first measure the time of work for any manufacturing process. In this study we will see how much the energy consumption of 10 TSC model shirts would be. Stages to be followed to realize the TSC shirts are [7, 12]:

Initially we measured working time and calculated the energy necessary for the realization of each process (the known hourly energy consumptions of each machinery and equipment are helpful).
In Computer Projection (Designing)

Shirt’s designing was made possible by the software Adobe Illustrator. The time required for the design was 11 minutes (660s). This time depends on a variety of factors, such as type of model, adjustment measures, setting the number, name etc. For 660 seconds required for the design of 10 shirts, are needed 0.0774kw (computer has 0.422 kW/hour energy consumption).

In environment where a computer is located are two fluorescent bulb lights with consumption 40 w/hr. The amount of energy consumed in 660s of design is 0.01467kw.

Printing

After designing, the second step is printing of patterns. The time needed to print 10 shirts resulted 42.85 minutes (2571s). During printing, three of shirts featured defect because of the printer ink. To repair this defect (print once again the three shirts) took 770.4s.

To print 10 shirts, the energy consumption for printer is 0.139kw and for lighting 0.074 kw. To repair three defective shirts took 770.4s. Consumption for this period of time is 0.0321kw.

Spreading of mattress

The measurement of time with stopwatch was conducted by dividing the working time into two components:

Time of preparation, which is the time of taking parts, sealing them with each other, setting them in machine and removing [9].

Efficient time [9] is the time from the moment the needle enters the fabric until the end of the sewing process.
The average time required for spreading the mattress of 10 sheets of fabric resulted 182s (18.2 s for a fabric sheet) and for three shirts repair were needed 47 s.

**Tab.2** Measurements of working time in the process of spreading the mattress and the corresponding productivity

<table>
<thead>
<tr>
<th>No</th>
<th>Efficient time[s]</th>
<th>Total time/ Working time[s]</th>
<th>Productivity η [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>15</td>
<td>33.33</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>15</td>
<td>26.66</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>14</td>
<td>28.57</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>14</td>
<td>28.57</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>27</td>
<td>14.81</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>39</td>
<td>10.25</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>14</td>
<td>28.57</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>15</td>
<td>26.66</td>
</tr>
<tr>
<td>9</td>
<td>3</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>10</td>
<td>4</td>
<td>14</td>
<td>28.57</td>
</tr>
<tr>
<td>11</td>
<td>5</td>
<td>16</td>
<td>31.25</td>
</tr>
<tr>
<td>12</td>
<td>4</td>
<td>14</td>
<td>28.57</td>
</tr>
<tr>
<td>13</td>
<td>5</td>
<td>17</td>
<td>29.41</td>
</tr>
</tbody>
</table>

For mattress spreading, would need 0.005kw of energy consumption and for lighting 0.0051kw. Three defective repaired shirts took 47s. Consumption for this period is 0.00104kw

- Placement of patterns on spread mattress

After spreading the mattress, the next step, is placement of paper’s patterns on spread mattress and then fix them with an iron. The time required for this process is 32s. The time of repair was 26s.

**Tab.3** Measurements of working time in the process of placement of patterns on spread mattress and productivity

<table>
<thead>
<tr>
<th>No</th>
<th>Efficient time[s]</th>
<th>Total time/ Working time [s]</th>
<th>Productivity η [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15</td>
<td>32</td>
<td>46.87</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
<td>26 (repairs)</td>
<td>46.15</td>
</tr>
</tbody>
</table>

To place the patterns on spread mattress, for 10 shirts, will need a 0.0193kw of electricity and for lighting 0.0013kw.

To repair three defective shirts it took 26 s. Consumption for this period of time is 0.00058kw

- Cutting patterns in mattress

In spread mattress will share each pattern from each other by a saw machine. To realize this process was needed 34.6s for 10 shirts. To repair was needed 26s.
Tab.4 Measurements of working time in the process of Cutting Patterns and productivity

<table>
<thead>
<tr>
<th>No</th>
<th>Efficient time [s]</th>
<th>Total time/ Working time [s]</th>
<th>Pattern</th>
<th>Productivity η [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>39</td>
<td>58</td>
<td>Back</td>
<td>67.24</td>
</tr>
<tr>
<td>2</td>
<td>36</td>
<td>51</td>
<td>Front</td>
<td>70.58</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>15</td>
<td>Collar</td>
<td>13.33</td>
</tr>
<tr>
<td>4</td>
<td>12</td>
<td>26</td>
<td>Sleeve</td>
<td>46.15</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
<td>23</td>
<td>Sleeve</td>
<td>43.47</td>
</tr>
<tr>
<td>6</td>
<td>17</td>
<td>26</td>
<td>Repair</td>
<td>65.38</td>
</tr>
</tbody>
</table>

To cut patterns, for 10 shirts, will need 0.00168kw of electricity and for lighting 0.00135 kw. To repair three defective shirts it took 26s. Consumption for this period of time is 0.00058kw.

- Printing patterns in fabric
This process is realized in printing machine. The time necessary to print all patterns, for ten shirts, resulted 500s. The time required to repair three defective shirts resulted 133s.

Tab.5 Measurements of working time in the process of Printing Patterns and productivity

<table>
<thead>
<tr>
<th>No</th>
<th>Efficient time [s]</th>
<th>Total time/ Working time [s]</th>
<th>Productivity η [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>415</td>
<td>500</td>
<td>83.00</td>
</tr>
<tr>
<td>2</td>
<td>113</td>
<td>133</td>
<td>84.96</td>
</tr>
</tbody>
</table>

To print fabric patterns, for 10 shirts, will need 4.22kw of energy consumption and for lighting 0.0141kw. To repair three defective shirts it took 133s. Consumption for this period of time is 0.00296kw.

- Control of printed parts (organoleptic assessment)
This process is realized by two workers with organoleptic assessment, so we have not got any energy consumption by manufacturing machinery, but only energy consumption by electric bulbs. The time of this process was 105s and 27s are needed to control the three repaired shirts.
To control fabric printed patterns, for 10 shirts, will need energy consumption for lighting 0.00293kw.
To repair three defective shirts it took 27s. Consumption for this period of time is 0.0006kw.

- Setting Sleeves
Setting sleeves is the first process of joining the shirt. This process is realized in lockstitch.
To realize this process was needed 782 s for 10 shirts (78.2 s for a shirt).
Tab. 6 Measurements of working time in the process of Setting Sleeves and productivity

<table>
<thead>
<tr>
<th>No</th>
<th>Efficient time[s]</th>
<th>Total time/ Working time [s]</th>
<th>Productivity η [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>61</td>
<td>79</td>
<td>77.21</td>
</tr>
<tr>
<td>2</td>
<td>72</td>
<td>89</td>
<td>80.89</td>
</tr>
<tr>
<td>3</td>
<td>58</td>
<td>76</td>
<td>76.31</td>
</tr>
<tr>
<td>4</td>
<td>59</td>
<td>77</td>
<td>76.62</td>
</tr>
<tr>
<td>5</td>
<td>60</td>
<td>79</td>
<td>75.94</td>
</tr>
<tr>
<td>6</td>
<td>59</td>
<td>76</td>
<td>77.63</td>
</tr>
<tr>
<td>7</td>
<td>58</td>
<td>75</td>
<td>77.33</td>
</tr>
<tr>
<td>8</td>
<td>60</td>
<td>78</td>
<td>76.92</td>
</tr>
<tr>
<td>9</td>
<td>59</td>
<td>79</td>
<td>74.68</td>
</tr>
<tr>
<td>10</td>
<td>57</td>
<td>74</td>
<td>77.02</td>
</tr>
</tbody>
</table>

For Setting Sleeves, for 10 shirts, will need a 0.109kw of energy consumption and for lighting 0.0174 kw.

- Labeling

For Labeling was needed 537s for 10 shirts (53.7 s for a shirt).

Tab. 7 Measurements of working time in the process of Labeling and productivity

<table>
<thead>
<tr>
<th>No</th>
<th>Efficient time[s]</th>
<th>Total time/ Working time [s]</th>
<th>Productivity η [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
<td>57</td>
<td>10.52</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>54</td>
<td>9.25</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>72</td>
<td>6.94</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
<td>52</td>
<td>15.38</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>55</td>
<td>12.72</td>
</tr>
<tr>
<td>6</td>
<td>7</td>
<td>44</td>
<td>15.90</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>47</td>
<td>14.89</td>
</tr>
<tr>
<td>8</td>
<td>6</td>
<td>47</td>
<td>12.76</td>
</tr>
<tr>
<td>9</td>
<td>5</td>
<td>51</td>
<td>9.80</td>
</tr>
<tr>
<td>10</td>
<td>6</td>
<td>58</td>
<td>10.34</td>
</tr>
</tbody>
</table>

For labeling, for 10 shirts, will need 0.298kw of energy consumption and for lighting 0.0119 kw.
- Ornamental stitch on back and front closure of TSC shirt.

The ornamental stitch was performed in five needle sewing machine. To realize this process was needed 580s for 10 shirts (58s for a shirt).

During this process two defects occurred. To fix them was needed 1020s.

<table>
<thead>
<tr>
<th>No</th>
<th>Efficient time [s]</th>
<th>Total time/ Working time [s]</th>
<th>Productivity η [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>51</td>
<td>60</td>
<td>85</td>
</tr>
<tr>
<td>2</td>
<td>47</td>
<td>56</td>
<td>83.92</td>
</tr>
<tr>
<td>3</td>
<td>55</td>
<td>63</td>
<td>87.3</td>
</tr>
<tr>
<td>4</td>
<td>44</td>
<td>52</td>
<td>84.61</td>
</tr>
<tr>
<td>5</td>
<td>50</td>
<td>58</td>
<td>86.2</td>
</tr>
<tr>
<td>6</td>
<td>58</td>
<td>68</td>
<td>85.29</td>
</tr>
<tr>
<td>7</td>
<td>47</td>
<td>55</td>
<td>85.47</td>
</tr>
<tr>
<td>8</td>
<td>52</td>
<td>61</td>
<td>85.24</td>
</tr>
<tr>
<td>9</td>
<td>45</td>
<td>53</td>
<td>84.9</td>
</tr>
<tr>
<td>10</td>
<td>45</td>
<td>54</td>
<td>83.33</td>
</tr>
<tr>
<td>11</td>
<td>Time to repair, def I</td>
<td>600</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Time to repair, def II</td>
<td>420</td>
<td></td>
</tr>
</tbody>
</table>

For the ornamental stitch on back and front closure, for 10 shirts, will need 0.222 kw of energy consumption.

To repair the defect it took 1,020 s. Consumption for this period of time is 0.142kw. Power consumption for lighting is 0.0356kw.

To repair the defect occurred in the machine it took 1,020s. Consumption for lighting for this period of time is 0.0227kw.

- TSC shirt’s side closure

This process was conducted in lockstitch. The time required, for 10 shirts, resulted in 530s (53s for a shirt).
For the side closure, for 10 shirts, will need a 0.0736kw of energy consumption and for lighting 0.0117kw.

- Collar ironing

This process is realized through industrial ironing. To realize this process, for 10 shirts, was needed 77s (7.7s for a collar).

For ironing the collar, for 10 shirts, will need a 0.0257kw of energy consumption and for lighting 0.0017kw.
• Collar preparation and assembly

Preparation and installation of the collar is realized in straight stitch sewing machine. The time of process resulted in 288s.

**Tab. 11** Measurements of working time in the process of Collar preparation and fitting and productivity

<table>
<thead>
<tr>
<th>No</th>
<th>Efficient time [s]</th>
<th>Total time/ Working time [s]</th>
<th>Productivity η [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>104</td>
<td>288</td>
<td>36.11</td>
</tr>
</tbody>
</table>

For the preparation and assembly of the collar, to 10 shirts, will need a 0.04kw of energy consumption and an energy consumption for lighting by 0.0064kw.

• Collar Placement

This process is realized in lockstitch. For this process, for 10 collars, was needed 173s (17.3 s/collar)

**Tab. 12** Measurements of working time in the process of Collar Placement and productivity

<table>
<thead>
<tr>
<th>No</th>
<th>Efficient time [s]</th>
<th>Total time/ Working time [s]</th>
<th>Productivity η [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>18</td>
<td>55.55</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>18</td>
<td>55.55</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>18</td>
<td>55.55</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
<td>19</td>
<td>42.10</td>
</tr>
<tr>
<td>5</td>
<td>9</td>
<td>15</td>
<td>60.00</td>
</tr>
<tr>
<td>6</td>
<td>10</td>
<td>18</td>
<td>55.55</td>
</tr>
<tr>
<td>7</td>
<td>9</td>
<td>17</td>
<td>52.94</td>
</tr>
<tr>
<td>8</td>
<td>9</td>
<td>16</td>
<td>56.25</td>
</tr>
<tr>
<td>9</td>
<td>9</td>
<td>17</td>
<td>52.94</td>
</tr>
<tr>
<td>10</td>
<td>8</td>
<td>17</td>
<td>47.05</td>
</tr>
</tbody>
</table>

For placement of the collar, to 10 shirts, will need 0.024kw of energy consumption and for lighting 0.0038 kw.

• Shirts Folding

To realize this process was needed 168s to 10 shirts (16.8 s for a shirt).
Tab. 13 Measurements of working time in the process of shirt’s folding and productivity

<table>
<thead>
<tr>
<th>No</th>
<th>Efficient time [s]</th>
<th>Total time/Working time [s]</th>
<th>Productivity η [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>16</td>
<td>62.5</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
<td>17</td>
<td>70.58</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>17</td>
<td>58.82</td>
</tr>
<tr>
<td>4</td>
<td>11</td>
<td>16</td>
<td>68.75</td>
</tr>
<tr>
<td>5</td>
<td>13</td>
<td>19</td>
<td>68.42</td>
</tr>
<tr>
<td>6</td>
<td>12</td>
<td>18</td>
<td>66.66</td>
</tr>
<tr>
<td>7</td>
<td>12</td>
<td>17</td>
<td>70.58</td>
</tr>
<tr>
<td>8</td>
<td>10</td>
<td>17</td>
<td>58.82</td>
</tr>
<tr>
<td>9</td>
<td>10</td>
<td>16</td>
<td>62.5</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>15</td>
<td>66.66</td>
</tr>
</tbody>
</table>

For the shirts folding, for 10 shirts, will need 0.023kw of energy consumption and for lighting 0.0037kw.

- Sleeves folding
To realize this process was needed 242s to 10 pairs (12.1 s for a sleeve).

Tab. 14 Measurements of working time in the process of sleeve folding and productivity

<table>
<thead>
<tr>
<th>No</th>
<th>Efficient time [s]</th>
<th>Total time/Working time [s]</th>
<th>Productivity η [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
<td>12</td>
<td>50.00</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>12</td>
<td>50.00</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>12</td>
<td>50.00</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>13</td>
<td>46.15</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>13</td>
<td>46.15</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>11</td>
<td>45.45</td>
</tr>
<tr>
<td>7</td>
<td>6</td>
<td>12</td>
<td>50.00</td>
</tr>
<tr>
<td>8</td>
<td>7</td>
<td>13</td>
<td>53.84</td>
</tr>
<tr>
<td>9</td>
<td>5</td>
<td>11</td>
<td>45.45</td>
</tr>
<tr>
<td>10</td>
<td>6</td>
<td>12</td>
<td>50.00</td>
</tr>
</tbody>
</table>

For the sleeve folding, to 10 shirts, will need a 0.0336kw of energy consumption and 0.0054kw for lighting.
- Shirt’s ironing

To realize this process was needed 418 s for 10 shirts (41.8s for a shirt). In this process we have loss of time due to return back by the employee who performs ironing process. If this process would conduct an auxiliary would be saved 40s.

**Tab. 15** Measurements of working time in the process of shirt’s ironing and productivity

<table>
<thead>
<tr>
<th>No</th>
<th>Efficient time [s]</th>
<th>Total time / Working time [s]</th>
<th>Productivity η [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>27</td>
<td>49</td>
<td>55.1</td>
</tr>
<tr>
<td>2</td>
<td>26</td>
<td>48</td>
<td>54.16</td>
</tr>
<tr>
<td>3</td>
<td>26</td>
<td>39</td>
<td>66.66</td>
</tr>
<tr>
<td>4</td>
<td>30</td>
<td>41</td>
<td>73.17</td>
</tr>
<tr>
<td>5</td>
<td>26</td>
<td>39</td>
<td>66.66</td>
</tr>
<tr>
<td>6</td>
<td>27</td>
<td>39</td>
<td>66.23</td>
</tr>
<tr>
<td>7</td>
<td>28</td>
<td>40</td>
<td>70</td>
</tr>
<tr>
<td>8</td>
<td>26</td>
<td>38</td>
<td>68.42</td>
</tr>
</tbody>
</table>

To ironing 10 shirts will need a 0.139kw of energy consumption and 0.0093kw for lighting.

- Final control [10],[11] of shirts (organoleptic assessment)

This process is realized with the organoleptic assessment, so we have not got the energy consumption of any manufacturing machinery, but only energy consumption by electric bulbs. The time of this process was 740s and the energy consumption for lighting is 0.0164kw.

- Packaging

This process is carried out without the presence of any production machine; here we have only energy consumption by electric bulbs. The time of this process was 211s for 10 shirts. For packaging of 10 shirts will need a 0.0047kw of energy consumption for lighting.

**Results and discussion**

By analyzing all production processes; for times of work, the time needed for repairs of defects, the energy required for each process, as well as sharing its power for machinery, lighting and repairs, we note that:

1. From design to printing, for the production of 10 shirts, will need a period of 5114 s, of which only 4858.4s are effective time (95%).
2. From sewing to packaging process, for the producing of 10 shirts, will need a period of 5768 s, of which only 3095 s are effective time (53.65%).
3. The whole process was conducted for 10,882 s. Only 73% of it is effective time.
4. It is noted that printing productivity is higher.
5. The time required to repair the defects resulted 2051.4s, which occupies 18.85% of the total time.
6. From projection process to printing (including the control), the power consumption resulted in 4,576kw and from sewing to packing 1,116kw.
7. For the realization of 10 shirts were consumed 5,692kw.
8. 76.95% of the energy goes to machinery and equipment, for lighting 4.24% and the energy needed to repair the defect occupies 18.81% of the total energy consumed.
9. The energy consumption from the projection to printing is higher; 80.39%.

**Tab. 16** Component processes, working times and corresponding energy consumption

<table>
<thead>
<tr>
<th>No</th>
<th>Process</th>
<th>Working time (for 10 shirts)</th>
<th>added repair's time[s]</th>
<th>Energy consumption[kw]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Machinery</td>
</tr>
<tr>
<td>1</td>
<td>Projection(in computer)</td>
<td>660</td>
<td></td>
<td>0.0774</td>
</tr>
<tr>
<td>2</td>
<td>Printing</td>
<td>2571+770.4</td>
<td>0.1070</td>
<td>0.07400</td>
</tr>
<tr>
<td>3</td>
<td>Spreading</td>
<td>182+47</td>
<td>0.0050</td>
<td>0.00510</td>
</tr>
<tr>
<td>4</td>
<td>Placement of patterns on mattress</td>
<td>32+26</td>
<td>0.0106</td>
<td>0.00130</td>
</tr>
<tr>
<td>5</td>
<td>Cutting patterns</td>
<td>34.6+26</td>
<td>0.0010</td>
<td>0.00135</td>
</tr>
<tr>
<td>6</td>
<td>Printing patterns(in fabric)</td>
<td>500+133</td>
<td>3.3330</td>
<td>0.01410</td>
</tr>
<tr>
<td>7</td>
<td>Control of printed parts(organoleptic assess)</td>
<td>105+27</td>
<td>-</td>
<td>0.0293</td>
</tr>
<tr>
<td>8</td>
<td>Setting Sleeves</td>
<td>782</td>
<td>0.1090</td>
<td>0.01740</td>
</tr>
<tr>
<td>9</td>
<td>Labeling</td>
<td>537</td>
<td>0.2980</td>
<td>0.01190</td>
</tr>
<tr>
<td>10</td>
<td>Ornamental stitch on back and front closure of TSC</td>
<td>580+1020</td>
<td>0.0805</td>
<td>0.03560</td>
</tr>
<tr>
<td>11</td>
<td>Shirt’s side closure</td>
<td>530</td>
<td>0.0736</td>
<td>0.01178</td>
</tr>
<tr>
<td>12</td>
<td>Collar ironing</td>
<td>77</td>
<td>0.0257</td>
<td>0.00170</td>
</tr>
<tr>
<td>13</td>
<td>Collar preparation and assembly</td>
<td>288</td>
<td>0.0400</td>
<td>0.00640</td>
</tr>
<tr>
<td>14</td>
<td>Placement of collar to shirt</td>
<td>173</td>
<td>0.0240</td>
<td>0.00380</td>
</tr>
<tr>
<td>15</td>
<td>Bottom shirt’s folding</td>
<td>168</td>
<td>0.0230</td>
<td>0.00370</td>
</tr>
<tr>
<td>16</td>
<td>Sleeve’s folding</td>
<td>242</td>
<td>0.0336</td>
<td>0.00540</td>
</tr>
<tr>
<td>17</td>
<td>Shirt’s ironing</td>
<td>418</td>
<td>0.1390</td>
<td>0.00930</td>
</tr>
<tr>
<td>18</td>
<td>The final control(organol.)</td>
<td>740</td>
<td>-</td>
<td>0.01640</td>
</tr>
<tr>
<td>19</td>
<td>Packaging of TSC shirts</td>
<td>211</td>
<td>-</td>
<td>0.00470</td>
</tr>
</tbody>
</table>
The printing process has a higher productivity, 83%, followed by setting sleeves with 77.1%.

**Fig. 2** Productivity in some of the processes

**Fig. 3** Power for machinery, lighting and repair defects for each process.

**Fig. 4** The energy for machinery, lighting and repair defects (from projection to printing and from printing to packaging)
We note that more energy is used in printing process; 74.31% of the total.

Expressed in monetary value the amount of energy required to realize 10 shirts will be as follows:

We know that cost is 12.2 ALL for kilowatt [4], therefore 69.44ALL for 5.692kw. If we assume that the production company will not work with electricity but electricity produced by the fuel expense would have amounted to 4649.8 ALL [5].

The generator consumes 4 liters of diesel to produce 1kW. In our case we have 5,692 kW, ie for the production of 10 shirts 22.76 liters of diesel needed. Cost of fuel is 4275.11 ALL. Obviously due to the high price of diesel the company cannot use the energy produced by fuels.

Conclusions

Assessment of the energy consumption in the garment production; step by step process of garment production, working times and productivity, energy consumption of each step, brings us to these conclusions:

- Energy is one of the sources of the garment production existence.
- In companies that operate FP, the cost of energy is considerably higher due to the large number of machines at work.
- If a garment production company wants to reduce energy consumption, it must undertake a series of measures for implementation of efficient project on energy.
- For every increase of working time will increase the power consumption for the production process.
- Defects have a direct impact on the cost of energy because we will need extra time to fix them, and consequently the additional energy consumption.
- In the machinery cannot intervene to reduce energy consumption.
- Qualification of staff will enable the reduction of working time and consequently the lowest consumption of electricity.
- Obviously due to the high cost, garment production companies can not use the energy produced by fuel.
References

[2]. C. Bhurtun, N. Kistamah and J. Chummun, ENERGY SAVING STRATEGIES IN TEXTILE INDUSTRY: THE CASE OF MAURITIUS,
[6]. R.Jananthan1 and Sadam Ameer. COMPARATIVE STUDY OF ENERGY ASSESSMENT FROM APPAREL INDUSTRIES: THE CONTEXT OF SRI LANKA
[8]. Shahidul I. Khan. Energy Efficient Lighting
[10]. Mohammad Faizur RAHMAN at al. QUALITY MANAGEMENT IN GARMENT INDUSTRY OF BANGLADESH
[14]. Gary Gereffi. Stacey Frederick, The Global Apparel Value Chain, Trade and the Crisis Challenges and Opportunities for Developing Countries, Appril 2010
TRANSITION PERIOD OF TURKISH CLOTHING ENTERPRISES FROM TRADITIONAL MARKETING TO ELECTRONIC COMMERCE

T. Atılgan, S. Kanat

Ege University, Department of Textile Engineering, Turkey
turan.atilgan@ege.edu.tr, seher.kanat@ege.edu.tr

Keywords: Clothing sector, electronic commerce, marketing, Turkish clothing sector

Abstract

Textile and clothing sector appears as an important tool of development in Turkey as well as many countries. The sector still has a significant place in Turkish economy in terms of export, gross domestic product and employment. Its occurrence depends on 1920s and plays its pioneer role successfully in 1980s during transition process of Turkey to liberal economy and internationalization. Between 1980 and 2000 sector is the subcontractor of significant international brands whereas during 2000s it rapidly starts to change its shell and structure due to the effects of World Trade Organization’s regulations and entrance of new countries. Therefore, sector transforms into a qualified supplier. Besides, it starts to gain a place in international markets with its own original brands. Although the Turkish clothing sector has been unable to use marketing function during 1990s, due to these reasons, it rapidly starts to give importance to marketing and gains lots of success in marketing area. During this period, government actualizes Turquality project depending on the pressures of sector. Turquality project aims to create, improve and live international Turkish brands. On the other hand, Turkish enterprises turn towards retail store chains. Nowadays leading Turkish clothing enterprises averagely open 50-60 stores in a year so they demonstrate a significant growth potential both in national and international markets. Throughout the 2000s the sector shows another alteration and it turns towards electronic commerce besides retail store chains. Due to an alteration in Turkish Commercial Law, the enterprises have to open their own web sites and have to share accurate information about them. This obligation leads many enterprises to do electronic commerce. At the present time, there are national web sites over 14,000 which deal with electronic commerce. Most of them include electronic commerce of clothing products.
In this study, the orientation reasons of Turkish clothing enterprises in terms of electronic commerce, their orientation speeds, growth rates and issues throughout this process are analyzed. Besides the transition periods and performances of Turkish enterprises, which are successful in this area both nationally and internationally, are analyzed. Afterwards, the future of electronic commerce in clothing sector is estimated.

1. Evolution of Marketing

The evolution of marketing is divided into three eras: production era, sales era and marketing era. In the production era, which dates back prior to 1920s, principal was that a good product would sell itself. Therefore it was a production orientation dominated era. Further, this era is divided into two as production approach and product approach. For production approach, the aim of marketing was to enhance production means and effectuate distribution channel systems in order to enhance the market accessibility. Product approach had to do with enhancing product features and benefits as it was believed that consumer would buy the best product amongst alternatives [1].

After this period, a new era with sales orientation emerged due to the sophistications in worldwide production systems along with the era of industrialization between 1925 and the early 1950s. During this era, companies started to believe that consumers have a resistance to purchase and this resistance could be overcome by an intense sales operation. Moreover, in this new era, the amount of supply had started to surpass the amount of demand in the market. Thus, consumers had a wide range of brands to choose. The main aim of marketing became to reach the highest sales volumes [1].

Starting with the decreasing demand during the years of World War 2, managers realized that they had to pay closer attention to markets and that goods and services should have been marketed, not just produced or sold. In this period, the marketing era emerged, for which the main idea was the consumer is king. In an environment where consumers had strated to become more and more conscious, competition had become more intense and the distance between demand and supply had become clearer. Marketing specialists mostly focused on long term performances that would result in consumer satisfaction and loyalty [1].

Marketing era, which continues nowadays, hostes different marketing models. E-commerce is one of these models.

2. E-Commerce Concept and Its Impacts

Transition from traditional marketing to electronic commerce occurs due to globalization, improvement in international trade, technology development and knowledge economy [2,3]. Electronic commerce (e-commerce) offers a rich array of opportunities to improve business
performance. Choosing a particular e-commerce application is a strategic decision that must be made in the context of the company’s competitive strategy. Strategic approach to e-commerce decisions has become increasingly important as a result of the explosive adoption patterns rendering competitive aspects crucial. E-commerce is one of the most popular forms of electronic technology applied to businesses and that its impact on competitive strategy and its formulation is regarded to be fundamental. Adapting to changes in technology is a key factor driving competitive advantage [4].

The major product categories of electronic shopping include those items that are standard and require little information. They purchase products ranging from food, apparel, magazine subscriptions, books, CD’s, medicine to furniture and consumer electronics. Travel related services are on the top of the list of the products/services purchased online [5].

Commerce is defined as the process flow associated with a commercial relationship or transaction, including activities such as purchasing, marketing, sales and customer support. E-commerce is this same process enabled by the use of communications and information technology [6].

It is the process of trading goods, information or services via computer networks including the internet. Although e-commerce refers to trade via any information network, the emergence of the internet with its open commercial exchange approach has been the major force behind its fast growth [7].

As electronic commerce may include a wide variety of sub-fields, in general e-commerce activities can be broadly classified into following two sub-fields:

1. the linking of a firm to its forward and backward channel allies (e.g. retailers, distributors and suppliers), that is electronic commerce between firms Business-to-Business: B2B);
2. the commercial activities between firms and final customers (Self-Selection Purchasing or Business-to-Consumer: B2C) [8, 9].

Previous studies also indicated how the introduction of e-commerce channels in traditional companies changed their operations and business strategy. That impact has been described by three main issues that are integration, customization and internationalization. First, e-commerce networks improve value chain integration by reducing transaction costs, facilitating just-in-time delivery and improving information gathering and processing. Second, e-commerce databases and direct links between producers and customers support high levels of product and service customization. Finally the internet’s international scope allows even small companies to reach customers worldwide [7].

Usability of a company’s web site is an important criterion for the success of e-commerce strategy. Web sites must be designed and constructed with customer’s ease of use in mind. Effective web sites from a usability perspective provide easy navigation, straightforward access to information without clicking through many pages and ability to load quickly. Product and service information provided in the web site must be sufficiently comprehensive to meet the needs and expectations of potential customers. Detailed information provided about the
company’s products along with question-answer section, warranty information and return policy and procedures provide potential customers the credibility and functionality of the company’s web site [4].

3. E-Commerce in Clothing Sector

Due to the sensory and interactive nature of the clothing purchase process, clothing products are categorized as high-risk items and clothing shopping has been associated with high perceived risk. One key reason for this is the nature of clothing shopping. When consumers are shopping for clothing they like to physically examine the products to assess color, size, design and fabric. Also, for clothing product, fit is very important [10].

There is a vital discovery component within clothing stores. The consumers visit the clothing stores because they want to buy products (for example a shirt) which are proper to their styles. However, if they are unsure about the type of the product (shirt), they want to glance at all. In this context, inspiration is very important especially in emotional categories like fashion [11].

Compounding the difficulty in characterizing the product is the personal, often emotional nature of a clothing purchase. Clothing purchasing decisions are closely linked to individuals’ feelings about themselves, their body image and the image they wish to project. However brand names help consumers infer certain aspects of quality or fit, especially for consumers making repeat or replenishment purchases [12].

Basic clothing products are selling well online. Because the touch and feel of basic garments are quite familiar and are fairly similar across brands, which makes the buyer less hesitant to purchase them and produces fewer surprises when the garment arrives. Also for more basic items, the fit of the different garment styles tends to be better understood, making it easier to purchase online. It can be said that more fashionable items may be more risky to purchase online [12].

However, highly innovative people, who tend to have higher incomes, higher levels of education, greater risk propensity and higher occupational status are more likely to adopt new products and services than people with low general innovativeness. Therefore, an innovative person might adopt and utilize the internet for clothing shopping even though high risk is associated with purchasing clothing on the internet [10].

4. E-Commerce in Turkish Clothing Sector

According to the results of a research about information technology utilization of households, which is actualized by Turkish Statistical Institute [13], computer and internet usage ratios are 53.5% and 53.8% respectively in individuals at the age of between 16 and 74. The regular internet users ratio is 44,9 % within the individuals at the age of between 16 and 74. They use the internet almost every day or at least once in a week in the first three months of 2014. The individuals mostly use the internet for accessing to social networking sites (78,8 %). This is
followed by reading online news and journals (74.2%), searching information about products and services (67.2%), downloading or playing music, films or games (58.7%) and sending and receiving e-mails (53.9%) respectively. Nearly 30.8% of the internet users order or buy products or services. 51.9% of the individuals, who buy products or services via internet between April 2013 and March 2014, purchase garments and sport materials. 27% buys household goods (furniture, toys, white goods etc.) whereas 26.8% purchases tickets, 24.9% buys electronic tools (cell phones, cameras, televisions etc.) and 15.9% purchases books, journal and newspapers.

As it can be seen from the statistics approximately half of the individuals, who purchase via internet in Turkey, buy garments and sport materials. Despite its disadvantages which are mentioned above, consumers use the internet for buying reduced priced products of known brands in terms of style, texture and patterns. The consumers also purchase the basic and standard clothing products via internet. On the other hand the consumers are encouraged by short-term unconditional product return services of e-commerce web sites. The consumers try the clothing products which they bought and if they don’t like them, they send them back to the seller within the same day. All these factors increase the clothing products sale via internet.

The e-commerce of clothing products actualizes via two types of web sites in Turkey. The web sites like Trendyol and Markofoni sell clothing products of many brands via virtual boutiques through internet. These web sites can always sell the products of a brand or they can open a virtual boutique for a brand which lasts 4 or 5 days. At the end of this period, they stop the sale. The second type of sale is actualized through virtual stores which are established by brands. Turkish clothing enterprises, which succeed in retailing, also want to be successful in the virtual world. Therefore, they establish their own web sites for e-commerce and they reach to their consumers via these virtual stores. The investment costs of virtual stores are very low according to physical stores. The investment costs of physical stores increase due to the increasing rent or purchasing prices, salaries and insurances of store employees and energy expenditures. Besides, via virtual stores, the brands can make sales to places where their physical stores are absent. Therefore they can enrich their customer portfolios with a low investment cost.

In this study, the transition period and performances of Turkish clothing enterprises, which are successful both nationally and internationally, in terms of e-commerce are analyzed. For this purpose, interviews are made with marketing managers and/or e-commerce managers.

4.1 Kiğılı

Kiğılı, which is established in 1938, produces suits, shirts, trousers, jackets and casual wear for men. The enterprise owns two brands which are named as Kiğılı and Abdullah Kiğılı Exclusive Cut. The enterprise possesses 226 physical stores in 13 countries. Kiğılı has started to e-commerce activities in 2011. 35% of its e-commerce turnover comes from the sales in İstanbul, Ankara, İzmir and Bursa provinces. E-commerce sales constitute 3% of the enterprise’s total turnover by June 2014. E-commerce sales indicate 100% increase within the
last three years. The enterprise aims 100% turnover increase in 2014 according to 2013 with the contribution of mobile e-commerce applications.

The orders are couriered within 3-5 workdays. Extra courier fee is taken from orders. During campaign processes, the courier fee isn’t taken from orders which are above a definite amount. The customers can return the products, which they bought, unconditionally within 30 days.

4.2 Vakko

Vakko, which is established in 1934, produces women and men clothes. The enterprise owns three brands which are named as Vakko, Vakkoroma and WCollection. The enterprise possesses 65 physical stores in 5 countries.

Vakko has started to e-commerce activities in July 2010. However, the other brands within Vakko have started to e-commerce activities in 2011. E-commerce sales constitute 5% of the enterprise’s total turnover. The enterprise expects 40% increase in 2014 according to 2013. The enterprise aims 8% share from total turnover at the end of 2015.

The orders are delivered within 5 workdays. The customers can return the products, which they bought, unconditionally within 7 workdays.

4.3 LC Waikiki

LC Waikiki is established in 1985 as a French brand. Since 1997 it proceeds on its way as a Turkish brand. It produces women, men, children, teenager and baby clothes. The brand possesses 481 physical stores in 23 countries.

LC Waikiki has started to e-commerce activities in March 2011. The e-commerce web site of the brand is the best seller store within Turkey. It possesses 14 million Euro turnovers in 2013. 78% increase is achieved in 2012 according to 2011 in terms of turnover whereas 35% increase is achieved in 2013 according to 2012 in terms of order count. The brand aims to start e-commerce activities in Russia, Romania and Bulgaria markets by the end of 2014. The brand also aims 10% share from total global turnover at the end of 2023.

The orders are couriered within 3 workdays. The courier fee isn’t taken from orders which are above a definite amount. The customers can return the products, which they bought, unconditionally within 30 days.

4.4 DeFacto

DeFacto, which is established in 2003, produces women, men, children and teenager clothes. The brand possesses 240 physical stores in 5 countries.

DeFacto has started to e-commerce activities in October 2012. E-commerce sales constitute 5% of the enterprise’s total turnover. The internet store achieves a turnover over the sum of five stores’ turnovers which own the highest turnovers within physical stores of the brand.
The e-commerce volume of the brand is increased 400% in 2013 according to 2012. Each year, the turnover of the internet store increases two times more according to physical stores. The enterprise aims 25% share from total turnover at the end of 2023. The orders are delivered within 5 workdays. Extra courier fee is taken from orders. However it is very low. The customers can return the products, which they bought, unconditionally within 30 days. If the products’ amount is lower than a definite amount, the customers can also return them to physical stores.

4.5 Colin’s

Colin’s, who is established in 1983, produces women and men clothes and denim wear. The brand possesses 600 physical stores in 37 countries. Colin’s has started to e-commerce activities in July 2014. E-commerce sales constitute 2% of the enterprise’s total turnover. The enterprise aims 10% share from total turnover at the end of 2015. The orders are delivered within 5 workdays. The courier fee isn’t taken from orders which are above a definite amount. The customers can return the products, which they bought, unconditionally within 30 days. The size change can be done in physical stores even if the clothes are purchased from internet store.

4.6 Mavi

Mavi, which is established in 1991, produces denim wear and non-denim sportswear for women and men. Mavi has been the leading jeans brand in Turkey since the last 18 years with 11% market share. The brand possesses 326 physical stores in 50 countries. Mavi has started to e-commerce activities in January 2013. E-commerce sales constitute 2% of the enterprise’s total turnover by 2014. The e-commerce volume of the brand is increased 100% year over year. The enterprise aims 4% share from total turnover at the end of 2015. The orders are couriered within 3 workdays. Extra courier fee is taken from orders. The customers can return the products, which they bought, unconditionally within 30 days.

5. Conclusions and General Evaluation

The textile and clothing sector, which owns a significant place within Turkish economy, operates in international markets under intensive rivalry conditions. Especially the clothing enterprises must be flexible and agile in order to able to survive because a large variability exists within the sector. The enterprises must correctly determine the fluctuations in the markets and they must expeditiously adapt to variable conditions. In this context, they must give great importance to marketing strategies which connect them to ultimate consumer. Nowadays, customers’ desires and expectations are the keywords for clothing enterprises.
The enterprises, which meet the customers’ desires and expectations correctly and rapidly with proper prices, increase their competitiveness and thereby their profitability. For this purpose, they can use e-commerce strategy. The attractiveness of e-commerce is increased due to the reasons such as times spent at work, intensive traffic and overstrain. Therefore, the attractiveness of physical stores is decreased. Besides, the investment costs of physical stores (rent, salaries and insurances of store employees, energy expenditures etc.) are very high according to virtual stores. Due to these reasons the enterprises head towards e-commerce. Although the consumers want to buy clothing products after trying and feeling, they purchase the products of known brands or basic products via internet without hesitation. Besides, the unconditional return service of virtual stores, which is almost provided by all enterprises, attracts consumers.

As it can be seen from our research results, Turkish clothing brands expeditiously head towards e-commerce within last four years. There are many portals in Turkey which sell clothing products. However, our enterprises aim to open their own virtual stores and they prefer to reach to their customers personally. This decision is affected by the establishment of their own retail chains within last ten years. They aim to increase customer satisfaction and loyalty by reaching them personally via virtual and physical stores.

According to the result of our research the Turkish clothing brands’ e-commerce sales constitute approximately 5% of the enterprises’ total turnover. Besides, the turnover of the virtual stores increases in high rates according to physical stores. Our clothing enterprises aim 10-25% e-commerce share from their total turnover in future.

All of these results indicate that Turkish clothing enterprises give great importance to e-commerce. The sector successfully implements modern marketing strategies besides using traditional marketing channels.

References


CRAFTING THE DIGITAL

P. Kenny

London College of Fashion, University of the Arts London, 26, Beaufort Mansions, Beaufort Street, London, England, SW3 5AG
p.kenny@fashion.arts.ac.uk

Keywords: fashion, digital embroidery, textile design, fashion textiles, embellishment

Abstract

Historically the labour and materials involved in producing lavish embroidered textiles have made them the perfect medium through which to express great wealth and status. Materials with intrinsic wealth or rarity were used to denote rank, separation from the masses and position, whether secular or religious, in addition to being aesthetically desirable. The development of computerised embroidery and embellishment equipment, both software and hardware, has enabled the possibility for customised fashion at reduced cost. Ready to wear has been influenced by a resurgence of interest in couture and traditional textile craft techniques have been rediscovered and reworked in combination with the use of new technology and industrial processes. Embroidery software and hardware developers have responded to their designer client base by developing sophisticated tools enabling richer surface effects to be achieved. How are students and practitioners exploring both digital and hand processes to achieve luxury surfaces? This paper will consider through student case studies how designers are exploring the possibilities of craft and digital for textile design for fashion and what type of outcome may result.

Introduction

Hitoshi Tajima, company chairman of Tajima, a prominent computerised embroidery manufacturer identifies the ‘growing diversity of demands for embroidery, which are endless’ [1]. He notes that embroidery plays an important role in the necessity for apparel manufacturers to add ‘additional value’ to their garments to satisfy customer’s demands. The surface textiles area of the London College of Fashion (LCF) is equipped with embroidery
Computer Aided Design (CAD) software, Wilcom EmbroideryStudio e3 and Computer Aided Manufacture (CAM) hardware, Tajima Cornely and Amaya computerised embroidery machines. Both students and research staff combine these digital technologies as part of their creative practice.

Wilcom EmbroideryStudio e3 is one of the leading software applications for embroidery industry design and manufacture. The programme is a suite of CADCAM tools that provides a fast, flexible way to create, edit, and organise embroidery designs. Wilcom software offers particular advantages for textiles for fashion students through their software special effects and processes, many of these now being standard in all CAD embroidery software. The company also introduced tools that increased the opportunity for variety and more relation to hand processes. Wilson, co-founder of Wilcom, speaking of their software innovations over the past decade, states that “the ability to add the human touch was really important in top quality designs” [2].

The software supports the high-end productivity and efficiency requirements of professional designers but importantly the benefit of using this software within the curriculum is that it allows novices to become productive digitisers. Other universities identify the versatility of the CADCAM within their curriculum. Tina Downs discusses the use of the impact of Wilcom software at Nottingham Trent University:

“We have students who work in a really commercial way towards fashion application working with ideas for garment placement designs but we also have students who want to see really how far they can push the technology where different yarns and different threads, shrinking fabrics after they're stitched on and weaving fabrics, stitching into them, working with really long threads, all kinds of different things. So that's where the excitement is for us and what we can do really” [3].

According to Downs the increase in number of workstations allowed for an important shift in practice by enabling the students to digitise their own work and interpret it in a creative way rather than by technicians translating designs for them [4].

Digital CAD embroidery offers stitch perfection but not all digital embroidery is aesthetically desirable. Some designers are able to manipulate the software with more success than others. Awareness of the creative possibilities needs to be combined with an intimate knowledge of the software. The curriculum at LCF introduces CAD after initial understanding of embroidery has been gained through both hand and hand operated machine work. This supports our approach to digital textiles that encourages the integration of digital and craft processes.

The cost of industrial embroidery software packages and machinery has always been high. More recently lower prices for entry-level machines and multiple funding initiatives within the UK have enabled more universities and colleges to purchase or increase such industrial equipment. Single head machines for CADCAM embroidery are now affordable by artisan small businesses or textile departments that offer the same standard features as their more expensive models, a full-colour LCD display monitor, fast stitch capacity and yet capable of withstanding the rigors of a commercial embroidery business.
The availability of such technology supports the educational rationale for embedding the teaching and learning of embroidery CAD/CAM skills within textile programmes. Students can develop their knowledge in open access workshops with technical support and learning packages increasing their employability skills. The necessity of development of such skills has been identified by industry [5].

The Amaya CAM embroidery machine has been the choice of several universities and colleges including LCF and the University of Huddersfield [6]. When the Amaya was introduced into the market it offered several advantages that have since become available in other manufacturers' ranges. As one of the first modular machines the Amaya offered flexibility for concurrent use by students within workshops. More important was their introductions of the computerised tension system that allows for the possibility of more experimental work and that could more closely resemble hand stitching. This has facilitated increased thread and excessive top thread to be exploited by the students as a feature within designs.

Strong competition among CADCAM embroidery software producers has ensured constant investment in and development of software products. Wilcom have their developers participating on the site forums to help solve the customers’ problems and gain ideas for further software development [7].

Manufacture of CADCAM embroidery machinery continues to be as competitive as CAD software development and has constantly driven innovation. A wide range of multi-head embroidery machines are available that offer standard embroidery with chenille and chain stitch, coiling and taping, boring tools and sequin attachments [8]. Such machines offer a dazzling variety of creative design opportunities for surface texture.

Independent sequin devices compatible with most CADCAM embroidery machinery are available, [9] and responding to demand some manufacturers have developed optional sequin attachments for existing machines (Melco, Amaya, Tajima) [10]. Tajima have multi-head machines with high-speed sequin, lame attachment, lock-stitch chenille embroidery combined with multi-colour embroidery and coiling and taping [11]. They are also able to offer a mixed type 2 head machine (custom made) machine with regular embroidery and chenille heads with sequin, cording and large bed suitable for small businesses and colleges.

Within industry tubular CAD embroidery machines are available allowing embroidery of constructed sleeves or jeans [12]. Companies also offer large field computerised embroidery machines such as Barudan’s industrial Big Field embroidery machine with a staggering 1600 x 1600 mm field as well as a roll-to-roll machine allowing for higher industrial embroidery production.

In an interview with Printwear Promotion magazine, [13] Roy Burton Managing Director of Your Embroidery services Ltd (Yes) summarised the four main developments in CADCAM embroidery that have most contributed to the development of the industry over the past 30 years. In terms of the developments within computerised embroidery machines he identified these as being the introduction of automatic colour changing, increased speed of stitching in combination with the reduction of thread break and automatic thread trimming.
These improvements combined to make the operator's job easier and for more cost effective production. Additionally within the industry he identified that the introduction of drop table machines (tubular) has allowed for the embroidery of made up garments rather than the fixed tables used previously allowing only for embroidery onto panels. Hitoshi Tajima from Tajima, a prominent company within the embroidery machinery market, supports Burton’s view, identifying their landmark product as the TMB auto-colour changing system in 1973. This, he believes increased the efficiency of production and he identifies as being particular important in the development of embroidery machinery [14].

In terms of CAD software Burton identifies the key development during this period as the move from manual to computer punching, [15] and observes that the effect of this was to open up the potential of such software to a wider range of companies and designers. Most embroidery CAD software packages now offer several automatic digitising tools where, depending on the quality of the artwork and level of pre preparation, the image can be converted automatically to embroidery. However, although this facility may be popular with entry level businesses, this process allows neither understanding to be developed of how embroidery digitisation can be layered to achieve interesting surfaces nor the development of full understanding of the digitisation process. Within the curriculum it is more valuable for students to learn the whole process from input method to preparation for stitching to enable the full potential of the CAD tool to be explored.

The surface textile industry offers increasing combinations of embroidery used with other processes such as laser cutting and engraving. As early as 2006, several companies at IMB showcased laser-cutting machinery in combination with CADCAM embroidery. Whilst these offer exciting but high cost industrial opportunities other companies demonstrated smaller laser/embroidery combinations. GS UK for example continue to offer a series of laser cutting and engraving machines for textiles with entry level prices that are affordable for textile departments allowing students the opportunity to combine technologies and simulate commercial industrial equipment and designs.

There has been much debate about digital technologies in relation to textiles. In 2005, the symposium Autonomatic discussed digital craftsmanship in terms of the potential for digital technologies to ‘blur the boundaries between craft and mass production’ [16]. Autonomata [17] are a group of 3D designer-makers based at Falmouth College of Arts whose work involves the synthesis of digital technologies into crafts based processes. The symposium Fabricating Technology brought together practitioners to discuss current textile technologies. Vibeke Riisberg spoke of digital printing as ‘just one further tool in a box of many that can assist in the creation of pattern’ [18], a statement that is equally valid applied to digital embroidery and most ICT packages. This symposium also discussed the importance of digital skills being supported by firsthand knowledge and experience with cloth. This comes naturally if craft processes are developed in combination with digital skills. It is essential to have knowledge of making in the real world in order to design effectively with embroidery CAD software.
Personal textile practice

Textiles play an important part within rituals and rites of passage. From the earliest times materials with intrinsic wealth or rarity were used to show rank and position by denoting status and power, their value related to amount of time invested in their production. An opportunity for me to explore textiles steeped in ritual came with a collaborative international research project (eCHO) with Queensland University of Technology.

Archival museum pieces were made available to study and selected items of clothing informed the design process of textiles and garments drawing inspiration from the historical pieces investigated in relation to contemporary fashion and to principles of recycling. The original pieces displayed fragile materials evoking a sense of transient memory, by the passing of time and the vulnerability of textiles affected by wear. ‘Using historic textile practice or process has been used by many textiles designers to inform creative practice and practice-based research’ [19].

By referencing the disintegrating lace of the christening robe garment a digital degraded heavy lace was embroidered. This was used as a print resist suggestive of both the unraveling threads and absence of previous stitching on the eCHO pieces. These absent images were then overstitched with lace using different combinations of thread, some resistant to sublstatic dyes. The digital process was interrupted, incomplete motifs were used, stitching was stopped and restarted, offset, stitching, printing/ restitching/ reversed/ unpicking/ unraveling/ applying and developing the surface through process parallel to hand and craft. Re-used and altered, the original traces remained creating a palimpsest.

Fig. 1. Polly Kenny: CAD embroidered lace on net sample.

Fig. 2. Polly Kenny: CAD embroidered lace on net sample.
Within textile production digital CADCAM embroidery offers a pre-determined design delivering a consistent quality that is quick and relatively cheap. As discussed, CADCAM software companies have responded to customers’ requirements and developed tools offering more variety than that previously were available with some tools also relating to and imitating hand embroidery.

Drummond Masterton noted at the Challenging Craft Conference that amongst the many advantages of using CADCAM identified by several practitioners that ‘there was a continuing need to achieve a level of uniqueness within their work’ and asks that with the availability of standard CAD toolsets ‘how can an individual set about creating their unique ID?’ [20]. He identifies that ‘Traditional makers form an in depth understanding of the materials and tools that they work with, through various combinations of hands on experience, and technical/ scientific understanding. Through this dialogue with materials and processes they are able to develop an individual aesthetic, a personal visual vocabulary. It is necessary to develop a corresponding approach to the use of CAD and CAM. To this end this (his) project work intended to explore beyond the digital tools with the specific aim of ‘developing objects with greater personal integrity and uniqueness.’ [21].

This project was based on a practice-led developmental approach to explore the digital process beyond the defined CAD embroidery toolset with, sharing as Masterton, the specific aim of developing ‘objects with greater personal integrity and uniqueness.’ The aim was, through an amalgam of digital and craft/hand process, to achieve a sense of the mark of hand within the use of digital technology, applying the sensibilities of hand/craft practice. The work intended to use digital technology not only to facilitate production but also as the instrumentation of process through which new developments might take place affecting process, aesthetic and tactility.

In his book Abstracting Craft, Malcolm McCullough suggests ‘Our use of computers ought not
to be so much for automating tasks as for abstracting craft’ [22] whilst Masterton notes he makes use of CAD ‘to make time for exploration and reflection on the ideas developed with these tools [23]. This work intended to translate visual analysis of the archive to explore the positive use of CADCAM, in combination with hand process, as part of a methodology of practice.

The concept of slow textiles is referenced within this work re-establishing value through process, linking to characteristics within the original archival pieces and forming a new narrative through the metaphor of collage, chance and accident. The work is based on hand/ craft sensibility, a slow and meditative process in response to exploratory, emerging visual and tactile and aesthetic results.

The work subverts the technology to create new forms by applying craft processes and methodology to digital technologies. In some instances this is through allowing the craft process to be evidenced within the digital, in other instances through embracing chance and accident to strengthen the creative process as with traditional craft practice. Sometimes the very restrictions imposed by CAD technology can be creative starting points for new design.

Case Study 1

The first case study is of Andrew Kenny’s work during his MA at the Royal College of Art (RCA) [24]. He is an artist, designer, lecturer and researcher at the LCF, Studio Director and owner of the successful embroidery company, London Embroidery Studio. Based in East London, the company mixes traditional methods of hand and machine embroidery with state of the art computer technology to create London's most beautiful and innovative designs. Clients have included Louis Vuitton, the BBC, artist Hew Locke and shoe designer Nicolas Kirkwood [25].

Kenny’s research work is focused on the use of digital technologies that he uses to push the boundaries of the discipline within his degree, post-graduate and research work. His work has explored themes of user-centered design, anthropology, and social comment and he provides an interesting case study within his roles as lecturer, practitioner, researcher, and business entrepreneur.

Kenny reflects that his work is predominantly people based but admits that he is also very interested in computers, new media and Web 2.0 technologies and is also ‘a big machine geek’, interested in sewing machines, electronic machines, computer sewing machines and CAD programmes. Within his work he likes to ‘subvert these machines and programmes’. His work contains much social commentary as well as ideas about social media sites such as Facebook.

Kenny’s RCA final major project work Emotional Connections is a ‘sustainability themed fashion project’. The project interviewed several men about items of clothing in their wardrobe. Each of the interviews revealed a poignant story about one or two garments that they were unable to throw away for some reason. Kenny’s approach was to question whether emotional connections could be built in the design of the work for the end user.
By combining drawings initiated from images on one of the interviewees Facebook pages with his interest in subverting machines and programmes, Kenny produced his Robiotic drawings, the drawings being produced by configuring his computerised embroidery machine with a fine paintbrush replacing the needle [26]. Rich black expressive drawings were created that emphasise and add weight to the initial subject matter (Fig. 4-6).

In 2013, Kenny participated in Flight: Drawing Interpretations, a collaborative project drawing together artists and researchers from London College of Fashion and the National Gallery. ‘Over a year practice-led researchers from the College explored drawing as a methodological creative process in their responses to artworks at the Gallery. A theme was chosen, flight, which offered multiple ways of approaching the project’[27]. For this project Kenny continued work developed as part of his MA at the RCA utilising exploration of the CAD embroidery machine as a drawing tool, the drawings this time being retranslated into computerised embroidered textiles (Fig. 4).
Hand embroidery processes that are explored by Kenny through his manipulation of CAD programmes with the opportunities of the computerised embroidery machine include free machining, pulled work, satin stitch, eyelets and smocking techniques. His early undergraduate work, Wild Abandonment (Fig. 8) included pieces on dissolvable fabric worked by free machining using industrial hand operated Irish machine in combination with CAD that were very experimental of their time.

Later RCA work, Brush Strokes (Fig. 9) included collaboration with a RCA fashion designer and exploited heavy satin stitch and thread weight variation to create samples that are deliberately over-weighted, the luscious embroidery dominating the fabric quality to create rich surfaces and heavy sonorous draping fabric.
Recent work for fashion designers by The London Embroidery Studio includes: Joseph Turvey Fall/Winter 2014 where the embroidery enhances hand drawn illustrations, Bobby Abley Wishery collection AW 2014, Kit Neale SS14, Shi Mo Zhou SS14 and Treésors Sauvages.
Kenny’s background in traditional embroidery before studying digital supports his understanding both the limitations and opportunities of CAD CAM and informs both his research development and design practice as well as providing an enriched source of reference for experimentation, truly exploring the capabilities of both CAD software and CAM manufacture. His work draws on all these reference points to maintain a strong personal identity that celebrates and exploits the use of CAD processes based on research concepts.

**Case Study 2**

The second case study, Flett Bertram, [28] is chosen as an example of digital textile processes used successfully alongside hand processes to produce an integrated aesthetic within a fashion collection.

Flett Bertram’s final major project in fashion textiles at undergraduate level, *Omnia Vanitas*, is an investigation into the complex notion of mortality, an in-depth look into the delicate balance between life and death that relentlessly overshadows all human existence. Her collection aimed to explore the ever-changing perception of mortality, within the context of history, and to examine the ways in which we remind ourselves of our predestined fate. Her project investigates the subtle contrast between the delicate fragility of life and the eternal permanence of death, with particular reference to 17th Century Vanitas artwork and Victorian mourning rituals.

Bertram’s concept considers the impossibility of comprehending the contrast between the lives of those from centuries ago and contemporary life. She focuses on the consideration of mortality as the one constant factor crossing these two periods, ‘the knowledge of our inescapable destiny the acceptance of our inevitable death on both a personal and planetary level’ [29]. Bertram’s interest was to consider that behind the ‘somber exterior’ some Memento Mori also embraces the balance between life and death and consideration of life itself. The intention was not for a literal translation but a collection that will have a slight illusion to the macabre. The genre of Vanitas still-life paintings, predominantly from the Netherlands, during the 17th Century were examined focusing on objects symbolic of these themes such as skulls, decaying flowers, toppled glasses and analysis of the disorder carefully contrived within the composition of the paintings.

Her textile development focused on qualities expressing fragility or transience of life within the paintings such as delicate glass objects and decaying vegetation. She notes that her textile interpretation of this may result in delicate lace-like work reminiscent of lace from the period and that she intends to explore the use of the techniques of laser cutting, devoré print process and other abrasion techniques to explore this concept. She intends to contrast these vulnerable textiles with intricate remembrance jewelry from Victorian mourning rituals to make use of their idea of remembrance through permanence.
Students within LCF study units of cultural and contextual studies at levels four and five and are encouraged to draw an and reference these within the context of their design reports and concept development for final major projects. Part of this process is to consider appropriate research methodologies to contextualise practice. Bertram defines her methodology here as: ‘literal to abstract… I like to take a relatively limited literal base as the foundation for my ideas, which then gain interest and personality as they are abstracted away from their original state – predominantly through extensive 2D paperwork and the creation of personal artwork and then through textile experimentation’ [30].

Her proposed methodologies were to include sketching, photography, museum visits, appropriate contemporary exhibitions and films, [31] graveyards and churches, in addition to literary sources to contribute to her background knowledge of this concept. This research follows a standard design development path. The concept and research was used to inform colour scheme, materials selection and textile processes used and garment silhouette. The intended textile ideas were allowed to develop organically throughout the project through critique of their success in relation to her intended theme.

In the final collection laser cutting was used but not in itself to create distressed and degraded fabrics but more in reference to suggested patterns developed from within broken crystal and glass. Laser cutting on black leather and suede was further manipulated to emphasise the broken glass patterning.

![Fig. 10. Flett Bertram, Omnia Vanitas Workbook detail.](image1)

![Fig. 11. Flett Bertram, Omnia Vanitas Workbook detail, drawn threadwork and laser cutting samples.](image2)

Instead of using laser cutting to suggest decay other textile processes suggestive of abrasion were explored such as drawn threadwork that were to prove more visually exciting, individual and interpretative of the project. The intended fragility was translated through investigation of the
replication of hair from mourning jewelry by using drawn thread work on organza and silk inclusive of wrapped and knotted threads, creating both a delicate fabric referencing aged deterioration and yet rich textural surface. Further fragility was maintained through the use of organza alone for supporting garments.

![Image](image1)

**Fig. 12.** Flett Bertram, *Omnia Vanitas* Workbook detail, drawn threadwork sample and design.

![Image](image2)

**Fig. 13.** Flett Bertram, *Omnia Vanitas* Workbook detail, laser cut leather and design.

Other textile artists use their work to critique technology and examine the relationship between digital technology and hand-produced pieces in contemporary textiles [32]. Emily Campbell in her article Personal touchnotes that:

‘Designers begin to corrupt the inevitable standardization of industrial and digital production; they begin to contrive ways to find uniqueness with volume-production processes. Certainly, what we’re seeing a lot in design in an assertion of personal quality: a creator’s personal story or leitmotifs made explicit and integral to a product; private mythologies of the designer’s own devising offered as alternatives to the all-pervasive, objective world of commercial brands’ [33]

**Conclusion**

Within this paper I have reviewed the development of digital software for embroidery and the means by which its integration with creative practice establishes exciting and innovative responses to new design concepts, allowing for growth and development of artistic design opportunity. Leading embroidery machine and software developers such as Wilcom have been
instrumental in keeping pace with digital technology, enabling the marriage of digital and machine techniques to produce high quality work both in operation and design which reflects ‘a human touch’. The review also demonstrates the importance of such technological advances for today’s student to acquire much prized traditional embroidery techniques essential to support experimental digital work, pushing boundaries in the creative process.

The LCF workshops have been set up to mirror a small studio practice and the importance of having students learn the operation of the CAM machinery in addition to the CAD software is paramount to developing their skill set by understanding the inherent limitations. Furthermore, this provides an opportunity for students to consider the ‘what if’ and other potential approaches. Subverting the intention of the software or hardware is an increasing theme within student work at LCF building on work of previous cohorts and also through the examples of staff practice. Technical textiles staff equally inform the student progress through their exploratory design development.

To illustrate the discussion, case studies of both my own research work and that of Andrew Kenny and Flett Bertram have facilitated exploration of the physical pieces (albeit in photographic form). These have been informed by the integration of craft and digital embellishment. In Andrew Kenny’s case to the extent of using digital embroidery technologies to become a drawing implement and as Masterton states achieving ‘uniqueness’ and a ‘personal visual vocabulary’. The advantages for the practitioner are clearly evident, digital and craft technological integration holding infinite design opportunities for innovation, embracing the concept of artistic design solutions emanating from experimentation, chance or accident as well as directed exploration. Pushing boundaries forms the crux of this paper as the examples illustrate, extensively invading digital technology to produce a ‘remix’ of machine and the digital. The complexities of the themes seen in the sample cases reinforce the desire to embrace and discover new creative and innovative means of embroidery design solutions and artistic realization.

References

[9] Richpeace and EMco sequin machines to cut, feed and sew sequins either automatically or manually providing an interesting option for extending the application of existing equipment, IMB Cologne 2006.
[17] Dr Katie Bunnell leads the 3D Digital Production research cluster located at the University of Falmouth concerned with the integration of digital technologies into the creative processes of designing through making (http://www.autonomic.org.uk).
[28] Flett Bertram studied Fashion Textiles at London College of Fashion, graduating 2011, and later studied Mixed Media at the Royal College of Art, graduating 2014
SECTION V:
Textile Education
TEXTILE ENGINEERING EDUCATION IN THE WORLD IN THE LIGHT OF GLOBAL DEVELOPMENTS

S. Kanat, T. Atilgan
Ege University, Department of Textile Engineering, Turkey,
seher.kanat@ege.edu.tr turan.atilgan@ege.edu.tr

Keywords: Globalization, globalization in education, differentiation in education, textile engineering education

Abstract
As known, globalization can be defined as the free movement of labor, capital, information, goods and services. Therefore, these free movements has affected and altered many things radically. Under the intensive rivalry, the enterprises need human resources which are innovative, creative, differential and entrepreneur. Educational institutions of textiles, which are one of the most significant employment resources of textile and clothing enterprises, are affected from this global alteration and interaction. As a consequence, educational institutions of textiles must implement programs which can raise engineers who are dynamic, technically and socially powerful and adaptive to global culture. This development indicates that, textile engineers must be multifunctional engineers who have information about marketing, management, behavioral science, economy and supply chain management. Also they must be powerful in terms of technical information, they must be able to evaluate the enterprise totally and they must be attuned to team work between different enterprise departments. Thus, globalization movements globalize the textile engineering education on the one hand and on the other hand it reveals partial differentiations by organizing specialized education programs which are proper to the profile that the sector needs.
In this study the education programs of leading universities throughout the world, which give textile engineering education, are comparatively analyzed. The leading textile education fields and differentiations between countries are emphasized. Suggestions for the future of textile engineering education are made.

1. Globalization and Effects of Globalization
Globalization can be defined as the disappearance of national borders and transformation of the world to a unique market. Proliferation and free movement of products and services, capital and
technology are the result of globalization [1]. Globalization generally entails the international movement of capital, labor, products, technology and information in increasingly expanding amounts [2].

The effects of globalization can be summarized as; the social transformation, transition process from industrial society to knowledge-based society, the increasing importance of service sector, the increasing significance and power of knowledge, the increasing importance of education and individualization, appearance of new occupational groups, rise in global rivalry, power loss of national states and the alteration of enterprises [1]. Textile and clothing sector is one of the sectors which are affected by globalization.

For many years, the textile and clothing sector has been on the forefront of globalization. No industry is more broadly dispersed around the world than the textile and clothing industry. Approximately 200 nations are involved with clothing production for international markets. In addition, a single clothing item produced and marketed within one country is a rarity. Along with the proven importance of global sourcing and marketing the need for efficient global supply chain management is highly regarded among practitioners. The textile and clothing production-distribution supply chain involve many fragmented nodes: agriculture (fiber sources such as cotton, linen/flax, wool, mohair and silk), manufacturing at various levels (yarn and fabric production, clothing production and wet finishing), distribution and consumers. Coordinating these nodes correctly with overseas suppliers requires the most sophisticated management skills. Despite these remarkable changes in clothing production, marketing and management, our understanding of the important changes is vague [3].

On the other hand, globalization affects the education because it affects knowledge and knowledge share. Nowadays, educational institutions work for globalizing themselves and their curriculum. The reasons of globalization in education can be summarized in three main topics.

Leveraging the home base: In its simplest form this means that educational institutions want to use their home base capabilities in order to make more money. In some cases this simply means attracting foreign students to come and study in their institutions. Australian, British, French and American universities have always been good at this and have enhanced their pool of foreign students significantly in the 1990s [4].

Enriching the home base: In this case the educational institutions feel the need to attract international students or offer their own students the opportunity to study in a more international environment, in order to improve their selling proposition. Business is globalizing and thus they want their students to be exposed to international groups and issues. Exchange programs and study missions are in this case the preferred method [4].

Learning from the world: A few institutions have come to the conclusion that research is actually the main driver for their internationalization [4].

As it can be seen, the globalization affects the textile and clothing sector, education and educational institutions. In the light of this information, we can say that globalization affects the textile education.
2. Textile Engineering Education in the World

Engineering Criteria 2000, which is prepared by ABET (The Accreditation Board for Engineering and Technology), defines the properties that must be improved by engineering education programs [5]:

a) Implementation ability of mathematics, science and engineering information,
b) Experimental design, experimentation, data analysis and data interpretation abilities,
c) Design ability of a system in terms of required properties,
d) Working ability in interdisciplinary studies,
e) Defining, modeling and solving abilities of engineering issues,
f) Ability of being consciousness about professional and ethical responsibilities,
g) Ability of effective communication,
h) Creation ability of broad perspective in terms of understanding the social and global effects of engineering solutions,
i) Ability of lifelong learning and ability of defining necessities,
j) Having information about regulations,
k) Utilization ability of modern engineering tools, skills, and techniques which are necessary for engineering applications.

According to ABET, courses within engineering undergraduate programs must be distributed evenly between; a) Sciences and mathematics, b) Engineering sciences, c) Human sciences, d) Social sciences and communication, e) Department courses [6].

As it can be seen engineering doesn’t only focus on technical information and skills. Engineering education must gain social information and abilities as well as technical information and skills. A well-trained engineer must possess effective communication and managing skills. Nowadays, the engineers work in marketing and management departments as well as production. Therefore, the significance of gaining social skills increases.

Nowadays, there are many universities which give textile engineering education. However, the contents, study periods and institutions vary in terms of countries. Textile engineering education period is 3- 4 years in European Union whereas it is 4 years in Turkey and USA. The education concentrates on technical textiles, new materials, textile management and marketing in developed countries whereas it concentrates on traditional materials and production in developing countries. There are textile universities in China, which takes an important share form world’s textile and clothing production. On the other hand, textile education is integrated with other disciplines in Japan, USA and United Kingdom. Textile undergraduate education in Turkey is given in departments under engineering faculties.

In this study, the education programs of leading universities throughout the world, which give textile engineering education, are comparatively analyzed. For this purpose, curriculums of five
different universities, which give Bachelor of Science Degree (B.Sc.), from five different countries (USA, United Kingdom, Germany, Spain, Turkey) are analyzed.

2.1 United States of America (USA)

North Carolina State University is one of the significant universities of USA which gives textile education. Undergraduate education of textile is given in 5 departments under 14 programs which are connected to College of Textiles. The period of study is 4 years for each program. 120-128 credits are necessary for graduation. The college gives education under 5 departments; Fashion and Textile Management, Fashion and Textile Design, Polymer and Color Chemistry, Textile Engineering, Textile Technology.

Fashion and Textile Management Department consists of three programs. Textile Brand Management and Marketing teaches how to position products and services for success in the marketplace, particularly in the fashion, retail and textile industries. Fashion Development and Product Management focuses on design and development of fashion products, from jeans to bridal gowns. Retail and Supply Chain Management in Textiles teaches a broad perspective from textile production to retail sales. It covers merchandising and logistics and distribution strategies to bring the product to the consumer [7].

In Brand Management and Marketing program, the students take principles of microeconomics, academic writing and research, calculus for life & management sciences A, intro to textile technology, intro to college of textiles, chemistry, general chemistry laboratory, computational math for life and management sciences, calculus for life & management sciences B, intro to fiber science, business of textiles as compulsory courses in their first year. They also take one elective course from health & exercise studies group. In their second year they take concepts of financial reporting, principles of macroeconomics, college physics I, yarn production & properties I, intro to textile brand management & marketing, financial management, formation and structure of textile fabrics, principles of retailing & supply chain management as compulsory courses. They also take three elective courses; one from health & exercise studies group, one from general education program and one from textile management group. In their third year they take entrepreneurship in textiles, fashion and the consumer, intermediate textile brand management & marketing, technical textiles wet processing, textile brand communication, communication for business & management I, visual merchandising textile products, textile market research as compulsory courses. They also take two elective courses; one from statistics group and one from general education program. In their fourth year they take advanced textile brand management & marketing, the fashion industry, textile & apparel labor management, global textile trade & sourcing as compulsory courses. They also take six elective courses; three from general education program, two from textile management group and one from interdisciplinary perspectives group [8].

In Fashion Development and Product Management program, the students take principles of microeconomics, academic writing and research, calculus for life & management sciences A,
intro to textile technology, intro to college of textiles, chemistry, general chemistry laboratory, computational math for life and management sciences, calculus for life & management sciences B, intro to fiber science, principles of retailing and supply chain as compulsory courses in their first year. They also take one elective course from health & exercise studies group. In their second year they take concepts of financial reporting, principles of macroeconomics, college physics I, yarn production & properties I, fashion product analysis, financial management, formation and structure of textile fabrics, computer-aided textile design, intro to textile brand management & marketing, fashion product design as compulsory courses. They also take one elective course from health & exercise studies group. In their third year they take technical textiles wet processing, fashion and the consumer, CAD for fashion, entrepreneurship in textiles, fashion development processes, communication for business & management, intermediate textile brand management & marketing as compulsory courses. They also take three elective courses; one from statistics group, one humanities group and one from additional breadth group. In their fourth year they take the fashion industry, fashion product development, senior collection studio as compulsory courses. They also take five elective courses; two from interdisciplinary perspectives group, one from optional group, one from humanities group and one from social sciences group [9].

In Retail and Supply Chain Management program, the students take principles of microeconomics, academic writing and research, calculus for life & management sciences A, intro to textile technology, intro to college of textiles, chemistry, general chemistry laboratory, computational math for life and management sciences, calculus for life & management sciences B, intro to fiber science, business of textiles as compulsory courses in their first year. They also take one elective course from health & exercise studies group. In their second year they take principles of retailing & supply chain management, principles of macroeconomics, college physics I, yarn production & properties I, intro to textile brand management & marketing, concepts of financial reporting, formation and structure of textile fabrics as compulsory courses. They also take four elective courses; one from health & exercise studies group, one from statistics group and two from general education program. In their third year they take technical textiles wet processing, retail merchandising in fashion & textiles, management and controlling of textile apparel systems, intermediate textile brand management & marketing, communication for business & management, product costing for textiles, financial management, fashion and consumer, entrepreneurship & new product development in textiles as compulsory courses. They also take one elective course from general education program. In their fourth year they take retail buying in fashion and textiles, decision making in textiles, the fashion industry, supply chain management for textiles as compulsory courses. They also take six elective courses; there from elective group, two from general education program and one from interdisciplinary perspectives group [10].

In Retail and Supply Chain Management program, the students take principles of microeconomics, academic writing and research, calculus for life & management sciences A, intro to textile technology, intro to college of textiles, chemistry, general chemistry laboratory, computational math for life and management sciences, calculus for life & management sciences B, intro to fiber science, business of textiles as compulsory courses in their first year. They also take one elective course from health & exercise studies group. In their second year they take principles of retailing & supply chain management, principles of macroeconomics, college physics I, yarn production & properties I, intro to textile brand management & marketing, concepts of financial reporting, formation and structure of textile fabrics as compulsory courses. They also take four elective courses; one from health & exercise studies group, one from statistics group and two from general education program. In their third year they take technical textiles wet processing, retail merchandising in fashion & textiles, management and controlling of textile apparel systems, intermediate textile brand management & marketing, communication for business & management, product costing for textiles, financial management, fashion and consumer, entrepreneurship & new product development in textiles as compulsory courses. They also take one elective course from general education program. In their fourth year they take retail buying in fashion and textiles, decision making in textiles, the fashion industry, supply chain management for textiles as compulsory courses. They also take six elective courses; there from elective group, two from general education program and one from interdisciplinary perspectives group [10].

Fashion and Textile Design Department consists of two programs as Textile Design and Fashion Design. Students gain knowledge and hands-on experience using industry-specific technologies in an educational environment similar to that found in today’s textile and apparel complex [7].
In Textile Design Program, the students take academic writing and research, design and culture, introduction to textile technology, design thinking 1, design studio 1, introduction to college of textiles, design thinking 2, design skill workshop, design and culture2, calculus for life and management sciences, design studio 2 as compulsory courses in their first year. They also take one elective course from fitness and wellness courses of the university. In their second year they take computer aided textile design & color, the textile industry, physics for engineers & scientists, yarn production and properties I, basic drawing, intro fiber science, formation & structure of textile fabrics, yarn design studio, surface design and texture, computational mathematics, calculus for life and management sciences as compulsory courses. In their third year they take entrepreneurship and NPD, woven textile design studio I, knitted textile design studio I, chemistry- a molecular science, general chemistry laboratory, introduction to statistics for engineers, intro to textile brand management, technology textile wet processing as compulsory courses. They also take three elective courses; one from humanities group, one from advised group and one from social sciences. In their fourth year they take woven textile design studio II, knitted textile design studio II, senior textile design studio as compulsory courses. They also take five elective courses; one from additional breadth requirement group, one from advised group, one from physical/healthy living group, one from social sciences group and one from humanities group [11].

In Fashion Design Program, the students take academic writing and research, design and culture, introduction to textile technology, design thinking 1, design studio 1, introduction to college of textiles, design thinking 2, design skill workshop, design and culture2, calculus for life and management sciences, design studio 2 as compulsory courses in their first year. They also take one elective course from fitness and wellness courses of the university. In their second year they take computer aided textile design & color, fashion design I, physics for engineers & scientists, yarn production and properties I, basic drawing, fashion workroom practices, the textile industry, formation & structure of textile fabrics, fashion illustration, computer-aided design for fashion, computational mathematics as compulsory lessons. They also take one elective course from physical/healthy living courses. In their third year they take chemistry-a molecular science, general chemistry laboratory, fashion design 2, intro fiber science, fashion design by draping, calculus for life & management sciences, introduction to statistics for engineers, intro to textile brand management as compulsory courses. They also take three elective courses; one from additional breadth requirement group, one from social sciences group and one from advised group. In their fourth year they take fashion design 3, entrepreneurship and NPD, technology textile web processing, senior collection studio as compulsory courses. They also take three elective courses; one from humanities group, one from social sciences group and one from humanities group [11].

Polymer and Color Chemistry Department consists of three programs as Science and Operations, American Chemical Society Certification, Medical Sciences. The programs combine core physical science subjects with a focus in a number of important applied chemistry related fields. The students have the opportunity to get hands-on training on state-of-the-art technology [7].
In Science and Operations Program, the students take intro to college of textiles, intro to polymer & color chemistry, intro to polymer & color chemistry laboratory, calculus for life & management sciences A, chemistry- a molecular science, general chemistry laboratory, academic writing & research, polymer synth. sustainability & the environment, organic chemistry I, organic chemistry I laboratory, calculus for life & management sciences B as compulsory courses in their first year. They also take two elective courses; one from humanities group, one from advised group. In their second year they take intro to polymer science & engineering, organic chemistry II, organic chemistry laboratory II, college physics I, college physics I laboratory, intro to fiber science, intro to fiber science laboratory, chemistry- a quantitative science, quantitative chemistry laboratory, college physics II, college physics II laboratory as compulsory courses. They also take four elective courses; two from health & exercise studies group, one from interdisciplinary perspectives group and one from social sciences group. In their third year they take fiber forming polymers, fiber forming polymers laboratory, tech of dyeing and finishing, tech of dyeing and finishing laboratory, textile product formation, textile product formation laboratory, thermodynamics for textile engineers, intro to color science & application, color science laboratory as compulsory courses. They also take four elective courses; two from advised group, one from humanities group and one from polymer and color chemistry group. In their fourth year they take physical & chemical processing of textiles, characteristic & physical properties of textiles, characteristic & physical properties of polymers, impact of industry on the environment & society, textile chemical analysis, textile chemical analysis laboratory as compulsory courses. They also take six elective courses; three from polymer and color chemistry group, two from advised group and one from additional breadth group [12].

In American Chemical Society Certification Program, the students take intro to college of textiles, intro to polymer & color chemistry, intro to polymer & color chemistry laboratory, calculus I, chemistry- a molecular science, general chemistry laboratory, academic writing & research, polymer synth. sustainability & the environment, organic chemistry I, organic chemistry I laboratory, calculus II as compulsory courses in their first year. They also take two elective courses; one from humanities group, one from advised group. In their second year they take intro to polymer science & engineering, organic chemistry II, organic chemistry laboratory II, calculus III, physics for engineers and scientists I, physics for engineers and scientists I laboratory, intro to fiber science, intro to fiber science laboratory, chemistry- a quantitative science, quantitative chemistry laboratory, physics for engineers and scientists II, physics for engineers and scientists II laboratory, applied differential equations as compulsory courses. They also take one elective course from health & exercise studies group. In their third year they take fiber forming polymers, fiber forming polymers laboratory, tech of dyeing and finishing, tech of dyeing and finishing laboratory, textile product formation, textile product formation laboratory, physical chemistry I, intro to color science and applications, color science laboratory, physical chemistry II, probability and statistics for engineers as compulsory courses. They also take two elective courses; one from humanities group and one from interdisciplinary perspectives group. In their fourth year they take physical & chemical processing of textiles, characteristic &
physical properties of polymers, syst. inorganic chemistry, impact of industry on the environment & society, textile chemical analysis, textile chemical analysis laboratory, chemical synth. & natural biopolymers as compulsory courses. They also take five elective courses; two from polymer and color chemistry group, one from additional breadth group, one from health & exercise studies group and one from social sciences group [13].

In Medical Sciences Program, the students take intro to college of textiles, intro to polymer & color chemistry, intro to polymer & color chemistry laboratory, calculus for life & management sciences A, calculus I, chemistry- a molecular science, general chemistry laboratory, academic writing & research, polymer synth. sustainability & the environment, organic chemistry I, organic chemistry I laboratory, calculus for life & management sciences B, calculus II, intro biology, intro biology laboratory as compulsory courses in their first year. In their second year they take intro to polymer science & engineering, organic chemistry II, organic chemistry laboratory II, college physics I, college physics I laboratory, intro to biology II, intro to biology II laboratory, intro to fiber science, intro to fiber science laboratory, chemistry- a quantitative science, quantitative chemistry laboratory, college physics II, college physics II laboratory as compulsory courses. They also take two elective courses; one from health & exercise studies group, one from advised group. In their third year they take fiber forming polymers, fiber forming polymers laboratory, tech of dyeing and finishing, tech of dyeing and finishing laboratory, textile product formation, textile product formation laboratory, thermodynamics for textile engineers, intro to color science & application, color science laboratory as compulsory courses. They also take five elective courses; one from advised group, one from health & exercises studies group, two from humanities group and one from social sciences group. In their fourth year they take physical & chemical processing of textiles, impact of industry on the environment & society, general microbiology, general microbiology laboratory, textile chemical analysis, textile chemical analysis laboratory, principles of biochemistry as compulsory courses. They also take five elective courses; one from polymer and color chemistry group, two from advised group, one from interdisciplinary group and one from additional breadth group [14].

Textile Engineering Department consists of three programs as Chemical Processing, Product Engineering, and Information Systems. The programs have interdisciplinary curriculums drawing on diverse science and engineering principles [7].

In Chemical Processing Program the students take chemistry, general chemistry laboratory, introduction to engineering & problem solving, intro to computing environment, academic writing & research, calculus I, intro to college of textiles, chemistry-quantitative science, quantitative chemistry laboratory, calculus II, physics for engineers I, physics for engineers I laboratory, comp model engineering as compulsory courses in their first year. In their second year they take chemical processing and printing, physics for engineers II, physics for engineers II laboratory, calculus III, polymer science & engineering, textile engineering science, analog & digital circuits, engineering statistics, chemical production systems, applied differential equations as compulsory courses. They also take one elective course from general education program. In their third year they take probability & statistics for engineers, transport processes I, engineering
textile structures I, thermodynamics, process system analysis and control, textile mfg production II, six sigma quality, textile engineering quality improvement laboratory, techniques of dyeing & finishing, found of graphics as compulsory courses. They also take one elective course from general education program. In their fourth year they take textile engineering design I, textile engineering design II, and economics as compulsory courses. They also take seven elective courses; one from engineering group, three from general education program, one from interdisciplinary group and two from health & exercise studies group [15].

In Product Engineering Program the students take chemistry, general chemistry laboratory, introduction to engineering & problem solving, intro to computing environment, academic writing & research, calculus I, into to college of textiles, textile engineering: materials and systems, comp. model engineering, calculus II, physics for engineers I, physics for engineers I laboratory as compulsory courses in their first year. They also take two elective courses; one from general education program and one from health & exercise studies group. In their second year they take calculus III, engineering statistics, physics for engineers II, physics for engineers II laboratory, polymer science & engineering, found of graphics, applied differential equations, structure and properties of engineering materials, textile engineering science, analog & digital circuits, economics as compulsory courses. In their third year they take engineering textile structures I, thermodynamics, solid mechanics, probability & statistics for engineers, textile mfg production II, six sigma quality, textile engineering quality improvement laboratory, techniques of dyeing & finishing as compulsory courses. They also take three elective courses; two from general education program and one from health & exercise studies group. In their fourth year they take textile engineering design I, polymer engineering, textile engineering design II as compulsory courses. They also take six elective courses; three from engineering group and three from general education program [16].

In Information Systems Program the students take chemistry, general chemistry laboratory, introduction to engineering & problem solving, intro to computing environment, academic writing & research, calculus I, into to college of textiles, textile engineering: materials and systems, comp. model engineering, calculus II, physics for engineers I, physics for engineers I laboratory as compulsory courses in their first year. They also take two elective courses; one from general education program and one from health & exercise studies group. In their second year they take calculus III, engineering statistics, physics for engineers II, physics for engineers II laboratory, polymer science & engineering, found of graphics, applied differential equations, textile engineering science, analog & digital circuits, economics as compulsory courses. They also take one elective course from general education program. In their third year they take engineering textile structures I, thermodynamics, information systems design, probability & statistics for engineers, process system analysis and control, textile mfg production II, stoch mod ISE, six sigma quality, textile engineering quality improvement laboratory as compulsory courses. They also take two elective courses; one from general education program and one from health & exercise studies group. In their fourth year they take textile engineering design I, techniques of dyeing & finishing, facilities design, textile engineering design II, engineering
economy analysis as compulsory courses. They also take four elective courses; one from engineering group and two from general education program and one from interdisciplinary group [17].

Textile Technology Department consists of three programs as Supply Chain Operations, Technical Textiles, and Medical Textiles. The programs are comprehensive academic programs that interweave basic knowledge of fiber materials, science and technologies relevant to fiber processing with product design and development throughout curriculums [7].

In Supply Chain Operations program the students take chemistry, general chemistry laboratory, academic writing & research, calculus for life & management sciences A, intro to textile technology, intro to college of textiles, calculus for life & management sciences B, comp. math for life & management, college physics I, intro to fiber science, business of technical textiles as compulsory courses in their first year. They also take one elective course from health living group. In their second year they take fundamentals of economics, college physics II, yarn production & properties, management & control of textiles & apparel systems, intro to statistics, polymer science, woven fabric technology, knitted fabric technology, concepts of financial reporting as compulsory lessons. They also take one elective course from humanities group. In their third year they take intro to nonwoven products & processes, design tech. of technical textiles, technology of textile wet processing, operational management decisions for textiles, performance evaluation of textiles materials, bio-textile product development, advanced nonwoven processes, supply chain management in textile industry as compulsory courses. They also take two elective courses; one from social sciences group and one from additional breadth group. In their fourth year they take senior design I, financial management, senior design II, quality management and control as compulsory courses. They also take six elective courses; one from humanities group, two from interdisciplinary perspectives group, one from health & exercise studies group and two from textile supply chain operations group [18].

In Technical Textiles program the students take chemistry, general chemistry laboratory, academic writing & research, calculus for life & management sciences A, intro to textile technology, intro to college of textiles, calculus for life & management sciences B, comp. math for life & management, college physics I, intro to fiber science, business of technical textiles as compulsory courses in their first year. They also take one elective course from fitness group. In their second year they take fundamentals of economics, college physics II, yarn production & properties, management & control of textiles & apparel systems, intro to statistics, polymer science, woven fabric technology, knitted fabric technology as compulsory courses. They also take two elective courses; one from humanities group and one from technical textiles group. In their third year they take nonwoven fabric formation, structures and properties of engineering materials, technology of textile wet processing, design technology of technical textiles, performance evaluation of textiles materials, bio-textile product development, advanced nonwoven processes, experimental methods for structural analysis of materials as compulsory courses. They also take two elective courses; one from social sciences group and one from additional breadth group. In their fourth year they take senior design I, senior design II, quality
management and control as compulsory courses. They also take seven elective courses; three from technical textiles group, one from humanities group, two from interdisciplinary perspectives group and one from health & exercise studies group [19].

In Medical Textiles program the students take chemistry, general chemistry laboratory, academic writing & research, calculus for life & management sciences A, intro to textile technology, intro to college of textiles, calculus for life & management sciences B, comp. math for life & management, college physics I, intro to fiber science, business of technical textiles as compulsory courses in their first year. They also take one elective course from fitness group. In their second year they take fundamentals of economics, college physics II, yarn production & properties, management & control of textiles & apparel systems, intro to statistics, polymer science, woven fabric technology, knitted fabric technology as compulsory lessons. They also take two elective courses; one from humanities group and one from medical textiles group. In their third year they take intro nonwoven products & processes, technology of textile wet processing, design technology of technical textiles, intro to biology: cell & molecular biology, performance evaluation of textiles materials, bio-textile product development, advanced nonwoven processes, bio-textiles evaluation as compulsory courses. They also take two elective courses; one from social sciences group and one from additional breadth group. In their fourth year they take senior design I, senior design II, quality management and control as compulsory courses. They also take seven elective courses; three from medical textiles group, one from humanities group, two from interdisciplinary perspectives group and one from health & exercise studies group [20].

2.2 United Kingdom (UK)

The University of Manchester is one of the significant universities of United Kingdom which gives textile education. Undergraduate education of textile is given in Textile Science and Technology, Fashion Retail, Fashion Buying and Merchandising, Fashion Management and Fashion Marketing programs in School of Materials. The period of study is 3 years for each department.

Textile Science and Technology Program is a unique course in combining traditional science and technology aspect of textiles with exciting and innovative applications in smart textiles, sportswear, aerospace and automotive materials and biomedical implants. The students take materials science I, raw materials for fashion, fashion function and aesthetics, management and the apparel pipeline, mathematics I and II, core skills I and II in their first year as compulsory courses. In their second year they take product performance and evaluation, coloration and polymer technology, design, management and team project, product performance and evaluation, coloration and polymer technology, fiber, yarn and fabric technology I and II, sensors and smart textiles I and II as compulsory courses. In their third year they take advanced manufacturing techniques, advanced coloration and performance evaluation, production management, technical
textiles, dissertation project I and II as compulsory courses [21].

Fashion Retail Program provides students with an opportunity to focus on retail theory as well as textiles science and technology. The first year establishes the fundamentals in fashion business, textile science and technology through the core units of introduction to fashion, introduction to management, introduction to marketing and retail and design management and the core textile science units where students are introduced to fibers, materials, fabrics and textile production processes. The second year builds on the principles introduced in the first year by exploring specific aspects of management and marketing with subjects such as fashion product development and brand management for fashion. Subjects such as global sourcing and smart materials also feature. The third year is an opportunity to consolidate and extend specialist knowledge in areas of fashion buying and merchandising as well as clothing technology. A final year project allows students to specialize in an area of their choices, for example focusing on developing a retail strategy [22].

Fashion Buying and Merchandising Program is designed to provide students with and appreciation of the creative fashion drivers needed to be a successful fashion buyer, such as the ability to pick out and identify trends as well as solid understanding of the business acumen required for the products they buy to be a commercial success. The first year establishes the fundamentals in fashion business, textile science and technology through the core units of introduction to fashion, introduction to management, introduction to marketing and retail and design management and the core textile science units where students are introduced to fibers, materials, fabrics and textile production processes. The second year builds on the principles introduced in the first year by exploring specific aspects of management and marketing with subjects such as product development, branding and textile technology. The third year is an opportunity to consolidate and extend specialist knowledge in areas of buying and merchandising. A final year project allows students to specialize in an area of their choices, for example focusing on developing a broader corporate strategy for a fashion business [23].

Fashion Management Program provides students with an opportunity to focus on management theory as well as the textiles science and technology context of the fashion industry. The first year establishes the fundamentals in fashion business, textile science and technology through the core units of introduction to fashion, introduction to management, introduction to marketing and retail and design management and the core textile science units where students are introduced to fibers, materials, fabrics and textile production processes. The second year builds on the principles introduced in the first year by exploring specific aspects of management and marketing with subjects such as product development, branding and textile technology. The third year is an opportunity to consolidate and extend specialist knowledge in areas of management. A final year project allows students to specialize in an area of their choices, for example focusing on developing a broader corporate strategy for a fashion business [24].

Fashion Marketing Program has a strong focus on the unique way in which fashion products are marketed. Key marketing theory is studied with specialist emphasis on the interface between design/creativity and the commercial imperative. The first year establishes the fundamentals in
fashion business, textile science and technology through the core units of introduction to fashion, introduction to management, introduction to marketing and retail and design management and the core textile science units where students are introduced to fibers, materials, fabrics and textile production processes. The second year builds on the principles introduced in the first year by exploring specific aspects of management and marketing with subjects such as product development, branding and textile technology. The third year is an opportunity to consolidate and extend specialist knowledge in areas of buying and merchandising. A final year project allows students to specialize in an area of their choices, for example focusing on developing a broader corporate strategy for a fashion business [25].

2.3 Germany

Hochschule Niederrhein – University of Applied Sciences is one of the significant universities of Germany which gives textile education. Undergraduate education of textile is given in Textile and Clothing Technology, Design Engineer and Textile and Clothing Management programs in Faculty of Textile and Clothing Technology. The period of study is 3.5 years (7 semesters). In Textile and Clothing Management Program the students take practical training in textile materials, yarn technology, fabric technology, business mathematics, general chemistry, organic chemistry, communication and presentation, project management, intercultural management, business English, technical English, project textile chain, clothing technology, pattern making, CAD construction of garments, computer applications, practical training computer applications, economics, business administration, business organization, process organization, internal accounting, external accounting, law in their first year as compulsory courses. They can also take a project as an elective course. In their second year they take internet and e-business, data management and statistics, nonwovens, weaving, knitting, textile coloration and finishing, quality control as compulsory courses. They can also take a project as an elective course. Starting from second year they take optional courses according to their specialization phase. These courses are product development process design, CAD 2D/3D clothing construction, advanced product engineering, clothing production machinery, clothing production engineering, design theory, color glass, multidimensional design, fashion theory, marketing, logistics and procurement, human resources management, ergonomics, controlling, global sourcing, product data management, production planning/control, spinning, manufacturing of technical textiles, application of technical textiles, ecology, weaving process, home textiles, textile products, narrow fabrics. In the specialization phase they also take compulsory courses as study work and project. In the last semester they take workshop scientific methods and workshop final thesis as compulsory courses [26].

In Textile and Clothing Technology Program the students take vector analysis and geometry, analysis and probability, fundamentals of chemistry, organic chemistry, chemistry laboratory, mechanics, technical drawing, physics laboratory, basics of IT, IT laboratory, internet and e-business, computer graphics, economics, business administration, cost and efficiency calculation,
marketing I, thread technology, surface technology, finishing and ecology, textile materials, textile materials laboratory, assembly technology, textile fabric, textile mesh, basics of clothing construction, basic design of men wear, basic construction DOB in their first year as compulsory courses. In their second year they take machine design and electrical drives, electrical and optical, organization theory, intercultural management, staff and leadership, labor and social law, project management and presentation technique, study work, technical textiles, statistics, applied quality management, basics of color measurement, method or yarn production, method of tissue preparation, method of knitting, technology of nonwovens, materials of technical textiles, application areas of technical textiles, equipment and coating, dyeing and printing, jacquard technology, tissue engineering technology, narrow fabrics, business mathematics, ergonomics, operating organization, marketing II, surfactants and auxiliary surfaces, CAD stem tissue, jacquard CAD, CAD clothing design, product data management, processing technology 1 and 2, manufacturing process, business mathematics, apparel machinery, fundamentals of interface design, special section design, special clothing construction 1 and 2 as compulsory courses. In their fifth semester they take projects, study work, logistics, process planning and control, applied performance technology, enterprise controlling, factory planning and special industrial engineering, technology of dyeing and printing, technology of equipment and coating, applied color measurement, CAD textile printing, CAD knitwear, special clothing machinery, model development classic, model development casual as compulsory courses. In their sixth semester they do optional internship in industry or they study abroad (in a foreign university). In their last semester they take methods seminar and seminar as compulsory courses. They can also take applied management science, applied market research, applied marketing, CAD assist, CAD system Lectra, CAD system Gerber, CAD system Grafis, CAD engineering drawing, introduction to numerical simulation, excel-intensive course, finite element method for textile, tissue engineering II, production of technical textiles, laboratory of braiding, laboratory of narrow fabrics, laboratory for technical textiles, macromolecular and colloid chemistry, laboratory of mesh technology, lingerie modeling, men’s underwear modeling, model development, stitch model development, online trading, fabric development, special areas in product development, knitting, special materials, technical weaving, business game, macromolecular chemistry, surfactant chemistry and fundamentals of color measurement as elective courses during their education [27].

In Design Engineer Program the students take mathematics, fundamentals of chemistry, basics of IT, IT laboratory, internet and e-business, computer graphics, thread technology, surface technology, finishing and ecology, textile materials, textile materials laboratory, assembly technology, textile fabric, textile mesh, object draw, nude and model drawing, creativity teaching, morphology, theory of color, presentation technique, product and fashion design, clothing construction, basic design of men wear, basic construction in their first year as compulsory courses. In their second year they take textile and costume history, design history and theory, art history, organization theory, business administration, marketing, cost and profitability statement, project management and presentation technique, study work, design
analysis, design methodology, method of yarn production, method of tissue preparation, method of knitting, jacquard technology, tissue engineering design, knit construction, jacquard CAD, applied performance, equipment and coating, dyeing and printing, textile design of printed products, textile design of woven and knitted products, design analysis, design methodology, processing technology 1 and 2, manufacturing process, basic grading, fundamentals of CAD clothing design, laboratory of CAD clothing design, fundamentals of interface design, special section design, clothing design, special clothing construction 1 and 2, clothing design of men wear, special clothing design of men wear 1 and 2 as compulsory courses. In their fifth semester they take project, CAD textile printing, technical textiles, collection development of printed products, collection development of woven and knitted products, collection design DOB, classic model development DOB, casual model development DOB, classic model development HAKA, collection design HAKA as compulsory courses. In their sixth semester they do optional internship in industry or they study abroad (in a foreign university). In their last semester they take methods seminar and seminar as compulsory courses. They can also take applied computer graphics, applied management science, applied market research, applied marketing, CA assist, CAD of stem tissue, CAD of flat knitting, CAD system Lectra, CAD system Gerber, CAD system Grafis, CAD sketch, CAD fashion illustration, computer-aided fashion design, designator, introduction to numerical simulation, excel-intensive course, basics of color measurement, production of technical textiles, make your own label, mesh technology laboratory, lingerie modeling, men’s underwear modeling, components of the product development, stitch model development, online trading, fabric development, software applications: textile design I, special CAD textile printing, special areas in the product development, knitting, business game, macromolecular chemistry, surfactant chemistry and fundamentals of color measurement, reinforced fabric as elective courses during their education [27].

2.4 Spain

UPC (Universitat Politecnica De Catalunya) is one of the significant universities of Spain which gives textile education. Undergraduate education of textile is given in Textile Technology and Design Department which is connected to engineering school. The period of study is 4 years. 240 credits (including the bachelor's thesis) are necessary for the graduation. One credit is equivalent to a study load of 25-30 hours. In this bachelor’s degree in Textile Technology and Design course, students will build on the common industrial engineering component and come to understand the fundamentals of textile materials and processes, the integral development of textile products and industrial garment making, linear textile structures and non-woven fabrics (technical and smart fabrics), processing and finishing operations, biopolymers, and global textile business logistics and management. When you complete it, you will be capable of understanding, selecting and using textile products and materials, including technical and smart fabrics; designing, optimizing and developing
technologies related to textile products and processes; supervising and managing textile companies [28].

The students take chemistry, economics and business administration, environmental technologies and sustainability, foundations of computing, graphic expression in engineering, materials science and technology, mathematical methods I, mathematical methods II, physics I, physics II as compulsory courses in their first year. Industrialization of mechanical projects is the only optional course of the first year. In their second year they take electric systems, electronic systems, fluid mechanics, industrial automation and control, materials for textile design, mathematical methods III, mechanical systems, probability and statistics, production organization, thermal engineering as compulsory courses. In their third year they take bleaching and dyeing design colorimetry, clothes making with textile structures, coloring agents and auxiliary materials, design of dying, printing and coating processes, design of laminar mesh structures, design of laminar net structures, design of nonwoven linear and laminar structures, dressing and finishing processes, integral development of textile products as compulsory courses. Technology, society and globalization: the sustainability challenge in the XX. century is the only optional course of the third year. In their fourth year they take innovation project management and project oriented methodology as compulsory lessons. They also take their bachelor’s thesis as project. Other courses (adjustments and numerical control, advanced programming, air conditioning systems and instrumentation, air pollution and treatment technologies, basic robotics, drives and transmissions, experimental design workshop product, initiation to paper and graphic industrial technologies, integral design of product, international projection of design, internship, jacquard design, mechanical CAD, modelization, complexity and sustainability, numerical methods for engineers, photonics, optics applied to engineering, plastic materials technology, polymers in engineering, practical design of goods and equipment, project of machines and mechanisms, treatment and reuse of black water, treatment and waste management, workshop in plastic objects design) are optional. They have to take at least 5 optional courses for graduation [28].

2.5 Turkey

Ege University is one of the significant universities of Turkey which gives textile education. Undergraduate education of textile is given in Textile Engineering Department which is connected to engineering faculty. The period of study is 4 years. 240 credits (including the bachelor's thesis) are necessary for the graduation. Ege University’s textile engineering department is the only department in Turkey which gives an education under three different optional programs; textile technology, textile chemistry and finishing, apparel manufacturing.

In textile technology program the students take Turkish language I, Ataturk’s principles and history of Turkish revolution I, mathematics I, physics I, natural fibers, chemistry, organic chemistry, computer, introduction to university life, foreign language I, social service applications, Turkish language II, Ataturk’s principles and history of Turkish revolution II,
economics, mathematics II, physics II, statistics, statics, materials science, chemical fibers, foreign language II in their first year as compulsory courses. In their second year they take mathematics III, dynamics, principles of spinning, textile chemistry I, general business, electronics, strength of materials, principles of weaving, principles of textile finishing, mathematics IV, principles of knitting, principles of apparel manufacturing, physical textile testing I, business management, technical drawing, principles of dyeing and printing as compulsory courses. Also at the end of their second year they have to do a three-week summer internship. In their third year they take physical textile testing II, machine elements, cotton spinning I, wool spinning I, woven fabric construction, factory organization, thermodynamics and heat transfer I, mechanism technique, cotton spinning II, wool spinning II, preparation of weaving, weft knitting, fabric analysis as compulsory lessons. They also take four technical elective courses and they do a three-week summer internship. In their fourth year they take work study in textiles, weaving machines, warp knitting, nonwovens II, quality control, system analysis and design, graduation project (bachelor’s thesis), cost accounting, modern spinning processes, chemical textile testing I, business law, technical textiles, fabric information as compulsory courses. They also take two technical elective courses and two social elective courses [29].

In textile chemistry and finishing program the students take Turkish language I, Ataturk’s principles and history of Turkish revolution I, mathematics I, physics I, natural fibers, chemistry, organic chemistry, computer, introduction to university life, foreign language I, social service applications, Turkish language II, Ataturk’s principles and history of Turkish revolution II, economics, mathematics II, physics II, statistics, statics, materials science, chemical fibers, foreign language II in their first year as compulsory courses. In their second year they take mathematics III, dynamics, principles of spinning, textile chemistry I, general business, electronics, strength of materials, principles of weaving, principles of textile finishing, mathematics IV, principles of knitting, principles of apparel manufacturing, physical textile testing I, business management, technical drawing, principles of dyeing and printing as compulsory courses. Also at the end of their second year they have to do a three-week summer internship. In their third year they take physical textile testing II, analytical chemistry, macromolecular chemistry, physical chemistry, basic textile finishing treatments, nonwovens I, factory organization, thermodynamics and heat transfer I, fluid mechanics, pretreatment processes in textile finishing, dyestuff chemistry, textile auxiliary agents, textile dyeing I, textile chemistry II as compulsory lessons. They also take two technical elective courses and they do a three-week summer internship. In their fourth year they take textile dyeing II, textile printing, chemical textile testing II, quality control, system analysis and design, graduation project (bachelor’s thesis), cost accounting, finishing processes, color information and measurement, business law, technical textiles, fabric information as compulsory courses. They also take two technical elective courses and two social elective courses [29].

In apparel manufacturing program the students take Turkish language I, Ataturk’s principles and history of Turkish revolution I, mathematics I, physics I, natural fibers, chemistry, organic
chemistry, computer, introduction to university life, foreign language I, social service applications, Turkish language II, Ataturk’s principles and history of Turkish revolution II, economics, mathematics II, physics II, statistics, statics, materials science, chemical fibers, foreign language II in their first year as compulsory courses. In their second year they take mathematics III, dynamics, principles of spinning, textile chemistry I, general business, electronics, strength of materials, principles of weaving, principles of textile finishing, mathematics IV, principles of knitting, principles of apparel manufacturing, physical textile testing I, business management, technical drawing, principles of dying and printing as compulsory courses. Also at the end of their second year they have to do a three-week summer internship. In their third year they take machine elements, pattern drawing I, apparel machines I, work study in apparel I, physical textile testing III, production applications in apparel I, materials of apparel manufacturing, factory organization, fashion-collection design and management I, thermodynamics and heat transfer II, computer aided apparel design I, mechanism technique, chemical textile testing III, pattern drawing II, apparel machines II, work study in apparel II, production applications in apparel II, fashion-collection design and management II, computer aided apparel design II as compulsory lessons. They also take one technical elective course and they do a three-week summer internship. In their fourth year they take pattern drawing III, organization and planning in apparel I, quality control in apparel, apparel model application in CAD system I, system analysis and design, graduation project (bachelor’s thesis), cost accounting, organization and planning in apparel II, business law, apparel model application in CAD system II, fabric information as compulsory courses. They also take two technical elective courses and two social elective courses [29].

Technical elective courses are; nonwoven textiles and recycling, natural fibers, spinning technology, energy management I, coating and lamination, process analysis in apparel manufacturing, production processes and management in fashion industry, production techniques of special clothes, pattern design in textile printing, garment technology, computer applications in textile engineering, patterning on flat knitting machines I, texturing, finishing technology, analyses of woven fabrics, hosiery technology, energy and water recovery in textile finishing mills, synthetic fibers, knitting technology, special fabrics with high performance, energy management II, factory organization of dyeing and finishing, ergonomics and textile, pattern drawing of lingerie, leather garment technology, nonwoven technical textiles and composites, quality control in textiles, supply chain in textile, introduction to technical textiles, automatic control, machine dynamics, factory organization in textiles, analysis of knitted fabrics, patterning on flat knitting machines II, color measurement in textiles, ornamentation techniques in apparel, design in textiles and new product development. Social elective courses are; general sociology, communication, marketing, ethics in life and engineering, basics of business management and managerial skills for engineers, German I, history and philosophy of science, work safety and worker’s health in textile, customer relationship management, entrepreneurship, German II [29].
3. Conclusions and General Evaluation

As it can be seen from our research, textile engineering education doesn’t only focus on technical information and skills. Textile engineering education gains social information and abilities as well as technical information and skills. Nowadays, there are many universities which give textile engineering education. However, the contents, study periods and institutions vary in terms of countries. In our study, the education programs of leading universities throughout the world, which give textile engineering education, are comparatively analyzed. For this purpose, curriculums of five different universities, which give Bachelor of Science Degree (B.Sc.), from five different countries (USA, United Kingdom, Germany, Spain, Turkey) are analyzed.

According to the results of our research, study periods differ in terms of countries. Textile education lasts for 4 years in USA, Spain and Turkey whereas it lasts 3 years in United Kingdom and 3.5 years in Germany. There is only one education program in UPC (Spain) whereas there are three programs in Ege University (Turkey) and Hochschule Niederrhein (Germany). The University of Manchester (UK) possesses five programs whereas North Carolina State University (USA) has 14 programs. As it can be seen USA gives the maximum opportunity in terms of specialization.

Our research results also indicate the leading education fields and differences and similarities between textile education programs. In North Carolina State University, students can specialize in fashion and textile management, fashion and textile design, polymer and color chemistry, textile engineering and textile technology. All of the students have to take fundamental courses of textiles (such as fiber and yarn technology, weaving, knitting, finishing, nonwovens, apparel, technical textiles), science courses (such as mathematics, chemistry, physics) and university’s social courses. Design students take science courses in minimum level whereas management students take in intermediate level. Design students intensively take drawing and design courses whereas management students take intensive management, marketing, economy and supply chain management courses. Students who specialize in polymer and color chemistry take intensive polymer and chemistry courses. On the other hand, the students in textile engineering and textile technology programs take intensive textile courses. Both programs include a specialization area of medical textiles/science. Also all students can take technical elective courses according to their specialization areas.

In University of Manchester, students can specialize in textile science and technology, fashion retail, fashion buying and merchandising, fashion marketing and fashion management. All of the students have to take fundamental courses of textiles. Besides the students in textile science and technology concentrate on science courses whereas the students of fashion retail program concentrate on courses related to retail. The students of fashion buying and merchandising, fashion marketing and fashion management take intensive marketing, management and retail courses. Also all students take a final year project.

In Hochschule Niederrhein, students can specialize in textile and clothing management, textile and clothing technology and design engineering. All of the students have to take science courses
and fundamental courses of textiles. Textile and clothing management students take intensive management, economy and marketing courses whereas textile and clothing technology students take intensive textile science courses. On the other hand design engineering students take intensive drawing and design courses. Also all students can take technical and social elective courses according to their specialization areas. Besides, they take semester seminar or workshop final thesis in the last semester.

In UPC, students can only specialize in textile technology and design. The students take intensive science courses and fundamental courses of textile. They take management and economy courses minimally. They also take bachelor’s thesis as project in their last year.

In Ege University, students can specialize in textile technology, textile chemistry and finishing and apparel manufacturing. All of the students have to take science courses, fundamental courses of textiles and fundamental courses of economy, business and management. They also take bachelor’s thesis as project in their last year. Besides, they must take social elective courses and technical elective courses according to their specialization areas.

As it can be seen from our study textile engineering education differ in terms of countries, study periods, specialization areas, compulsory and elective courses. However, all universities are affected from each other due to globalization movements. Therefore there are similarities in terms of fundamental textile courses and science courses. But depending on the development level of the country and historical background of country’s textile and clothing industry, the textile courses, social courses (management, economy, marketing etc.), technical elective courses and their intensiveness alter. The countries prefer to give education in terms of their industries’ specialization areas.

References

[29] Curriculum of Ege University’s Textile Engineering Department for 2014-2015 (in Turkish)
ANALYSIS OF LEARNING INTERVENTIONS AMONG STUDENTS OF CLOTHING TECHNOLOGY

G. Ćubrić¹, I. Salopek Ćubrić²

¹ Department of Clothing technology, Faculty of textile technology, University of Zagreb, Croatia
gcubic74@gmail.com

² Department of Projecting and Management of Textiles, Faculty of textile technology, University of Zagreb, Croatia,
ivana.salopek@ttf.hr

Keywords: learning, interventions, survey, clothing technology

Abstract

The aim of this paper is to get insight the interventions on student learning that are likely to lead to success. The perception of students is observed at different levels of higher education and the differences are reported. The participants in this study are students that attend Faculty of textile technology, Clothing technology courses at three different levels of education. The outcomes of this study pointed out that students at different level of educational process agree that the most important learning intervention is teacher style. Among the remaining offered interventions, as the most important were identified instructional quality and class environment.

1. Introduction

The educational institutions give great effort to the improvements of teaching and approaches to teaching, in order to assist successful learning. Also, many institutions are re-examining the fundamental question of what it means to be educated in the 21st century and are experimenting with alternatives designed to enhance successful learning. For each learner, it is important to define a proper learning style or method to be used. According to some authors, wrongly selected method of learning can do more harm than one can imagine. Some authors report that an individual's learning orientation, and therefore their approach to learning, is partially determined by their personality [1, 2]. The others report that age is very important variable in student's approaches to learning [3, 4] and should be seriously taken into account when defining main competencies.
It also has to be taken into account that the improvement of learning can also be done by interventions outside the normal teaching context. By the term “normal teaching context” is considered the one in which teaching is principally focused on the content to be taught and learned. An innovation or other shift from “normal teaching” becomes an intervention when it:

- is outside what the teacher involved in the study intended to do in the course of teaching;
- requires an outside person to design and evaluate the intervention;
- involves a formal experimental design that includes provision for evaluating the effects of the intervention and
- focuses on independent variables that aim to increase various kinds of performances, usually including academic performance but going beyond content learning itself [5].

The aim of this paper is to get insight into the interventions on student learning that are likely to lead to success. The perception of students is observed at different levels of higher education and the differences are reported. The secondary aim of the paper is to raise awareness of the importance of interventions for learning, but also for the success in the future employment.

2. Methodology

Survey methodology was selected as the most suitable to test the study’s objectives, i.e. student’s perception of the most important interventions that encourage their learning process. For the purpose of the research was developed a questionnaire consisted of two parts:

1. Personal information relevant for the survey,
2. Assessment of the level of importance of a single intervention for success in learning.

As the most important interventions are defined the following: reinforcement, student's prior cognitive ability, instructional quality, direct instruction, student's disposition to learn, class environment, peer tutoring, parental involvement, teacher style, affective attributes of students, individualization, behavioural objectives and team teaching.

In the first part of survey, related to personal information, students were asked to define their age, gender, school they completed before enrolment at the university and module they enrolled. In the second part, students are asked to grade the importance of each intervention for the success in learning and achievement of excellence in learning process. For the assessment is used Likert scale - a psychometric scale commonly involved in research that employs questionnaires. It is the most widely used approach to scaling responses in survey research. In this case is used a format of a typical five-level Likert item, as follows: 1 - strongly disagree, 2 – disagree, 3 - neither agree nor disagree, 4 – agree and 5 - strongly agree.

The participants of this study are students that attend courses at three different levels of education. The first group of participants completed a three-year or four-year high school education and attend the second year of professional study. Second group of participants completed four years of secondary education and attends the last semester of undergraduate
study. The third group of participants has undergraduate education degree (Bachelor) and attends the last semester of graduate program. The socio-economic indicators are given in the Table 1.

<table>
<thead>
<tr>
<th>Group</th>
<th>Age</th>
<th>Gender (male:female)</th>
<th>Elementary education (gymnasium : vocational school)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>20-33</td>
<td>25%:75%</td>
<td>0%:100%</td>
</tr>
<tr>
<td>II</td>
<td>21-25</td>
<td>11%:89%</td>
<td>44%:56%</td>
</tr>
<tr>
<td>III</td>
<td>24-26</td>
<td>20%:80%</td>
<td>20%:80%</td>
</tr>
</tbody>
</table>

3. Results and discussion

Statistical analysis of data obtained through questionnaires, regarding the perception of most/least important interventions for learning, is shown in the Tables 2-4. Each table brings the results given by a single group of participants.

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Percentage of single grade</th>
<th>Mean</th>
<th>CV</th>
<th>ST DV</th>
<th>Variance</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Reinforcement</td>
<td>-</td>
<td>-</td>
<td>25</td>
<td>74</td>
<td>-</td>
<td>3,75</td>
</tr>
<tr>
<td>Student's prior cognitive ability</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>50</td>
<td>-</td>
<td>4,25</td>
</tr>
<tr>
<td>Instructional quality</td>
<td>-</td>
<td>-</td>
<td>25</td>
<td>25</td>
<td>50</td>
<td>4,25</td>
</tr>
<tr>
<td>Direct instruction</td>
<td>-</td>
<td>-</td>
<td>25</td>
<td>75</td>
<td>-</td>
<td>3,75</td>
</tr>
<tr>
<td>Student's disposition to learn</td>
<td>-</td>
<td>-</td>
<td>25</td>
<td>50</td>
<td>25</td>
<td>4,00</td>
</tr>
<tr>
<td>Class environment</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>75</td>
<td>25</td>
<td>4,25</td>
</tr>
<tr>
<td>Peer tutoring</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>50</td>
<td>-</td>
<td>2,50</td>
</tr>
<tr>
<td>Parental involvement</td>
<td>25</td>
<td>-</td>
<td>75</td>
<td>-</td>
<td>-</td>
<td>2,50</td>
</tr>
<tr>
<td>Teacher style</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>50</td>
<td>4,50</td>
</tr>
<tr>
<td>Affective attributes of students</td>
<td>-</td>
<td>25</td>
<td>25</td>
<td>50</td>
<td>-</td>
<td>3,25</td>
</tr>
<tr>
<td>Individualization</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>0</td>
<td>4,00</td>
</tr>
<tr>
<td>Behavioural objectives</td>
<td>-</td>
<td>25</td>
<td>50</td>
<td>-</td>
<td>25</td>
<td>3,25</td>
</tr>
<tr>
<td>Team teaching</td>
<td>-</td>
<td>50</td>
<td>25</td>
<td>25</td>
<td>-</td>
<td>2,75</td>
</tr>
</tbody>
</table>
Table 3. Descriptive statistics of grades for group II

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Percentage of single grade</th>
<th>Mean</th>
<th>CV</th>
<th>ST DV</th>
<th>Variance</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Reinforcement</td>
<td>22</td>
<td>11</td>
<td>44</td>
<td>22</td>
<td>-</td>
<td>2.67</td>
</tr>
<tr>
<td>Student’s prior cognitive ability</td>
<td>11</td>
<td>11</td>
<td>44</td>
<td>11</td>
<td>11</td>
<td>3.11</td>
</tr>
<tr>
<td>Instructional quality</td>
<td>-</td>
<td>-</td>
<td>22</td>
<td>33</td>
<td>44</td>
<td>4.22</td>
</tr>
<tr>
<td>Direct instruction</td>
<td>-</td>
<td>11</td>
<td>33</td>
<td>11</td>
<td>44</td>
<td>3.89</td>
</tr>
<tr>
<td>Student’s disposition to learn</td>
<td>11</td>
<td>33</td>
<td>33</td>
<td>22</td>
<td>-</td>
<td>3.56</td>
</tr>
<tr>
<td>Class environment</td>
<td>22</td>
<td>11</td>
<td>11</td>
<td>22</td>
<td>33</td>
<td>3.33</td>
</tr>
<tr>
<td>Peer tutoring</td>
<td>-</td>
<td>22</td>
<td>44</td>
<td>22</td>
<td>11</td>
<td>3.22</td>
</tr>
<tr>
<td>Parental involvement</td>
<td>11</td>
<td>22</td>
<td>-</td>
<td>55</td>
<td>11</td>
<td>3.33</td>
</tr>
<tr>
<td>Teacher style</td>
<td>-</td>
<td>11</td>
<td>-</td>
<td>44</td>
<td>44</td>
<td>4.22</td>
</tr>
<tr>
<td>Affective attributes of students</td>
<td>11</td>
<td>33</td>
<td>44</td>
<td>11</td>
<td>-</td>
<td>3.56</td>
</tr>
<tr>
<td>Individualization</td>
<td>-</td>
<td>22</td>
<td>22</td>
<td>33</td>
<td>22</td>
<td>3.56</td>
</tr>
<tr>
<td>Behavioural objectives</td>
<td>11</td>
<td>11</td>
<td>44</td>
<td>33</td>
<td>-</td>
<td>3.00</td>
</tr>
<tr>
<td>Team teaching</td>
<td>22</td>
<td>33</td>
<td>-</td>
<td>44</td>
<td>-</td>
<td>2.67</td>
</tr>
</tbody>
</table>

Table 4. Descriptive statistics of grades for group III

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Percentage of single grade</th>
<th>Mean</th>
<th>CV</th>
<th>ST DV</th>
<th>Variance</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Reinforcement</td>
<td>-</td>
<td>-</td>
<td>20</td>
<td>80</td>
<td>-</td>
<td>3.80</td>
</tr>
<tr>
<td>Student’s prior cognitive ability</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>80</td>
<td>20</td>
<td>4.20</td>
</tr>
<tr>
<td>Instructional quality</td>
<td>-</td>
<td>-</td>
<td>20</td>
<td>60</td>
<td>20</td>
<td>4.00</td>
</tr>
<tr>
<td>Direct instruction</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>80</td>
<td>20</td>
<td>4.20</td>
</tr>
<tr>
<td>Student’s disposition to learn</td>
<td>-</td>
<td>-</td>
<td>20</td>
<td>40</td>
<td>40</td>
<td>4.20</td>
</tr>
<tr>
<td>Class environment</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>60</td>
<td>40</td>
<td>4.40</td>
</tr>
<tr>
<td>Peer tutoring</td>
<td>-</td>
<td>-</td>
<td>20</td>
<td>60</td>
<td>20</td>
<td>4.00</td>
</tr>
<tr>
<td>Parental involvement</td>
<td>-</td>
<td>20</td>
<td>20</td>
<td>40</td>
<td>20</td>
<td>3.60</td>
</tr>
<tr>
<td>Teacher style</td>
<td>-</td>
<td>-</td>
<td>20</td>
<td>20</td>
<td>60</td>
<td>4.40</td>
</tr>
<tr>
<td>Affective attributes of students</td>
<td>-</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>40</td>
<td>3.80</td>
</tr>
<tr>
<td>Individualization</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>60</td>
<td>40</td>
<td>4.40</td>
</tr>
<tr>
<td>Behavioural objectives</td>
<td>-</td>
<td>-</td>
<td>20</td>
<td>40</td>
<td>40</td>
<td>4.20</td>
</tr>
<tr>
<td>Team teaching</td>
<td>-</td>
<td>-</td>
<td>20</td>
<td>60</td>
<td>60</td>
<td>4.60</td>
</tr>
</tbody>
</table>
From the descriptive statistics shown in the tables 2-4, it is well seen that there is a high consistency between all participating students regarding the most important learning intervention. Namely, all three groups of students have rather high opinion about the influence of teacher style to their learning outcomes. The mean values of grades obtained for this learning intervention are in the range 4.22-4.50. The named intervention is followed by instructional quality (grades 4.00-4.22). Groups I and III also point out at the class environment (average grades 4.25 and 4.40), while the group III additionally outlines the importance of team teaching and individualisation.

In this study, as the interventions that are not important for learning are defined those that obtained average grades lower than 3.00, i.e. with description disagree and strongly disagree. The members of group I gave the lowest grades to peer tutoring and parental involvement. Considering the fact that the members of remaining two groups gave higher grades to the influence of parental involvement, there is a certain possibility that the members of the first group are unwilling to acknowledge the parental influence. It is also interesting to note there was highest variation of given rates within group I for the named intervention (coefficient of variation is 34.64%). Rather low grades by both first and second group are given to team teaching (average grades 2.75 and 2.67). It is important to point out that the members of third group (students that attend the last semester of graduate program) did not rate any intervention by average grade lower than 3.60.

4. Conclusion

The importance of interventions for success in learning is recognised, but in many educational institutions, this knowledge may not be adequately utilized. The outcomes of this study pointed out that students at different level of educational process agree that the most important learning intervention is teacher style. This finding definitely should have positive effect on teachers and encourage them towards further efforts to remodel or improve their own style.

Among the remaining offered interventions, as the most important were identified instructional quality and class environment. Therefore, each teacher may think of additional measures that may affect named two interventions and thus provide an additional contribution to the success of learning.
References:


COMPUTERIZED SELECTION OF MATERIALS FOR TENTS, USED IN THE LIGHTWEIGHT CONSTRUCTIVE STRUCTURES

Sh. Caslli

Production and Management Department - Mechanical Engineering Faculty at Polytechnic University of Tirana; Square ‘Nënë Teresa’ No. 4, Tirana, Albania
shcaslli@fim.edu.al

Keywords: Tent, Computerized Selection, Two Axially Tensile, Warp and Weft Fiber, Tear.

Abstract

This paper is presented in the form of a methodological Case Study, prepared for the 3rd year Bachelor students in 'Materials Science' course, Textile Department - University of Ghent, Belgium.

As in any Case study, the aim is to present a full procedure for the selection of materials in technical textiles products, used as lightweight constructive elements: mainly for temporary covering in structural facilities. The method of computerized selection for tent materials is applied through CES EduPack 2012 software. According to this method, initially are set the design requirements for problem solving: the Function of the product (tent), Constraints it should meet and the Objectives/Targets. Based on this combination: Function, Constraints and Objectives/Targets, calculates the performance indices and then it passes to the selection procedure. This procedure goes through several stages; first is screening, where the largest amount of records contained in the database is selected by the help of performance indexes and limit properties, while the last stages of selection are linked with constraints that depend on the local conditions of product application. Two databases of CES EduPack 2012, each independently, are used: one is for 'Architecture and the Built environment' and the other is a custom database, which we have built specifically for textile products used for this purpose. The winning record according to procedure 1 is a plasticized fabric, while refining selection is done for plastic records that serve to coat the textile fabrics (procedure 2). In conclusions this paper suggests to create and enrich a specific database with material records used for textile products within the CES program; creation of specific attributes of records to be suitable for computerized selection and acquisition advantages of material selection methods by students of the 'Textile
Engineering'. The aim is for the students to draw up of rigorous problem requirements for the design of specific textile products, in order to do an optimal selection and find materials with high performance.

**Introduction**

‘Tent’ term, in Albanian language has two meanings: first, a shelter or a material draped over a ‘lightweight and temporary constructive structure’- called as ‘tent’, and second for the ‘product’ consisting of sheets of fabric, rubber, plastic, etc., called as ‘rubber or plastic coated fabrics’.

Tents are several types and mainly classified according to their size and by usage. There are small tents as tents for camping, which should be even lighter: small because do not occupy a lot of room, space and light, as will be transferred by the people to the place of camping; huge tents as military, circus, stadium or celebrations outdoors. In more general terms tents provide maximum protection from the sun, such are tents for windows or balconies, sun umbrellas and typically used as overhead shelter for festivals, weddings, backyard parties, and major corporate events. They are also used for excavation (construction) covers, industrial shelters. In the case of camping tents, they serve to protect against insects for a peaceful sleep at night, but also from various weather conditions, especially wind, rain or light snow.

Textile fabrics for tents can be prepared from cotton, wool, nylon and polyester fibers. Cotton fabrics are not suitable because they become wet from rain and heavy from the moisture absorption; this is among the main reasons why they dress up paraffin, to become more resistant to it. While fabrics of nylon or polyester fibers are lighter than those of cotton, and absorb much less water. With a suitable outfit, they become more resistant to water and environment moisture; their flaw is that over time they decolorized by the action of ultraviolet rays. These days, most manufacturers of quality tents use nylon or polyester fabrics. They each have their strengths, and technological advances are improving the weight, durability and water resistance of both materials. Tent fabric weight and coating differ from tent to tent, depending on manufacturing quality and the specific tent purpose.

What should consider a designer when he is selecting materials for tents?

- For what will serve tents? What is its function? It is a sun or camping tent? In the first type the fibers of fabric are rubberized and do a well breathe, while the second of the tent type, its fabric is coated with plastic coating layer. Coatings on one or both sides guarantee the integrity, contribute to the protection of the fabric against mechanical damage, atmospheric influence and also against damage caused by animals, plant and chemical agents [1];

- **Tensile mechanical behavior** – Tents are loading in biaxial tensile. The designer have to do the calculation of monoaxial tensile in warp and weft direction (are most of the time sufficient for design) and should refer the obtained results the tensile properties measured by means of relevant test according EN ISO 1421 [1];
- **Tear strength** – In order to assess the risk of propagation of a tear due to lack of quality of the coated fabric or to an accident, the tear strength performances of a coated fabric shall be measured according to EN 1875-3 and declared by the manufacturer [1];

- **Coating adhesion** – The adhesion between the base fabric and the coating layer of the membrane material shall be assumed by coating adhesion tests according to Annex B [1];

- **Dimensional stability** – during its life the tent membrane made up of coated fabric is submitted to many environmental loads (wind, snow, rain) and many mounting and dismantling of the structure. In order to limit any dimensional change of the membrane panels during the life of the tent, the fabric shall be dimensionally stable. The dimensionally stability of the fabric shall be measured in both directions according to the test method described in C.1. [1];

- **Color fastness to weathering and light** – Color fastness is assessed by comparison with the grey scale and specimens exposed for 2000 h to artificial ageing and non-exposed specimens. The ageing procedure detailed in Annex A is based on EN ISO 4892-3 exposure mode 1 (UV, moisture cycle and elevated temperature) that simulate the outdoor natural ageing [1];

- **Susceptibility to the development of microorganisms** – In some climatic and environmental conditions, microorganisms may fix and develop on the surface of coating. Their presence may damage the coating layer itself (discoloration, degradation of plastic coating) and may also hinder the use of coated fabric membrane. The manufacturer of coated fabric shall ensure that the coated fabric is treated with the adapted treatment or sufficiency resistant to the action of microorganisms according to EN ISO 846 [1];

- **Reaction to fire** – In order to protect peoples against the risk of full development of fire, the coated fabrics used for tent or related structures shall have an appropriate reaction to fire behaviour. For the purpose, the coated fabrics shall be tested according to EN 14115. Materials shall be classified in 4 categories (T1, T2, T3, T4) or declared ‘Non classified’. During the test (for level T1, for example) afterflame times shall not exceed 5 seconds in any of the specimens tested any growing propagation effect shall not exceed 25 mm from the lower edge of the specimen [1];

- **Lightweight and low cost** - These requirements constitute the objectives of their design.

### The presentation of engineering problem

Design and select the materials for tent with high performance; Tent will be use as a shelter that draped over a barrack with dimensions: length, 24m x width, 10m, height 2.5m + height roof, 1.2m. The structure is build with steel pipe profiles (as in Fig. 1) and serve as safety of temporary structure for up to 3 years.

The Study case will be the safety of a temporary structure, a barrack near an industrial center and will serve as cafeterias and fast food for the employees. The geographical area of this industrial center is the district of Tirana, about 10 km north of the capital. The Mediterranean climate and weather conditions in this geographical area characterized by mild winter: average rain,
infrequent frosts and sometimes light snow; summers are hot with temperatures up to 40-42 °C. The design and material selection for tent is required to do as four-season tent: it should be suitable for winter in the most extreme conditions, should be strong enough to cope with heavy snow, strong winds, as well as heavy rain.

**Fig. 1.** The completed barrack (above); fragments from the process of installation of membrane coating (Pictures of built object from ‘Tenda Dielli’shpk, Autostrada Tirana-Durres, km 12).

**Material selection for tents: Method, Procedures and Results**

Traditionally, according to a recognized engineering practice, cover tent – roof of temporary structure have to calculate to be resistant against wind pressure, $P_w = 60 \text{ daN/m}^2$ and loading from snow weight, $P_s = 75 \text{ daN/m}^2$ [4]; must be elastic, flexible and in the membrane form; waterproof – to resist the absorption of water (rain, snow); does not decolorized by the action of UV radiation; should not allow the adherence of dirt, stains and foreign materials; should have dimensional stability, slow reaction to fire, low cost and should be more environmentally friendly, because serve as a material draped over of a temporary structure.
In this paper we will describe a Case Study of the selection of materials through Ashby method for tents, as light structural element of temporary constructive structures.

**The essence of Ashby’s Method and the algorithm of material selection;**

The essence of this method consists in “screening” by a certain algorithm for all possible alternatives that are included in the available database. A combination of properties and characteristics is used as a screening tool which synthesizes the usage value of the object and which is found in the performance indexes as well. The best solution will be the one which maximizes the performance of component (P), which in universal appearance is expressed through the equation [2, 3]:

\[
P = \left[ (function \ requirements), (geometric \ parameters), (property \ of \ material) \right]
\]  

The algorithm of selection predicts the gradual limitation of research zone through constraints which become more and more restrictive until the identification of few records that in the long run can be compared according to the informal engineering considerations in analytic relations [2]. As selector environments for this Case Study have served two databases: ‘Architecture and the Built Environment ’ and the other created by the user (‘Custom db’) in the CES EduPack 2012 software (Cambridge Engineering Selector) [8]. For this case are two databases used separately, and then they respond to two selection procedures, which will describe one after another, until we arrive at a short list of winning candidates.

**Determination of design requirements**

The Ashby approach is 'design-led'. It starts by asking 'What is the function of the component in the design?', 'What objectives need to be optimized and what constraints must be satisfied?' [3]. For our instance, tent as a shelter (cover/roof) of temporary structure (function) needs to be as
light and as cheap (low cost) as possible (objectives) for a specified tensile strength, tear strength, durability stability (geometric), etc. [1] (constraints). With these dates we can express formally the objective (objectives) of designing and constraints that are put up against it (Table 1), a way that will serve us to search the optimized solutions.

Table 1: Design requirements: Function, constraints and objectives of materials for tent

<table>
<thead>
<tr>
<th>Function</th>
<th>Tent, a coated fabric that draped over metallic pipes construction of a temporary structure; The cover/roof consider as a panel loaded in biaxial tensile.</th>
</tr>
</thead>
</table>
| Constraints | Form: membrane;  
Tensile strength break (warp/weft) before ageing > 280/280 daN/5cm (EN ISO 1421) [1]*;  
Tear strength (warp/weft) > 10/10 daN (EN 1875-3) [1];  
Elongation under load (warp/weft) < 2/2% [1];  
Colour fastness to weathering and light >3 grey scale [1];  
Water penetration > 60 kPa (ISO 1420) [1];  
Aesthetic requirements;  
Length, width specified. |
| Objectives | Minimize of mass: light weight;  
Minimize of cost  
Minimize of embodies energy – environmental cost. |

*When we are defining the Constraints for material selection of textile product, it is specific that their values are referred the standards [1].

**Determination of the main performance index**

To make the "screening" of records that contain in these databases, according Ashby’s Method, the engineer designer is needed to calculate the performance index based on the analysis of membrane compute model [5]. Being based on the constraints, we define the analytic relations that connect the function requirements (the resultant load, $P$) with geometric parameters of the tent panel and the properties of material. Determination of deflection caused from resultant load, $P$: wind pressure and weight of more thickness snow layer (Fig. 3 & 4), will be our performance index [4].
Fig. 3. Deflection, $\delta$, that caused by loading of snow weight, $W_s$

Fig. 4. Deflection, $\delta$, that caused by loading of wind pressure, $P_w$

As we can see from this relation (Eq. 2), deflection, $\delta$, that will be the main performance index is expressed from resultant load (blue circle - function), Young’s Modulus (red circle – property of materials) and a geometric parameter, as Second Moment Areas (orange circle). For our Case Study is calculated [4]: $\delta = 34 \text{ mm} < [\delta] = 40 \text{ mm}$ [1], according of elongation constraint; it is calculated linear tensile strength in each of two directions caused by biaxial loading: $\sigma_{\text{warp}} = 9.24 \text{ daN/cm}^2$ and $\sigma_{\text{weft}} = 289 \text{ daN/cm}^2$ [4] where $[\sigma] > 280 \text{ daN/5cm}$ [1].

$$M = \delta^3 = \frac{P \cos \alpha}{E \left( \frac{l_1}{a^3} + \frac{l_2}{a^3} \right)}$$
Procedure 1: Computerized Material Selection on ‘Architecture and Built environment’ database.

This database contains a total of 127 material records. This database is used for the selection of structural building products and material records containing here will respond to this aim.

Limit Stage 1. In properties sessions: ‘Material form’ and ‘Building system’

This selection of materials for tents aims the form of product, as ‘sheet’ – first constraint and its function as ‘enclosure’ constructive elements of barracks – the cover/roof, for a constructed object that can be classified for ‘service’ [7]. These constraints in this stage will select just those building materials that are fibrous and serve as tent fabric.

![Image of CES Selector interface](image)

Fig. 3. A fragment from CES Selector interface in ‘Architecture and Built environment’ db, for screening on three attributes [6, 8].

With first three constraints the number of records that becomes candidates for next stage of selection process, step by step is screened in 83 and then in 41 of 127 material records. Let narrow the number of them by selection in ‘Hydro-thermal properties’ session where add ‘Good’ for ‘Frost resistance’ and there are only 11 candidates that pass this stage.

Graph Stage 2, Light materials for tents with low embodies energy

Winner candidates should have their density less 1000 kg/m$^3$ and their Embodies energy, primary production, less 100 MJ/kg (objectives). There are 3 winning candidates: ‘Cork’, ‘Geotextiles’ and ‘Duck, canvas, sailcloth and drill’.
Limit Stage 3, ‘Durability in Fresh Water, Rural and Marine atmosphere’

After this selection stage remain only two candidates: ‘Cork’ and ‘Duck, canvas’; ‘Geotextile’ record failed. Understandably ‘cork’ material is not used for tents and winning candidate remains: ‘Duck, canvas, sailcloth and drill’. This record is widely used for tent fabrics. Our selection according to this database, 'Architecture and Built environment', is not complete and correct, because many of the candidates that are used for tents in engineering practical are excluded from this selection, because of they do not contained in it. That has happened because these material records don’t contain in their attribute profiles a session of them, Mechanical properties, the lack of which causes them (records) to be excluded from the selection through performance index (2).

That is the reason why we have created another database, called ‘Custom’ that contains records according to designer criteriors from these material classes: Fibers & Particulate (Naturals and Polymers), Elastomers and Plastics: 676 records in total.

Procedure 2: Material selection on ‘Custom’ database

Limit Stage 1. In properties session ‘Material form’

Initially we are looking for light materials (objective) with density, \( \rho < 1250 \text{ kg/m}^3 \) (fabric of calculated tent with thickness \( t = 0.5 \text{ mm} \) has density of 607 gr/m\(^2\) or 1210 kg/m\(^3\) [4]); for coated
fabrics: add ‘Coated / laminated structure’ and ‘Other’ (function). There are 244 records of 676 that pass this stage.

Graph Stage 2, Strength materials for tents with high Toughness

Among the most important constraints imposed on materials for tents is tensile strength in both axial directions and tear strength, otherwise expressed with Toughness, \( T = \frac{K_{IC}^2}{E} \). Candidate records that pass this stage, according to the constraints shown in plotted graph chart (Fig. 6), are 110 records: mainly from classes: Elastomers and Plastics.

---

**Fig. 5.** A fragment from CES Selector interface in ‘Custom’ db, for screening on two attributes [8].

**Fig. 6.** Tensile strength plotted against Toughness; selection window requires the materials with \( \sigma \geq 4 \text{ MPa} \) and \( T = \frac{K_{IC}^2}{E} \geq 10 \text{kJ/m}^3 \) [8]
Graph Stage 3, Materials with high elongations, but low cost

By screening material records for tents they should be more elastic, for this the winners will have the average elongation > 200%, but nevertheless the price or cost of the product should be more reasonable (<10 Euro/kg) [8]. After this stage, are 86 winning candidates.

![Graph Stage 3](image)

**Fig. 7.** Elongation (%) plotted against the price (€/kg); searching window is put in the left top corner

Graph stage 4, Materials with high tensile strength and low Embodies Energy

In this stage we are searching the materials with low embodies energy (objective), but their tensile strength will be the highest (the main constraint). For this we narrowing the searching area as we can, until the number of winning candidates reaches 18 (fig.8). The candidates are from Elastomers, as PVC elastomers, Polychloroprene; Plastics, as Polyethylene – PE-LLD and PVC – flexible and Fibers: Natural rubber, Clorinated polyethylene, etc.
Limit stage 5, In properties session ‘Durability’

There are some selection steps by properties limits that reduce the top list of winners. First adding durability against ‘Fresh water’ and ‘UV radiation’ will reduce number of records in 16; then adding durability against flammability, checking the ‘Slow burning’ (number or winning records goes 15) and finally on ‘Thermal properties’ session we type the values of Maximum service temperature, +100°C and Minimum service temperature, -50°C. Now, the number of winning candidates is 5. There are: elastomers, PVC and TPU [8].

Through selection according to the ‘Custom’ database, that was created by us as users, makes it possible to include more complete, all constraints and objectives, to arrive at a list of winning candidate list, mainly from elastomers class. As described at the beginning, fabrics of tent are prepared from fibers which may be made of natural materials, but synthetic ones as: nylon, polyester, etc. Then this fabric is coated from rubber or plastic layer/s and adheres together with
it (fabric). In Procedure 1 we select the material for fabric of tent and in Procedure 2 we search the materials that serve as coating layers, which should meet several constraints and the objectives that put the designer at the beginning of practical engineering problem. The top list of computerized selection of materials for tents contains 5 winning candidates from elastomers. At the end will be engineering designer who will decides on specific material that serves as coating layer.

Conclusions

Studied Case of computerized selection for tents materials aims to show a complete procedure for many practical problems, finding solutions not only for the engineering students of the Textile, but much broader such as: Material, Mechanical, Civil Construction Engineering, etc.

1. Other goals are: further studies of students with the engineering analysis of practical problems and making correct formulation of design requirements; the definition and calculation of performance indices; finding a correct way with selective instruments of CES EduPack to do the continuous narrowing of the searching area using properties limits, plotted charts and applying to them performance indexes in the form of selection lines; helping to make decisions during the selection of winning candidates and the interpretation of results;
2. A correct design of practical problems and the drafting of its requirements: Function, Constraints and Objectives, assists in solving the engineering problem determining of the top-list of required materials. While computerized selection is a technical procedure, it is not difficult to acquire!
3. Difficulties, which were created during incomplete selection in ‘Architecture and Built environment’ happened because the records were missing, but also the attributes sessions that create 'holes' in the selection didn’t allow it. This brings the necessity of creating a database for 'Textile products' with records belonging to the classification of materials of CES, but especially with the specifics of the attributes of textile products, as defined in their standards.
Referenca


PUBLIC RELATIONS IN FASHION AND TEXTILES: FOCUS GROUP RESEARCH

I. Salopek Čubrić

Department of Textile Design and Management, University of Zagreb, Faculty of Textile Technology,
Prilaz baruna Filipovica 28a, 10 000 Zagreb, Croatia,
ivana.salopek@ttf.hr

Keywords: public relations, fashion, qualitative research, focus group, skills

Abstract

In the focus of this research are the soft skills that are needed for successful public relations in fashion and textile. Due to a number of advantages, the focus group is chosen to investigate the topic and get up-to-date views of PR specialists. Within the investigation in the focus group, the following issues are explored: preparedness of participants after formal education on work in fashion PR, how their career progressed since graduating and what suggestions they have for the educational institutions. The dominant view of participants in focus group is that the personal skills are the most important, for success in PR business. In regard to additional, non-listed skills that may be important for public relations, participants gave a strong accent to social media skills.

Introduction

For a number of years, technical knowledge was considered as the main factor that contributes to career and success of professionals. However, according to the recent surveys, soft skills are far more important than technical skills to reach the top. The results of conducted research indicated that 96% of survey respondents judged communication and interpersonal skills as the most important contributor to achieve career success [1]. It seems that there is a growing awareness of the importance of soft skills for each employee to deal effectively with the challenges in the professional and everyday life in various fields of human interest [2-4]. Recently, soft skills are considered as increasingly valued for employment [5].
Soft skills are defined in a number of ways - as a dynamic combination of cognitive and meta-cognitive skills, interpersonal, intellectual and practical skills, as a set of transferable skills that include personal and social behavioral traits and competencies, or as a broad set of knowledge, skills, work habits, and personal traits [6-8]. No matter how the definition is stated, researchers agree in one – soft skills help people to adapt and behave positively. Taking into account the importance of such skills, the significant effort in a number of studies is given to their popularization and recognition [9,10].

The topic of the research conducted and presented in this paper are the soft skills that are needed for successful public relations in fashion and textile. Due to a number of advantages, the focus group is chosen to investigate the topic and get up-to-date views of PR specialists. Within the investigation in the focus group, the following issues are explored:

- preparedness of participants after formal education for work in fashion and textile PR,
- how their career progressed since graduating, relative to other graduates and
- their suggestions for the educational institutions.

**Method**

Prior to investigation, a pilot survey was organized in order to get an insight into the perception of skills that are important for work in fashion and textile PR. In the recent studies, and a number of EU projects, different categorization of soft skills important for employment and educational process is given. There is a match of listed skills in a certain extent, but still there are significant differences in the views. Taking into consideration a number of proposed lists of soft skills, for the pilot testing in this study is used a list of skills that is defined within the EU project focused on improving professional competences and management abilities [1]. This list refers to 24 soft skills that are divided into four groups (Table 1).

The questionnaire in pilot survey consisted of two parts. In the first part, the participants of pilot study are asked to grade their perception of importance of each listed skill for the success in fashion and textile PR. For the questionnaire was used bipolar 5 - level Likert scale with following responses: 1 - strongly disagree, 2 - disagree, 3 - neither agree nor disagree, 4 – agree and 5 - strongly agree. In the second part, participants are asked to name additional skills that are not listed, but according to them, are also important for the success in fashion and textile PR. The results of pilot survey, that include the descriptive statistic (mean, standard error, median, standard deviation, sample variance and range) of answers given for each question, is given in the table 2.
### Table 1. List of skills for pilot survey

<table>
<thead>
<tr>
<th>L1</th>
<th>Leadership</th>
</tr>
</thead>
<tbody>
<tr>
<td>L2</td>
<td>Strategic Thinking</td>
</tr>
<tr>
<td>L3</td>
<td>Vision and Direction</td>
</tr>
<tr>
<td>L4</td>
<td>Inspiring Commitment</td>
</tr>
<tr>
<td>L5</td>
<td>Leading Change</td>
</tr>
<tr>
<td></td>
<td>Conflict Resolution</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>M1</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>M2</td>
<td>Planning and Managing Resources</td>
</tr>
<tr>
<td>M3</td>
<td>Delivering Results</td>
</tr>
<tr>
<td>M4</td>
<td>Managing Individual Performance</td>
</tr>
<tr>
<td>M5</td>
<td>Leading a Team</td>
</tr>
<tr>
<td>M6</td>
<td>Team Work</td>
</tr>
<tr>
<td>M7</td>
<td>Motivation</td>
</tr>
<tr>
<td>M8</td>
<td>Developing People</td>
</tr>
<tr>
<td>M9</td>
<td>Managing Projects</td>
</tr>
<tr>
<td></td>
<td>Quality and Standards: Monitoring and Evaluation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>P1</th>
<th>Personal Delivery</th>
</tr>
</thead>
<tbody>
<tr>
<td>P2</td>
<td>Effective Communication</td>
</tr>
<tr>
<td>P3</td>
<td>Presentation Skills</td>
</tr>
<tr>
<td>P4</td>
<td>Negotiation Skills</td>
</tr>
<tr>
<td>P5</td>
<td>Effective Meetings</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>S1</th>
<th>Self-Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>S2</td>
<td>Self-Awareness</td>
</tr>
<tr>
<td>S3</td>
<td>Integrity</td>
</tr>
<tr>
<td>S4</td>
<td>Flexibility &amp; Adaptability</td>
</tr>
<tr>
<td>S5</td>
<td>Self-Confidence</td>
</tr>
<tr>
<td>S6</td>
<td>Proactivity and Time Management</td>
</tr>
<tr>
<td></td>
<td>Resilience</td>
</tr>
</tbody>
</table>
### Table 2. Descriptive statistics of pilot survey

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean</th>
<th>Standard Error</th>
<th>Median</th>
<th>Standard Deviation</th>
<th>Sample Variance</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>4</td>
<td>0.26</td>
<td>4</td>
<td>0.82</td>
<td>0.67</td>
<td>2</td>
</tr>
<tr>
<td>L2</td>
<td>4.1</td>
<td>0.18</td>
<td>4</td>
<td>0.57</td>
<td>0.32</td>
<td>2</td>
</tr>
<tr>
<td>L3</td>
<td>3.4</td>
<td>0.16</td>
<td>3</td>
<td>0.52</td>
<td>0.27</td>
<td>1</td>
</tr>
<tr>
<td>L4</td>
<td>2.6</td>
<td>0.16</td>
<td>3</td>
<td>0.52</td>
<td>0.27</td>
<td>1</td>
</tr>
<tr>
<td>L5</td>
<td>2.7</td>
<td>0.15</td>
<td>3</td>
<td>0.48</td>
<td>0.23</td>
<td>1</td>
</tr>
<tr>
<td>M1</td>
<td>3.2</td>
<td>0.2</td>
<td>3</td>
<td>0.63</td>
<td>0.40</td>
<td>2</td>
</tr>
<tr>
<td>M2</td>
<td>4.8</td>
<td>0.13</td>
<td>5</td>
<td>0.42</td>
<td>0.18</td>
<td>1</td>
</tr>
<tr>
<td>M3</td>
<td>5.0</td>
<td>0.00</td>
<td>5</td>
<td>0.00</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>M4</td>
<td>5.0</td>
<td>0.00</td>
<td>5</td>
<td>0.00</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>M5</td>
<td>5.0</td>
<td>0.00</td>
<td>5</td>
<td>0.00</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>M6</td>
<td>5.0</td>
<td>0.00</td>
<td>5</td>
<td>0.00</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>M7</td>
<td>2.5</td>
<td>0.22</td>
<td>2</td>
<td>0.71</td>
<td>0.5</td>
<td>2</td>
</tr>
<tr>
<td>M8</td>
<td>4.8</td>
<td>0.20</td>
<td>5</td>
<td>0.63</td>
<td>0.4</td>
<td>2</td>
</tr>
<tr>
<td>M9</td>
<td>3.1</td>
<td>0.23</td>
<td>3</td>
<td>0.74</td>
<td>0.54</td>
<td>2</td>
</tr>
<tr>
<td>P1</td>
<td>5.0</td>
<td>0.00</td>
<td>5</td>
<td>0.00</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>P2</td>
<td>5.0</td>
<td>0.00</td>
<td>5</td>
<td>0.00</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>P3</td>
<td>5.0</td>
<td>0.00</td>
<td>5</td>
<td>0.00</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>P4</td>
<td>5.0</td>
<td>0.00</td>
<td>5</td>
<td>0.00</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>S1</td>
<td>5.0</td>
<td>0.00</td>
<td>5</td>
<td>0.00</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>S2</td>
<td>4.7</td>
<td>0.15</td>
<td>5</td>
<td>0.48</td>
<td>0.23</td>
<td>1</td>
</tr>
<tr>
<td>S3</td>
<td>4.9</td>
<td>0.10</td>
<td>5</td>
<td>0.32</td>
<td>0.10</td>
<td>1</td>
</tr>
<tr>
<td>S4</td>
<td>5.0</td>
<td>0.00</td>
<td>5</td>
<td>0.00</td>
<td>0.00</td>
<td>0</td>
</tr>
</tbody>
</table>

The average grades given by participants are lowest for the whole group of skills that are within the group “leadership”, i.e. strategic thinking, vision and direction, inspiring commitment, leading change and conflict resolution. Furthermore, lower grades are also given for two skills in the group management - quality and standards: monitoring and evaluation, as well as planning and managing resources. For a number of remaining skills, there was a high conformity of obtained grades and all grades are above 4.5. On the basis of conducted pilot survey, less important skills are excluded from further observation. Therefore, a list of 15 skills (all with average grades above 4.5) is defined for the further use in the focus group research. For investigation of skills needed for the success in the fashion and textile PR, a focus group research is used because it helps to gain substantial insights into a variety of issues from the macro level.
to a very detailed level. The focus group research in this study is conducted through the following five stages:

- Defining and planning,
- Recruiting and preparing the participants,
- Conducting and moderating and
- Reporting and analyzing.

Defining and planning

Methodologically, focus groups involve 6–12 people who come from similar social and cultural backgrounds or who have similar experiences or concerns. According to Elliot et al. [11], „ten is better and eight is ideal“. Considering the recommendations, it is decided to form a group of eight participants.

According to the Guidelines for conducting a focus group [11], it is advised to divide the questions into following three groups: engagement questions (questions that introduce participants to make them comfortable with the topic of discussion), exploration questions (questions that go straight to discussion) and exit questions (addition to the discussion, to add anything that may be missing in the discussion). Taking into consideration the described, for this focus research are designed 8 questions according to the following scheme: 2 engagement questions, 5 exploration questions and 1 exit question. The list of questions within each of named groups of questions is given in the Table 3.

**Table 3. Questions for focus group**

<table>
<thead>
<tr>
<th>Q – Engagement questions</th>
<th>Q1</th>
<th>How well were you prepared for the job in public relations in fashion and textile after completing formal education?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q2</td>
<td>How well were you prepared in each of the following areas of soft skills:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. Management skills (Delivering Results, Managing Individual Performance, Leading a Team, Team Work, Motivation, Developing People, Managing Projects)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. Personal delivery skills (Effective Communication, Presentation Skills, Negotiation Skills, Effective Meetings)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. Self-management skills (Self-Awareness, Integrity, Flexibility &amp; Adaptability, Self-Confidence, Proactivity and Time Management, Resilience)</td>
<td></td>
</tr>
<tr>
<td>Q – Exploration questions</td>
<td>Q3</td>
<td>Which among listed skills you consider most important for public relations in fashion and textile?</td>
</tr>
<tr>
<td></td>
<td>a. Management skills (Delivering Results, Managing Individual Performance, Leading a Team, Team Work, Motivation, Developing People, Managing Projects)</td>
<td></td>
</tr>
</tbody>
</table>
Projects

b. Personal delivery skills (Effective Communication, Presentation Skills, Negotiation Skills, Effective Meetings)

c. Self-management skills (Self-Awareness, Integrity, Flexibility & Adaptability, Self-Confidence, Proactivity and Time Management, Resilience)

Q4 Which skills, besides those 15 already listed, you consider important for job in public relations in fashion and textile?

Q5 Which skills have helped you to make the progress in your career?

Q6 What training or additional education you consider most important for employees in public relations to enhance their skills?

Q7 In your opinion, at which skills should be given focus in formal education?

Q8 Is there anything else you would like to say about the topic of this discussion?

Recruiting and preparing the participants

The recruitment of participants was based on the main criterion which is determined by the aim of the research, i.e. to illuminate perceptions and experiences of participants that already work in public relations, regarding the most important skills needed for successful public relations in fashion and textile business. For the success of the research, it was very important to form a homogenous group in which all the participants feel comfortable. The main selection criteria observed were gender, age and position (rank) in the company. The formed group is researcher-constituted and homogenous with respect to a single variable – the occupation in fashion and textile business related to public relation. In order to make the discussion within the group comfortable and without possible previous conflicts between participants, the participants of single group are in private life not close to each other.

Conducting and moderating

Participants were informed about the purpose and design of the research, as well as the ground rules for the conducting of focus group. This process was explained to participants in writing and once again prior to commencing the focus group. They were assured that there would be privacy in gathering, storing and handling data. Participants were asked to express what they think and feel, without repercussions, as well as to speak individually and not over each other. Before the start of focus group discussion, participants are reminded of the purpose of the focus group and the following ground rules are stated: it is important to do the talking, there are no right or wrong questions and what is said stays within the group. The discussion within the group is structured around a set of carefully predetermined questions already stated in the Table 3 and the discussion was free-flowing.
Discussion

The transcript of the session is used for the discussion of the outcomes of conducted focus group research. The summary of the main and most important findings is written in a narrative format. The first question was the engagement question related to the previous preparedness of participants. The participants expressed dissatisfaction with the level of preparedness for their job in public relations after completing formal education, especially regarding the presence of soft skills in curricula. At the same time, they are aware that job in fashion and textile public relations include multidisciplinary knowledge of both fashion/textile and public relations. Considering the statement, they are aware that it is difficult to organize a curricula that will cover all needed knowledge in a proper manner. According to participants, there is a number of tips, some of them well known, for the successful job interview. Familiarity of these tips is very useful for everyone at first job interview. In the discussion is also stated that there is a number of different courses that cover this topic, but still, it would be much better if the tips are included into one of the courses of formal education.

The aim of the second engagement question was to get insight into their perception of the own preparedness regarding the soft skills. This was also a question that aimed to familiarize the participants with concept of soft skills. The overall perception of participants regarding their preparedness in the named three groups of skills is quite negative. The majority of them felt that their educational institutions did not prepare them adequately for their future job. Regarding the management skills, they outlined that the emphasis in the educational system is still on “ex cathedra” teaching, rather than practical work. The majority of participants in the focus group regret that they did not have more tasks that should be performed in the groups. According to them, group tasks would affect management skills with special accent on leading a team and teamwork. Personal delivery skills are observed as most important group within three presented groups of skills. Therefore, the special accent in the educational process should be placed on the improvement of this group of skills. As the main problem in the educational process is defined a lack of seminars that will be very useful for improvement of personal delivery skills.

These two questions were followed by a group of exploration questions. First of them was related to the definition of important skills from the list. This question sparked intense debate and each participant elaborated own perception of most important skills. They all agreed that personal skills are on the top and are definitive must-to-have. Among the listed personal skills, effective communication is firmly underlined. Most of the participants think that a good PR practitioner in fashion and textile must be excellent in communication with a wide range of people – managers in companies, engineers in the production of textile goods, media, models, etc. There is a different approach to each group of people and it always must be effective. It is also very important for a PR to have excellent writing skills, as it is expected from a PR to produce a wide range of materials, such as press releases, articles, advertising and reports. Each type of materials has its rules and level of subjectivity/objectivity that needs to be incorporated. The second underlined skill within the group of personal skills is presentation skill. No matter
how good idea is, if it is not adequately presented, it will not reach to the targeted group. Therefore, in the context of this skill should be brought creativity, as there are countless opportunities to be creative in coming up with new ways to promote ideas and approach new clients. PR is definitely one of the leading professions which constantly call for fresh ideas and lateral thinking. Therefore, having a creative streak can be a crucial skill for a career success. The emphasis is also placed on the managerial group of skills. The need for excellent management and perfect organization of tasks is, according to them, more than evident.

The question number 4 was chosen for the focus group discussion in order to get a feedback from the professionals regarding the additional skills that are also needed in PR, but were not listed.

All participants agreed that, nowadays, social media skills play and huge role in public relations. As known, social media networks were a novelty few years ago, but today their importance, their final effect and power are no longer debated. The definitive benefits of social media are increased exchange of information, development of loyal fans, improved search ranking and something that is a benefit number one – significant reduction of expenses. There is a plethora of social networking tools on the web (such as Facebook, MySpace, LinkedIn, Plaxo and many more) that are user friendly and free to use. The only thing that is needed from PR professionals is the understanding of the leading social networks and the effort to be constantly online. Some participants of focus group pointed out the blogging and microblogging. The participants of focus group also added the work ethic on additional list of skills needed for success. The ethic is very important for everyone who works, not only in public relations. But, from the personal experiences, they are all aware that very often the ethics in the PR business is “on the edge”.

Now, when all skills important for the success in public relations were discussed, the participants were able to turn to the defining skills that were helpful indeed. Within the question 5, similar comments are given as earlier on the questions Q3 and Q4. Again, personal skills (especially communication) and management are pointed out. As all the participants were quite dissatisfied with their preparedness (seen from the answers on questions 1 and 2), the following question was directed towards enhancing of skills. Participants considered that almost each training can, in a certain way, help to be more efficient in public relations. The accent was definitely placed on different programs that are regularly conducted by PR agencies and societies.

Now, the discussion was redirected to the beginning. All participants again agreed that each of listed skill may be included in formal education. According to them, there is an evident lack of communicational and presentational skills, what is a problem for a number of jobs where such skills are strongly needed.

Discussion is closed by the, so called, exit question that enabled participants to give final remarks. The participants agreed that this discussion made them even more aware of the importance of the soft skills in public relations. Part of them even thinks of additional trainings to improve some of the listed skills at which they may not be as successful as they would like to be.
Concluding remarks

This paper has outlined the main features of focus group research, paying particular attention to the benefits of interaction and group dynamics which only this method can offer. The main findings of the focus group research regarding the success in fashion and textile PR are summarized:

- Participants of the focus group are a bit skeptical about the level of their preparedness after formal education for the employment in public relations. At the same time, they point out the specifics of their job and the fact that a wide range of skills is needed. They are aware that it is quite difficult to build up all needed knowledge and skills in one curriculum.
- The dominant view of participants in focus group was that the personal skills are the most important for success in PR business.
- In regard to additional, non-listed skills that may be important for public relations, participants gave a strong accent to social media skills.
- It was clear from the discussion that personal skills helped them all to make the progress in career.
- Many participants felt that each training can, in a certain way, help an individual to be more efficient in public relations. Therefore, they encourage each type of training, both formal and non-formal.
- Similar to the previously stated, the vast majority of focus group participants agreed that each of listed skills may be included in formal education.
- The general consensus of participants is that each contribution towards personal enhancement of skills is very welcome and valuable.
- Finally, all things considered, nearly all focus group participants noted that there is a number of soft skills important for employment in public relations and would recommend anyone planning to work in public relations to enhance personal level of skills.

From the view of researcher, it can be concluded that research within focus group was more collaborative than other forms of research and gave a totally different perspective on the research topic. This research was conducted with the participation of professionals that work in fashion and textile business. But, considering the outcomes, it is to expect that PR specialist in other fields may come to the same or similar conclusions.
References

SECTION VI:
Quality control, Management & logistic
EVALUATION OF OPERATOR PERFORMANCE THROUGH TIME MEASUREMENTS

S. Spahija, E. Shehi

Polytechnic University of Tirana, Department of Textile and Fashion, Square ‘Mother Teresa’, No.4, Tirana, Albania
sspahija@fim.edu.al

Keywords: operator performance, standard minute values, time measurements.

Abstract

Many companies use a Management Information System that includes the calculation of an Operator Efficiency Report which is a useful starting point for identifying operators performing below the standard set by the company.

The Assessment of operator performance is one of the most difficult skills for an industrial Engineer to acquire and takes a lot of practice in order to become consistent. The assessment or rating of an operator performance is used to adjust the observed time either up or down to what Industrial Engineer believes a standard operator would be able to achieve.

The study of operator performance evaluation is made in a company in Tirana. The company produces sportswear operating in full package. The main customers are French and Dutch.

The product studied is a sports jacket, for which at first we breakdown the operations of production and then we made 10 time measurements for every operation. Time measurements are done with the help of a qualified operator, using the stopwatch, based on BSI scale (Rate of working) and the data are recorded in the time study sheet. From data recorded it is noticed high values of standard minutes for different processes, which means a low level of operator performance. Than are given and analyzed the reasons of low level of operator performance.

If the efficiency of the operator increases (the operator works faster) than we could have lower values of standard minutes per garment. This mean, that the company could produce more output in less time.

Introduction

The Assessment of operator performance is one of the most difficult skills for an industrial Engineer to acquire and takes a lot of practice in order to become consistent.
The first step in evaluation of operator performance is to identify the operators who for a number of reasons may not be achieving the level of performance required by the company or the efficiency that their ability has indicated.

Time measurements of every work process are a useful starting point for identifying operators performing below the standard set by the company [3].

Time measurement is the application of techniques designed to establish the time for a qualified worker/process to carry out a task at a defined speed [5].

Once the time of processes has been calculated, it can then be used to evaluate the operators performance and set targets for an individual operator, in order to improve his/her performance.

Production targets are considered an important factor on work organization, for using the human and material resources in a rational way [4]. This is also related to the increase of work performance and the creation of best conditions for applying work principles and reward in quality and quantity basis [2].

Materials and Methods

The study is made in a company in Tirana. The company produces sportswear operating in full package, for French and Dutch customers.

To evaluate the operator performance and to put the production targets we studied a sport blouse. We measured the time of every work operation with the help of the operators [1]. During the process of time measurements we considered the conditions described below:

- The operator had known before the process which is going to be measured
- He knows very well the level of quality required
- The machinery had technical guaranty for working in continuity during chronometric measurements.
- Work place arrangement is done before starting the process of chronometric measurements.
- The time measurements are done in the middle of the day/shift, considering this period as more adapted time.

Then we breakdown the operations of production and made 10 time measurements for every of them.

The process of performance evaluation passes through 5 steps: 1) Recording observed time, ii) Assessment of operator performance (BSI scale-Rating of work), iii) Calculating basic minutes, iv) Allowances and v) Calculating standard minutes. [1]

The measurement of work helps on [2]:

1. Establishing the standard time for a task.
2. Optimizing employee levels.
3. Planning and controlling the production.

Time measurements are done using the stopwatch [1] and the data are recorded in the time study sheet. The assessment of operator performance is done using the BSI scale (Rates of working). The assessment or rating of an operator performance is used to adjust the observed time either up or down to what industrial engineer believes a standard operator would be able to achieve.

“Standard Performance” is defined as the output that a qualified (fully trained) and motivated operator can achieve over length of the working day/shift using specified method and meeting the required level of quality.

The Rating factor is used to convert the observed minutes into basic minutes, so the time taken (observed time) is multiplied by the Rating factor (using 0-100 scale) to give the basic minutes for an operation [6]. The basic minutes than can be adjusted by the addition of allowances to give a standard minute value [1].

There are two types of overall allowances:

a) Contigency allowances are given to compensate the operator for interruptions that occur during the normal completing of an operation. These include: changing of the threads and bobbins and as a result differs for each type of machine.

b) Personal allowances are given to compensate the operator for fatigue and breaks, but it is subject to the policy of the company.

We considered relaxation and contingency allowances 7% of total work hours.

Results

The first step of the evaluation of operator performance through time measurements, is the study of the product (sports blouse), after it arrives in the production line. After taking under consideration the requirements of the customer, together with the technician of line we break down the operations through which passes the production of this product.

![Figure 1. The sports (dacar) blouse we studied](image)
The production of a “dacar” blouse passes through 10 operations:

1. Locking side and fabric add in the back
2. Locking side of the sleeves
3. Ornamental seam in the side part
4. Installation of sleeves
5. Ornamental seam on the sleeves
6. Preparation of collar and its fixing
7. Installation of collar fillet
8. Locking collar with lockstitch
9. Setting the logo
10. Sleeves plait and the end plait

Figure 2. Views of different operations during the production of “dacar” blouse

After the operations breakdown we measured the time for every of 10 work operations. The calculation of production targets is made based on table 1 (Time Study observation sheet), considering the allowances, using the stopwatch and the BSI scale (rates of work). The average minutes per cycle are multiplied by rating for every process, which gives normal minutes per cycle. Standard minutes per GRMT (garment) are a summary of normal minutes per cycle with relaxation and contingency allowances. Standard minutes values are used to: a) set individual/line targets, b) calculate individual/line/factory efficiency, c) balance the processes, d) plan the production, e) calculate the cost.
Once having the results of time measurements and operators performance, the person responsible for ensuring that each operator achieves their best potential performance, must then approach those operators with a low performance, in order to analyze the reasons and set in place all procedures necessary to help the operators improve their efficiency.

It is equally important to speak to each operator who has performed above the standard performance target set by the company and give them praise and encouragement to at least maintain that level of efficiency and if possible improve upon it. Ensuring that each operator achieves their full potential in terms of productivity is ultimately the responsibility of the whole management team.

Referring to the studies in this field we conclude that the reasons of low performance are:

- The operator is not aware of the level of performance required
- The operator doesn’t know the volume of the output required to reach the required level of performance.
- The operator does not have sufficient and continuity of work for the whole shift/day.
- The machine is not working properly.
- The operators are not using the correct handling methods
- The workplace doesn’t laid out effectively
- The operator requires additional training on a different operation or equipment.

The boosting of operator performance is a team effort, so all individuals involved in production should be included at all times. This means production managers, technologists, trainers, instructors, supervisors, team leaders, operators, etc.

Regardless to the low level of performance, together with the management team during this period we have always believed to the existence of a possible higher performance of the operators in particular and the production line in general. If the level of performance increases only 10%, the benefit would be considerable. This idea is illustrated by graph 1.

The graph 1 shows the differences in time for every process using standard minutes per garment (last column of table 1) and of standard minutes per garment if the operators work with 10% more efficiency.

According to table 1 (Time study observation sheet), the quantity of blouses produced in a day is 60.

![Graph 1. Time differences of processes, when the operators work with 10% of higher performance](image)

If we referred to the idea of increasing the performance of operators 10% more (Graph 1. Time differences of processes, when the operators work with 10% of higher performance), the quantity of blouses produced in a day, will be 8 blouses more.

This value will be more considerable if the quantity of the product ordered is high.
Conclusions and Recommendations

The first step to improve operator performance is the identification of the operator who for a number of reasons may not be achieving the level of performance required by the company or the efficiency that his/her ability has indicated.

The reasons of low performance of the operators are related to: lack of qualified labour force on the market, often change of the operators, often change of the order, tiredness level of the operator, etc.

It is recommended that the operator should always be aware of the level of performance and the level of output required; he/she should have sufficient and continuity of work for the whole shift/day; the machine should work properly, the operator should use the correct handling method; the workplace should laid effectively; the operator should require additional training on a different operation or equipment.

By achieving an improved level of performance and by working at their full potential, the operator will benefit from increased salary.

References

PRE-CONSUMER APPAREL WASTE MANAGEMENT IN MACEDONIA

E. Tomovska¹, S. Jordeva², D. Trajković³, K. Zafirova¹

¹ University "Ss Cyril and Methodius", Faculty of Technology and Metallurgy, Skopje, Macedonia
elena.tomovska@googlemail.com

² University “Goce Delčev”, Faculty of Technology, Štip, Macedonia

³ University of Niš, Faculty of Technology, Leskovac, Serbia

Keywords: textile waste, apparel cutting waste, textile waste management

Abstract

By its origin textile waste can be divided in two broad categories: post-consumer waste derived from households, and pre-consumer waste generated during the manufacturing process. The division of the clothing supply chain between developed consumer markets and developing countries where apparel production capacities are outsourced implies that post-consumer waste is present in the former countries, whereas the later generate more pre-consumer waste. To effectively utilize the textile waste an accurate prediction of the quality of generated waste is required. Due to the structure of the industry textile waste in Macedonia mainly consists of apparel cuttings. The purpose of this exploratory study was to investigate the current state of apparel waste management practices in Macedonia, characterize the apparel cuttings waste and determine the attitudes of Macedonian top management towards managing the apparel cuttings. Data was obtained via a structured questionnaire distributed to top managers in apparel manufacturing. The results indicated that almost all apparel manufacturers use landfills to dispose of their waste. The analysis showed that the waste stream consisted principally of woven fabrics, predominately cotton and cotton blends, with presence of lycra. Bearing in mind the waste composition the most appropriate end use for the produced pre-consumer waste is insulation materials. Considering that the industry consists of small and medium companies with limited resources there is low likelihood of individual investments in recycling equipment. The survey results also show that the top management of Macedonian apparel companies has strong negative attitudes towards sorting and preparing cutting waste for further processing. Availability of workforce, sorting according to color and fiber content, and introduction of baling during the packing process are identified as key impediments to introducing sorting in the companies. Low awareness of waste management practices and technologies, as well as of existing markets for recycled products contribute to the negative attitudes to waste management.
Introduction

According to the 2011 FAO/ICAC survey issued by the United Nations [1], the world fiber consumption, and therefore the consumption of final product made of fibers, e.g. clothing, home textiles or industrial textiles, has grown nearly 30 times since the 1950s. The growing consumption of textile products is an indicator of the growing amount of textile waste generated in the world today. Waste is considered to be a problem for many reasons, of which the harm to the environment and human health, limited space for land fields, and increasing costs to use existing and replace landfills are dominant. As textiles present a nonhazardous solid waste, their recycling is often sidelined. Even though all contemporary waste management systems consider land fields disposal as the worst option, they remain the preferred manner of textile waste removal [2].

By its origin textile waste can be divided in two broad categories. On one hand, there is the post-consumer or household waste, while on the other the so called post-industrial waste generated during the manufacturing process. The division of the clothing supply chain between developed consumer markets and developing countries where apparel production capacities are outsourced, implies that household waste is present in the former countries, whereas the later generate more post-industrial waste. In the developed world increasing environmental awareness, as well as social responsibility, reinforced by strict legislations, has led to recycling postconsumer textile waste in innovative products. For instance, postconsumer textile waste is recycled into insulation materials in the EU, by companies such as the French Matériaux Naturels and the British Bonded logic. However, on the producer side of the supply chain, particularly amongst apparel producers, recycling post-industrial waste is not common [3, 4]. This fact gains importance as the apparel industry can produce up to 20% of waste in the form of apparel cuttings, depending on marker efficiency. Macedonia presents a typical example of an apparel producing country with high post-industrial apparel waste generation. About 1.400.000 pieces of clothing are exported per month, which leaves behind a large amount of apparel cutting waste, compared to the country size and per capita. A preliminary analysis has shown that annually 1.7 kg/per capita of new and clean textile waste, with preserved physical and mechanical properties, were left behind. The majority of apparel manufacturers dispose the apparel cutting waste together with community waste on land fields [5]. The generation of apparel waste infers not only a loss of valuable resources and energy, but also causes ecological problems and creates expenses for collecting, transporting and managing the waste. Hence, it is necessary to raise the awareness of all stakeholders, in particular apparel manufacturers, of the economic and ecological benefits from collecting, sorting and reusing apparel waste [5].

Although numerous researchers have written on the subject of textile waste, academic research on the specific problem of apparel waste management is sparse. Most researchers have begun by categorizing the type of waste generated by a local industry and reviewing the current recycling practices [3, 4, 6]. Further on, some have researched the challenges posed to the introduction of
recycling by apparel manufacturers [6, 7, 8]. For instance, the level of support for recycling textile waste by Missouri sewn products manufacturers by analyzing four independent variables: material utilization, community size, land fields fee increase, and economic feasibility to recycle were investigated. Results indicated that support was greater for plants in urban rather than rural areas, large companies with greater economic feasibility, those that have greater concern for efficient materials usage, and those in regions of the country that have experienced the greatest increases recently in landfill fees [8]. Furthermore, a study in South Africa has investigated market and technology barriers for recycling within apparel companies [6].

The purpose of this exploratory study was to (a) give a characterization of the apparel cuttings waste, (b) define the current state of apparel cuttings waste management and (c) determine the attitudes of Macedonian top management towards managing the apparel cuttings.

**Methodology**

The research was conducted through a questionnaire distributed to the top management of Macedonian apparel manufacturers. The questionnaire was designed to analyse: the waste types generated (type of fabric, fibre content, lycra content), waste packing practices, the waste disposal behaviours of manufacturers, waste disposal cost, and the attitude towards recycling apparel cuttings. Structured, multiple-choice questions, with a minimum of 5 and a maximum of 7 alternative answers were used. A pilot test was conducted to ensure the clarity of the questionnaire. The questionnaire was distributed to top managers in 120 apparel manufacturers in Macedonia, during September 2012. The sample included all companies belonging to the largest trade association of apparel manufacturers in the country – the Textile Trade Association. Together these companies contribute to about 70% of the employment and 90% of the GDP generated by this industry. All respondents were notified of the end use of obtained data. In 66% of cases a personal interviewing method was used, while 34% of questionnaires were distributed via e-mail. From the distributed questionnaires, 86 questionnaires completed by the companies’ top management were used in the analysis. In the Stip region, as the largest apparel production centre, 54 (62.8%) of the companies were located, whereas the remainder were from other regions in the country. The processing of the obtained data has been conducted by applying standard statistical analysis.

**Results and discussion**

The sample profile included companies of various size. According to EU classification [12] the companies were typically medium sized with 50 to 250 employees (48.8%), followed by small companies with under 50 employees (26.7%), and large companies with over 250 employees (17.4%). In 6 cases data for the number of employees was missing.

The results of the research confirmed that apparel cuttings are the main textile waste generated, since 97.67% of companies reported apparel cuttings as their dominant waste, while only 2.32%
had other textiles (nonwovens, fibres, yarns). This reflects the structure of the Macedonian textile industry, mainly composed of apparel manufacturers. The absence of vertically integrated companies implies no possibilities for in situ regeneration of textile waste in the overall production process.

The employed materials were further analysed according to the type of fabric, fibre content and presence of lycra. In general, the analysis showed that the waste stream consisted principally of woven fabrics, predominately cotton and cotton blends, with presence of lycra. Fabric type, fibre content and presence of lycra determine the procedures for further treatment of the textile waste, which can be mechanical, chemical or thermic. At present, mechanical rather than chemical recycling methods are preferred due to their cost-efficiency.

As seen from Figure 1, the majority of companies, 45.35%, used both woven and knitted fabrics. Only woven fabrics were used by 41.86% of the companies, whereas considerably less companies, 10.47% used only knitted fabrics. Nonwoven fabrics were reported by 2.33% of the companies. Standard mechanical recycling of fabrics requires cutting and opening. The opening process of fabrics necessitates loose structure; therefore woven fabrics, excluding wool, are harder to process. In order to create demand for woven fabric waste, products using woven fabric cuttings need to be developed.

The type of material used according to fibre content is shown in Figure 2. Pure cotton and cotton blends were most common as raw materials, cumulatively contributing to 50%, while 8.14% worked only with synthetic materials. A substantial number of companies, 41.86%, used materials with different fibre content, including cotton, cotton blends, synthetics, wool, flax, etc. Presence of animal fibres, such as wool or wool blends, which are frequently regenerated, was negligible (1.16%). The analysis showed that the biggest amount of waste consists of mixed fibre waste. Utilization of textile waste from blends and synthetic fibres appears to be a great problem, as these fibres are not biodegradable, hence the task of recycling such fibres should be given priority. In perspective this type of waste can be used in the construction industry as soundproof blocks, insulation, roofing felt, bank stabilization, pollution control filters, etc. Although cotton fibres are completely degradable, they can theoretically be fully recycled, partly in the spinning process or for quality paper production.

The content of lycra in fabrics was analysed separately, because it has significant influence on the recycling process. Only 14.12% of companies used materials with no lycra. The majority of companies – 60.0% used up to 30% of materials containing lycra in their production, whereas 25.88% used over 30% of materials containing lycra. The presence of lycra in fabrics would make the process of classical mechanical recycling even more difficult.
Furthermore, the methods of apparel waste management within the companies were analysed, including methods of packing the waste, presence of impurities, waste disposal practices and costs. (Figure 3). Packing in plastic bags was the most frequent way of collecting apparel cuttings, as 55.81% of companies used it, followed by packing in cardboard boxes – 17.44%, throwing cuttings straight in containers – 16.28%, baling – 4.65 %, or other methods (e.g. packing in cotton bags) – 5.81%. In other words, the commonly used packing methods do not add any value to the produced waste, as Grasso suggested that baling was the preferred option [9]. The generate textile waste was mainly clean, since 58.14% of companies reported that the bags, boxes or bales did not contain any other objects (Figure 4). Dominant non-textile impurities were cardboard and paper – 16.28%, as well as buttons and reels, 16.28%. With 9.3% of companies mixed impurities - cardboards, metal parts, buttons, and reels were present in the waste.

Recycling practices were virtually non-existent, as only one company recycled the cutting waste. In the majority of companies, 94.19%, apparel waste was collected together with municipal solid waste by governmental waste service companies, and subsequently disposed of in landfills, where it was combusted. Less frequent waste collection methods were by licensed companies, 3.49%, or individuals, 1.16%. Waste management had a small cost compared to the total company budget. For 44.3% of companies waste disposal costs were less than 1% of the budget, and for 34.18% they were between 1-2% of the budget. Merely 5.06% had disposal cost of above 5%. Relatively low disposal costs indicate that this factor is not a very important motivator for recycling.
General attitudes among top managers regarding the recycling of textiles were negative. The majority of top managers, 59.3% stated that they would not be willing to sort produced waste, compared to 40.7% who would be willing to do so. The main obstacle to sorting is the introduction of sorting process in companies, as 66.3% considered it difficult, and only 32.6% thought it would be easy. On the contrary, positive attitudes regarding the perceived usefulness of sorting prevailed: 84.9% thought sorting may be useful and 14.1% not useful. Lack of workforce was one of the key impediments seen by top managers when introducing sorting, as 79.1% of them disagreed that workforce for sorting was available. When looking into the processes of sorting, packing and transportation of the cuttings most difficulty was seen with the in situ sorting of apparel cuttings. Sorting by color, fiber content or type of material was considered difficult by 80.2%, 86.1% and 58.1% of top managers, accordingly. In addition, the majority of respondents considered sorting costly. Packing cuttings in bales, which requires obtaining new machinery, was considered a barrier, as 75.6% of the respondents considered the process to be difficult and 81.4% to be costly. Conversely, packing in boxes and plastic bags was considered an easy method by nearly three quarters of respondents. Opinions relating to the cost of both methods were evenly divided. Overall, packing in plastic bags was considered to be the easiest and least expensive method of collecting the cuttings within the factory. Positive attitudes were associated with the organization of transport as 67.5% of respondents considered it easy, although the process itself was deemed to be costly by 68.6% of them. Location of the production capacities was considered as a barrier by only 19.8% of respondents. Profitability is a vital aspect when introducing new operations. Even though 68.6% of respondents believed sorting can perceptively be profitable, lack of market, i.e. customers interested in apparel cuttings, was recognized as a problem by 66.2% of them. Almost all respondents (96.5%) identified preserving the environment as an important aspect of their operations.

**Conclusion**

The analysis showed that the waste stream mainly consists of woven fabrics, predominately cotton and cotton blends, with presence of lycra. According to its composition the waste has low value for textile application, excluding non-woven production. Therefore alternative usage should be explored. Recycling the apparel cuttings for insulation products in the construction industry would be the most appropriate end use for the produced pre-consumer waste. Priority should be given to non-biodegradable waste, using cutting rather than opening as a recycling method. Disposal on landfills is the dominant waste management practice. The waste is typically clean of any impurities and collected in plastic bags. Almost all waste is collected by governmental waste service companies. One factor that may play a role in inhibiting recycling practices is the insignificant waste disposal costs reported by most manufacturers. The results of this exploratory study indicate that The top management of Macedonian apparel companies shows strong negative attitudes towards sorting and preparing cutting waste for
further processing. Key difficulties are perceived regarding the availability of workforce, sorting according to color and fiber content, and introduction of baling technology for packing. Low awareness of waste management practices and technologies, as well as existing markets for recycled products contribute to the negative attitudes to waste management.

References


NICHE MARKETING IN NEW PRODUCT DEVELOPMENT: THE CASE OF ALBANIAN RETAILERS

J. Teta, E. Xhafka

Polytechnic University of Tirana, Department of Production and Management
jreta@fim.edu.al

Keywords: Fashion industry, Development Strategies, Niche Marketing, Product Development

Abstract

The purpose of this study is to investigate the growing trend of the use of private labeling as a competitive strategy among fashion retailers. In this paper is examined how Albanian retailers have started to differentiate and create niche markets for their own private label merchandise is examined. This research paper focuses on how retailers develop and expand their private label portfolios, while minimizing the risk of cannibalization.

Introduction

The Albanian fashion retail industry (footwear, jewelry, accessories and home textiles) nowadays is facing many challenges. The global recession mixed with the rising price of oil has caused slow consumer spending, which has put to a lower level the fiscal pressure on retailers. This caused deflation in prices and a decrease in profits because of rising costs. Consumers have a wide variety of shopping possibilities, which has created a competitive business environment. This has resulted in retailers looking for ways, other than price, to compete. One way they are doing this is by focusing on differentiation strategy in new product development. In order to achieve this market differentiation and to revitalize their merchandising mix retailers in Albania have started their own product development teams in order to create designs and brands that are exclusive to their stores. These brands are exclusive to one store and owned by the retailer are referred to as private labels (Stone, 2004). Private labels act to set the retailer apart from the competition by offering the customer an item which is available only in that particular
Retailers are able to achieve a higher margin of earnings by designing and distributing all items in house eliminating the middleman. The retailers are also able to provide the same goods with better
quality than other national or international brands (Coolidge, 2003). Currently in Albania private labels are estimated to make 25% of retailer’s merchandise. This situation brings the risk of cannibalization. According to Raynor (1992) this happens when one product offering “eats” away at the current market of an established product. By concentrating on the strategy of differentiation referred as niche marketing profitability can increase (Porter, 1998). The objectives of this study are to focus on the private labels of new product development in Albania and define their niche marketing strategy. This paper focuses also in the strategies that make these brands successful.

**Literature review**

Other studies focused on the upstream sectors like fibers, textiles use push and pull marketing approach. Push marketing is when a product is initially developed by the company and then to the customer needs while pull marketing is defined when a product is developed based on the customer needs (Parrish, 2004). Fiber and textile companies are more likely to use push marketing. In order to identify the market potential of niche products the most used strategy is research and development. In order to success in the potential market of a niche product some variables should be taken in analysis. One of the most important variables is the knowledge management of the consumers. Other variables are the creations of mergers and acquisitions. For the niche market, success variables are barriers to entry, communication to customers, customer service. Because the Albanian textile market is not oversaturated there is a possibility to differ with the price variable. The objective of this study is to incorporate the Albanian retailer’s perspective on a niche marketing strategy. Previous studies showed that branding is a way to create a niche product, but there is no published research how retailers in developing countries use a niche marketing strategy to create their private label brands. The objectives of this study are to examine the role of niche marketing strategies in new product development from the retailers prospective.

**Private label branding as a competitive strategy**

Private labels are products that are developed or owned by a retailer, for exclusive distribution in order for retailers to compete with branded products” (Keiser and Garner, 2008). Private labels typically cost less to sell national and traditionally have appealed to consumers due to cost savings (Keller, 2003). Fashion retailers have begun offering exclusive private label merchandise in their stores not only to enhance margins, but also to provide greater differentiation (Ryan, 2004).

**Advantages of private labels**

Recent years have seen an increased prevalence in private label merchandise (Keiser and Garner, 2008; Keller, 2003; Kotler, 2003). One of the main reasons retailers have increased
their proliferation of private labels is because private label margins typically run 6 percent to 10 percent higher, on average, than national brands (Ryan, 2004). Private label merchandise also differentiates the retailer from competitors, hopefully giving them a competitive advantage. According to an article by Stanley (2005), some of the advantages of developing a private labeling strategy are:

- create more dependence on the retailer by the consumer;
- customer sales increase;
- an opportunity to differentiate and provide variety;
- customer loyalty in a situation where you can avoid comparisons;
- positive image building;
- more freedom in your pricing strategy; and
- positive control over stock keeping inventory.

Another advantage of a successful private label program is that when retailers have gained brand equity in their proprietary products, this equity insulates them from competing retailers, which has the direct impact of increasing sales and profitability and has the indirect impact of decreasing costs as their leverage with brand manufacturers also increases (Ailawadi and Keller, 2004).

**Methodology**

Case study methodology is used in this research paper. Data collection is done by interviews. The survey was adapted for retailers. The sample survey is done in 10 companies based on the followed criteria:

1. the retailers are based in Albania;
2. the retailers develop an in- house private label;

**Analysis of results**

The respondents defined a niche market strategy as focusing on a specialized consumer segment or market. Related specifically to the product development process of private label merchandise, all 10 retailers stated that they used a niche marketing strategy to differentiate their products, not only from national brands, but from their own portfolio of brands. One respondent stated that this strategy included differentiating consumers based on their lifestyle. They stated that setting marketers and designers can create niche markets within by differentiating based on “fit, styling, brand image, and when appropriate, prestige pricing”; however, developing an innovative new product from scratch is not likely to happen or be worth the risk. The research showed that textile and apparel firms differentiate a niche market strategy based on market (pull marketing).
For niche markets within the private label merchandise to be successful all of the respondents agreed that the product and brand needed to be differentiated. They agreed that in order to offer a differentiated product is was important to know the market in order to offer the market what they need.

Another important variable in the success of a niche market strategy in a private label program is to create perceived value to the customer. In addition, the respondent stated that it was important to have the right mix of national brand/private brand in order to give the private brand credibility in the eyes of the consumer.

Consistency is another important variable in the success of a specialized private label. Other respondents pointed out that even though the focus is on developing a differentiated, niche brand, there still needs to be sizeable volume in order to gain any type of economies of scale. Without the volume, in addition to design and sourcing capabilities, the private label loses the profitability component.

All respondents state that the supply chain is adapted to the customers, and therefore, have more knowledge of the consumer. This makes it easier to use a pull marketing approach. Retailers typically use market research to analyze the demographics and lifestyle of their consumer base. Another strategy used, mainly in the moderate/better price points, is imitating competing international brands. Retailers conduct a trend analysis in order to adapt the trend to their consumers. Retailers are also forming agreements with local designers in order to bring differentiated labels into their stores.

This study found that the retail sector cannot afford introducing a totally new product to the consumer which could risk alienation.

It is important to point out that while retailers use only a market, or “push”, approach in their niche marketing strategy, the success variables of the strategy were both market and product focused.

References

ZARA AMONGST FAST FASHION BRANDS: WHICH ARE THE MOST IMPORTANT BRAND EQUITY DIMENSIONS FOR ALBANIAN CONSUMERS?

I. Shyle¹, F. Gjana²

¹ Department of Production and Management, Polytechnic University of Tirana, Albania, irmitash@yahoo.com
² Faculty of Mechanical Engineering, Polytechnic University of Tirana, Albania

Keywords: brand equity, fast fashion, awareness, perceived quality, brand relationships, brand loyalty, Zara.

Abstract

Nowadays, discussing brands has become an everyday subject. Individuals prefer to buy brand name products, companies tend to build strong brands, researchers study and draw conclusions relevant for building brands and their meaning for consumers etc. Since the 80s, researchers entered inside the brand concept, already turning this concept that was once abstract and imaginary into a real concept and that, if properly understood, can have many advantages for companies. Managers are also aware of the fact that the brand has become an important asset of the company and their focus is necessary in creating brand equity. A strong brand is one that possesses high brand equity. Studies point to strong evidence that brand equity is considered a key factor that can bring to the company: higher profits, brand extension opportunities, protection against competitors.

Zara is the flagship store of the Spanish company called Inditex Group – one of the world’s largest fashion retailers. Zara provides a considerable number of products, which are more than rival corporations in the fashion industry. So, Zara is the leading brand in “fast fashion”. It can redesign existing products in no more than two weeks. The shorter the product life cycle, the larger success it will have in meeting consumer preferences.

The research problem of this paper is to study the dimensions of brand equity for the fast fashion brands using Zara as the brand. The research question is: “what is the level of awareness, perceived quality, brand relationships and brand loyalty, for Zara to the Albanian consumers?”

Research into how Zara works towards becoming a strong brand will be conducted using a
quantitative research in the form of a questionnaire survey.

1. Brand equity

Brand equity is a multidimensional concept and a very complex phenomenon. Keller [1] focused on two main concepts related to two components: brand awareness and relationships. Aaker [2, 3] lumped elements associated with brand equity in five categories: perceived quality, brand loyalty, brand awareness, brand relationships and other company-owned asset such as: patents, trademarks, etc. Among these five dimensions of brand, the first four represent customers and assess their reactions to the brand and this enables a better understanding of customers [4,5]. Numerous studies have focused on measuring brand equity based on the customer. Thus it is evident that strong brand equity means that customers have high awareness of brand name, have a positive image to the brand, perceived that the quality associated with the particular brand is high enough to warrant their loyalty.

To understand better the concept of the brand, the brand can be divided in two: to a functional domain and to an emotional or symbolic domain. In the functional domain, the basic brand feature is to expect that the product keeps its promises of performance – in other words it maintains the promised quality.

Thereby, the very basic consumer benefit is the brand replicating a simple satisfaction of a functional need and thereby solving a problem the consumer has had. Additionally, the functional domain enables the consumer to feel relieved, as the product brings the prime benefit to them, and thereby provides the consumer with a level of certainty in the uncertain world. In the long run, this makes the choice easy for the consumer, and eventually evolves into habitual behavior, as buying something that has been found to work as promised makes sense to the consumer [6].

Positive customer-based brand equity can have far-reaching effects, as customers might be more accepting towards the brand’s new products, increasing prices, and withdrawal of advertising. They also might be more likely to go and look for the brand from new distribution channels. A brand has reached positive customer-based brand equity, when the customers are responding more positively to the brand’s product or the way it is marketed than to those of an unidentified brand. Naturally, when the brand has negative customer-based brand equity, the consumers’ reaction is exactly the opposite and they respond less favorably to the product of the unpleasant brand than to those of an unidentified competitor. [1] Brand equity is an asset to the consumer based on the other four dimensions: brand awareness, brand relationships, perceived quality and brand loyalty.

2. The definition of Fast Fashion

A commitment to fast fashion puts a considerable amount of pressure on an organization. Given the rate at which fashion seems to change, it is necessary to carry out extensive and up to date
market research to keep up with current trends within the fashion industry. The characteristics of fast fashion are ‘fast’ and ‘fashion’. By capturing and releasing the latest fashion products in a prompt and affordable manner and releasing new fashion design quickly, product updates quickly at a lower price to meet consumers demand for access to fashion.

In last years, the fast fashion has raced to become the new bright spot in the world’s clothing market. Fast fashion is a term that is used to describe clothing collections which are based on the most recent fashion trends presented at Fashion Week in both the spring and the autumn of every year.

The fashion market today is a highly competitive market and consumers have a constant need for new products and the latest fashion trends [7]. Additionally price in no longer enough to be able to compete on the market and the speed of product decisions are crucial for delivering what consumers are demanding and expecting, which is fashion products available on a frequent basis [8]. The fast changes in the industry require relationships with suppliers possessing different skills and products. Furthermore the fashion industry requires suppliers that understand the importance of changes and the ability to get trends into the store and available to the consumer in shortest possible time [8].

The product development of fast fashion to the market is very quick. As trends change rapidly, there is emphasis on quick delivery and a compromise on quality. The aim is not to create products that would last long, but rather something that is trendy and would last the fashion season.

3. Zara as fast fashion brand

Zara is a good case study to show how it has managed to become a powerful brand in the fashion industry [9]. Zara is a good example of a fast fashion company that have been successful in developing a quick and flexible supply chain. The company can design, produce and deliver a new product in only 15 days. This brings the possibility for Zara to offer up-to-date design and fashion which their consumer’s demand [10].

Zara has managed to become the most valuable brand of the Spanish fashion distribution group, Inditex (a brand portfolio). Having 8 endorsed brands in the portfolio has helped Zara to gain power. It has also extended to set up another product class, Zara Home, as a result of its success and influence [11].

Two key factors that distinguish Zara from other fashion brands are design (most fashionable) and speed of launching a new collection (fast); these factors make it easier to implement a good brand strategy. Zara brand managers are more likely to use design and brand name to carry out a brand strategy, and there is almost no advertising involved. In the fashion industry, the design of Zara plays the most significant role in the success of developing a strong brand. In addition, Zara is positioned in the premium price (price dimension) and impressive approach (intrinsic dimension) by managers, and the material and quality of it is relevant to this price strategy. The chosen values of Zara fulfill not only the material need of consumers (e.g.
clothing is for security), but also consumers’ demand for self-actualisation (e.g. wearing Zara, they feel they are beautiful). Besides these, there is a positive image (which can be obtained from Zara’s fashionable design) and a high brand-added value (which has high perceptions of quality and high brand name awareness) of Zara for consumers. For instance, Zara’s name springs to consumers’ minds when people mention the high street fashion brands. Fashionable design with medium price is one of the most valuable distinguishing features of Zara, which means Zara mix the active product design and a premium strategy in the price dimension of positioning. It is one of the determinants which makes Zara’s brand so strong; another one is unique product strategy. In comparison with other competitors, Zara can produce 11,000 different products per year. The speed of creating a new design and delivering it to Zara stores is fast.

Riezebos et al. [12] suggest that “A successful brand can more easily be exploited on an international market”. Obviously, Zara is a strong global brand; there are 68 countries that have Zara stores. Using an international branding strategy, Zara not only increases its financial position, but also reinforces its strategic position in the world.

4. Methodology

A quantitative approach was used to collect data in this study. A questionnaire is a simply instrument, which is convenient for collecting and recording information about a particular issue of interest. Through this method we can access a large number of people from different areas. It is easy to standardize (respondent is asked the same question in the same way) and it is more economic than other methods, in terms of cost and time because in a short period of time and in a relatively cost effective way, a large amounts of data can be collected. Still there is no way to tell how truthful a respondent is being because the researchers cannot visually observe the respondent’s reactions to questions.

The objective of the questionnaire was to find the most important brand equity dimensions including quality, price, loyalty, image, awareness, for Albanian consumers. There were 21 closed ended questions. Questionnaire was divided into three parts, the first part include questions that request personal information like age, gender, work status etc. The second part contain question about the attitude toward fashion, and the third part the attitude toward ZARA. The questions involve the main elements of brand equity. Evaluation will be under evaluation Likert scales from 5 : 1 - never ( or at all ) to 5 - always ( or more ). The reason that we refer to 5 - tiered evaluation of Likert -it is because it is the most frequently used in studies made in the measurement of brand equity based on the customer.

To gather information for this study, was used a questionnaire survey for data collected. We created an online questionnaire survey using Google forms (http://bit.ly/ZARA_Albania). The respondents was required to just click on the link, this would take them to the site and he / she
could fill the form online and all the data could automatically be assembled into a spreadsheet format.

On August 24 the link was published on Facebook and LinkedIn. Till August 31, the link of the questionnaire survey was clicked from 583 users and just 213 of them completed it. The target responders for this study were buyers who buy ZARA products. To analyze the ZARA brand equity dimensions for Albanian consumers was important that the participants should have purchased ZARA brand so they are able to comprehend ZARA as a brand. We took in consideration the participants that have bought a product at ZARA, 193 of all participants.

To analyze the data that was collect we used descriptive statistics to describe what's going on in our data and inferential statistic to arrive at conclusions that remain beyond the immediate data. For analyzing the data has been used SPSS 22.0 statistical software. For descriptive statistics we used indications such as percentage, frequency, standard deviation and mean. In inferential statistics have been applied structural equations and confirmatory factor analysis.

5. Data analyze

According to demographic characteristics, our respondents tended to be young with moderate to middle incomes. Among 193 respondents, 75.6% were female and just 24.4% were male (Table 1). 93.3% were between 18-35 years of age, about 35.8% of them works (Table 2) and almost 52.8% of them reported a monthly income less than 70.000 ALL. Descriptive statistical analysis of data collected is provided in table 1 and 2.

<table>
<thead>
<tr>
<th>Table 1: The statistical distribution of gender distribution of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2: The statistical distribution of work status distribution of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work status</td>
</tr>
<tr>
<td>--------------</td>
</tr>
<tr>
<td>Student</td>
</tr>
<tr>
<td>Working</td>
</tr>
<tr>
<td>Self employed</td>
</tr>
<tr>
<td>Retired</td>
</tr>
<tr>
<td>Jobless</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Analyzing the respondent attitude toward fashion we found that 38.3% of the respondent shop once a month, 32% of them often choose to shop for apparel at a department store. Related with the price, 42.3% of them be of the opinion that is an important factor when they decide to buy,
36.3% consider color and design very important and 34.7% are neutral about brand popularity.

**Perceived quality:**

Participants are inclined to consider that the branding of Zara offers them a guarantee of quality in products, we can see from the results that they enjoy to buy ZARA products. Most of the participants are not satisfied with ZARA prices, 33.2 % are neutral and 44% disagree.

Referring to Riezebos [12]: “By the purchase and open consumption of branded articles, consumers can make it clear to which social group they belong and those to which they do not want to belong”, was design and the question “You buy ZARA because it reflects your social class” but the respondents don’t agree that the motivation why they buy ZARA is because reflects their social class.

**Brand loyalty:**

Nowadays the apparel industry and fashion brands use specific programs of customer loyalty to build a one to one relationship. The result shows that the respondent would recommend ZARA to their friends and it would be their first choice

| Table 3: Mean ranking and prioritization of effective factors related with perceived quality |
|-------------------------------------------------|------------|------------|
| Question                                         | N          | Mean       |
| ZARA produces high quality products.             | 193        | 3.187      |
| You buy ZARA because it reflects your social class. | 193        | 2.508      |
| You enjoy buying ZARA                           | 193        | 3.347      |
| You are satisfied with ZARA prices.              | 193        | 2.674      |

| Table 4: Mean ranking and prioritization of effective factors related with brand loyalty |
|-------------------------------------------------|------------|------------|
| Question                                         | N          | Mean       |
| The design of ZARA is the most significant reason that you are loyal to it | 193        | 3.286      |
| ZARA creates a comfortable environment for customers. | 193        | 3.575      |
| ZARA Albania has a convenient location.          | 193        | 3.104      |
| I would love to recommend ZARA to my friends     | 193        | 3.4        |
| ZARA would be my first choice.                   | 193        | 3.273      |

**Brand Awareness:**

From where the respondents stand we can say for ZARA that the level of awareness is high. The major part of participants agrees that can distinguish the logo of ZARA and immediately knows it is a fashion brand.
Table 5: Mean ranking and prioritization of effective factors related with brand awareness

<table>
<thead>
<tr>
<th>Question</th>
<th>N</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>When you see or hear the brand name ZARA, you immediately know it is a fashion brand</td>
<td>193</td>
<td>3.7876</td>
</tr>
<tr>
<td>You can distinguish the logo of “ZARA” from other logos, such as H&amp;M and Gucci.</td>
<td>193</td>
<td>3.46114</td>
</tr>
<tr>
<td>Your awareness of Zara is high</td>
<td>193</td>
<td>3.1062</td>
</tr>
</tbody>
</table>

Brand association:

Table 6: Mean ranking and prioritization of effective factors related with brand association

<table>
<thead>
<tr>
<th>Question</th>
<th>N</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>I like the brand image of ZARA</td>
<td>193</td>
<td>4.0127</td>
</tr>
<tr>
<td>ZARA is a trendsetter</td>
<td>193</td>
<td>4.1228</td>
</tr>
<tr>
<td>ZARA has a good reputation amongst fashion brands</td>
<td>193</td>
<td>3.8648</td>
</tr>
</tbody>
</table>

Finally the brand association is related with anything which is stuck in customer’s mind about the brand. The respondents like the image of ZARA and consider the brand a trendsetter, the mean of the two is 4 (equal “to agree” alternative). 43.5% of the participants agree that ZARA has a good reputation amongst fashion brands. (Figure 1)

Figure 1: ZARA has a good reputation amongst fashion brand.

The correlation between variables

As we can see from table 9, the correlation coefficient is close to +1.0, we say that there is a strong positive linear relationship between x and y. In other words, if x increases, y also increases.

For example: “You enjoy buying ZARA” and “You are satisfied with ZARA prices”, the correlation between this two variables is 0.535, between this two variables is some positive relation. But since the value is not that close to +1.0, the relationship is not strong. The lowest relation is between variables “The design of ZARA is the most significant reason that you are loyal to it” and “When you see or hear the brand name ZARA, you immediately know it is a fashion brand” with a coefficient 0.014. The strongest relation is between variables “Your awareness of Zara is high” and “You can distinguish the logo of ZARA” from other logos, such as H&M and Gucci”, the coefficient of correlation is 0.760.
The Kaiser-Meyer-Olkin (KMO) and Bartlett's Test

The KMO measures the sampling adequacy which should be greater than 0.5 for a satisfactory factor analysis to proceed. Based on the results (table 7) the KMO test has a value higher than 0.5 (0.893) and close to 1.0 which indicate that a factor analysis is useful for our data. The Bartlett’s Test of Sphericity must be less than 0.05 to consider significant.

<table>
<thead>
<tr>
<th>Table 7. KMO and Bartlett's Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaiser-Meyer-Olkin Measure of Sampling Adequacy:</td>
</tr>
<tr>
<td>Bartlett's Test of Sphericity</td>
</tr>
<tr>
<td>Approx. Chi-Square</td>
</tr>
<tr>
<td>Df</td>
</tr>
<tr>
<td>Sig.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 8. Variable dimensions of brand equity and their degree of importance for ZARA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Q.1</td>
</tr>
<tr>
<td>Q.2</td>
</tr>
<tr>
<td>Q.3</td>
</tr>
<tr>
<td>Q.4</td>
</tr>
<tr>
<td>Q.5</td>
</tr>
<tr>
<td>Q.6</td>
</tr>
<tr>
<td>Q.7</td>
</tr>
<tr>
<td>Q.8</td>
</tr>
<tr>
<td>Q.9</td>
</tr>
<tr>
<td>Q.10</td>
</tr>
<tr>
<td>Q.11</td>
</tr>
<tr>
<td>Q.12</td>
</tr>
<tr>
<td>Q.13</td>
</tr>
<tr>
<td>Q.14</td>
</tr>
<tr>
<td>Q.15</td>
</tr>
</tbody>
</table>

The variable dimensions of brand equity according to their degree of importance, for ZARA are as follows:
### Table 9. The correlation between variables

<table>
<thead>
<tr>
<th></th>
<th>ZARA produces high quality products.</th>
<th>You buy ZARA because it reflects your social class.</th>
<th>You enjoy buying ZARA</th>
<th>You are satisfied with ZARA prices.</th>
<th>The design of ZARA is the most significant reason that you are loyal to it</th>
<th>ZARA creates a comfortable environment for customers.</th>
<th>ZARA Albania has a convenient location.</th>
<th>I would love to recommend ZARA to my friends.</th>
<th>ZARA would be my first choice.</th>
<th>When you see or hear the brand name ZARA, you immediately know it is a fashion brand.</th>
<th>You can distinguish the logo of ZARA from other logos, such as H&amp;M and Gucci.</th>
<th>Your awareness of Zara is high</th>
<th>I like the brand image of ZARA</th>
<th>ZARA is a trendsetter.</th>
<th>ZARA has a good reputation amongst fashion brands</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZARA produces high quality products.</td>
<td>1</td>
<td>.318</td>
<td>.317</td>
<td>.308</td>
<td>.241</td>
<td>.280</td>
<td>.332</td>
<td>.296</td>
<td>.398</td>
<td>.245</td>
<td>.261</td>
<td>.178</td>
<td>.201</td>
<td>.314</td>
<td>.302</td>
</tr>
<tr>
<td>You buy ZARA because it reflects your social class.</td>
<td>.318</td>
<td>1</td>
<td>.317</td>
<td>.308</td>
<td>.241</td>
<td>.280</td>
<td>.332</td>
<td>.296</td>
<td>.398</td>
<td>.245</td>
<td>.261</td>
<td>.178</td>
<td>.201</td>
<td>.314</td>
<td>.302</td>
</tr>
<tr>
<td>You are satisfied with ZARA prices.</td>
<td>.418</td>
<td>.308</td>
<td>.535</td>
<td>1</td>
<td>.531</td>
<td>.329</td>
<td>.141</td>
<td>.405</td>
<td>.360</td>
<td>.139</td>
<td>.537</td>
<td>.608</td>
<td>.598</td>
<td>.654</td>
<td>.523</td>
</tr>
<tr>
<td>The design of ZARA is the most significant reason that you are loyal to it</td>
<td>.492</td>
<td>.241</td>
<td>.607</td>
<td>.531</td>
<td>1</td>
<td>.303</td>
<td>.207</td>
<td>.557</td>
<td>.422</td>
<td>.014</td>
<td>.527</td>
<td>.542</td>
<td>.453</td>
<td>.416</td>
<td>.539</td>
</tr>
<tr>
<td>ZARA creates a comfortable environment for customers.</td>
<td>.311</td>
<td>.280</td>
<td>.353</td>
<td>.329</td>
<td>.303</td>
<td>1</td>
<td>.157</td>
<td>.326</td>
<td>.244</td>
<td>.317</td>
<td>.434</td>
<td>.325</td>
<td>.411</td>
<td>.687</td>
<td>.529</td>
</tr>
<tr>
<td>ZARA Albania has a convenient location.</td>
<td>.393</td>
<td>.332</td>
<td>.226</td>
<td>.141</td>
<td>.207</td>
<td>.157</td>
<td>1</td>
<td>.219</td>
<td>.462</td>
<td>.183</td>
<td>.122</td>
<td>.191</td>
<td>.385</td>
<td>.468</td>
<td>.642</td>
</tr>
<tr>
<td>I would love to recommend ZARA to my friends.</td>
<td>.476</td>
<td>.396</td>
<td>.636</td>
<td>.405</td>
<td>.577</td>
<td>.326</td>
<td>.219</td>
<td>1</td>
<td>.463</td>
<td>.142</td>
<td>.538</td>
<td>.538</td>
<td>.504</td>
<td>.331</td>
<td>.521</td>
</tr>
<tr>
<td>ZARA would be my first choice.</td>
<td>.538</td>
<td>.398</td>
<td>.432</td>
<td>.360</td>
<td>.422</td>
<td>.244</td>
<td>.462</td>
<td>.463</td>
<td>1</td>
<td>.232</td>
<td>.362</td>
<td>.345</td>
<td>.651</td>
<td>.389</td>
<td>.544</td>
</tr>
<tr>
<td>When you see or hear the brand name ZARA, you immediately know it is a fashion brand</td>
<td>.014</td>
<td>.345</td>
<td>.111</td>
<td>.139</td>
<td>.014</td>
<td>.117</td>
<td>.183</td>
<td>.142</td>
<td>.232</td>
<td>1</td>
<td>.545</td>
<td>.519</td>
<td>.477</td>
<td>.259</td>
<td>.514</td>
</tr>
<tr>
<td>You can distinguish the logo of “ZARA” from other logos, such as H&amp;M and Gucci.</td>
<td>.522</td>
<td>.361</td>
<td>.622</td>
<td>.537</td>
<td>.527</td>
<td>.434</td>
<td>.122</td>
<td>.538</td>
<td>.362</td>
<td>.545</td>
<td>1</td>
<td>.660</td>
<td>.342</td>
<td>.375</td>
<td>.456</td>
</tr>
<tr>
<td>Your awareness of Zara is high</td>
<td>.540</td>
<td>.378</td>
<td>.741</td>
<td>.608</td>
<td>.542</td>
<td>.325</td>
<td>.191</td>
<td>.538</td>
<td>.345</td>
<td>.519</td>
<td>.760</td>
<td>1</td>
<td>.395</td>
<td>.510</td>
<td>.436</td>
</tr>
<tr>
<td>I like the brand image of ZARA</td>
<td>.471</td>
<td>.301</td>
<td>.542</td>
<td>.598</td>
<td>.453</td>
<td>.411</td>
<td>.385</td>
<td>.504</td>
<td>.651</td>
<td>.477</td>
<td>.342</td>
<td>.395</td>
<td>1</td>
<td>.571</td>
<td>.404</td>
</tr>
<tr>
<td>ZARA is a trendsetter</td>
<td>.352</td>
<td>.314</td>
<td>.617</td>
<td>.654</td>
<td>.416</td>
<td>.687</td>
<td>.468</td>
<td>.351</td>
<td>.389</td>
<td>.659</td>
<td>.375</td>
<td>.510</td>
<td>.371</td>
<td>1</td>
<td>.674</td>
</tr>
<tr>
<td>ZARA has a good reputation amongst fashion brands</td>
<td>.455</td>
<td>.302</td>
<td>.365</td>
<td>.523</td>
<td>.539</td>
<td>.529</td>
<td>.642</td>
<td>.521</td>
<td>.544</td>
<td>.714</td>
<td>.456</td>
<td>.436</td>
<td>.404</td>
<td>.674</td>
<td>1</td>
</tr>
</tbody>
</table>

*Pearson Correlation. N 193
Sig. (2-tailed), Correlation is significant at the 0.05 level (2-tailed)*
So the most important variable for consumers is ZARA produces high quality products followed by ZARA is a trendsetter. The two variables are part of perceived quality dimensions.

We consolidate four variables that are related with perceived quality into one new variable called “Perceived quality”, five variables that are related with brand loyalty into one new variable called “Brand loyalty” and six variables that are related with brand awareness /association into one new variable called “Brand awareness/association”.

We analyzed the brand equity for Albanian consumers based on perceived quality, brand loyalty and brand awareness/association. Using statistical technique to SPSS we have been analyzed the research questions, how they impact on purchase decision of ZARA products. The information contained in table 10 indicate that the three possibilities (perceive quality, brand loyalty and brand awareness/association) influence on Albanian consumers.

<table>
<thead>
<tr>
<th>Table 10. The result of testing research hypotheses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Value = 0</td>
</tr>
<tr>
<td>t</td>
</tr>
<tr>
<td>Perceived quality</td>
</tr>
<tr>
<td>Brand loyalty</td>
</tr>
<tr>
<td>Brand awareness/association</td>
</tr>
</tbody>
</table>

Table 11. The Mean ranking and prioritizing of factors effects

<table>
<thead>
<tr>
<th>Factors</th>
<th>Mean ranking</th>
<th>Prioritizing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived quality effects</td>
<td>3.9171</td>
<td>1</td>
</tr>
<tr>
<td>Brand loyalty effects</td>
<td>3.8964</td>
<td>2</td>
</tr>
<tr>
<td>Brand awareness/association quality effects</td>
<td>3.6667</td>
<td>3</td>
</tr>
</tbody>
</table>

Significant level is less than the error rate (0.000 <0.05), so there is difference between mean of variables that effect on Albanian consumers. In other words, 95% confidence level can be stated that Mean ranking of variables related to the purchase decision isn’t equal and some variables than others from the perspective of the respondents have higher priority.

Which are the most important variables for Albanian consumer when they decide to buy clothes?

<table>
<thead>
<tr>
<th>Table 12. The most important variables for Albanian consumer when they decide to buy clothes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coefficient</td>
</tr>
<tr>
<td>The importance of price</td>
</tr>
<tr>
<td>The importance of on-trend</td>
</tr>
<tr>
<td>The importance of brand popularity</td>
</tr>
<tr>
<td>The importance of color and design</td>
</tr>
<tr>
<td>The importance of product quality</td>
</tr>
<tr>
<td>The importance of location</td>
</tr>
<tr>
<td>The importance of store atmosphere</td>
</tr>
</tbody>
</table>

*Extraction Method: Principal Component Analysis.*
In table 12 are showed all the variables with their coefficient. The most important variable is product quality followed by price. The store atmosphere is considered less important comparing with the other features.

6. Conclusion

According to the results of this study the three dimensions of brand equity, perceived quality, brand loyalty and brand awareness are consider very important for Albanian consumer. Not the three of this dimension have the same importance for them. The data collected from the questionnaire indicate that the perceived quality and brand loyalty are more important and can influence more on their purchase decision. The influence of brand awareness/association was a little bit low comparing with brand loyalty and perceived quality. Albanian consumers consider the perceived quality the most important from brand equity dimensions. The most important variable for Albanian consumers is “ZARA produces high quality products”.

Reference

EFFECT OF INORGANIC ADDITIVES IN POLYMERIC FIBER PROPERTIES

E. Liço, I. Boci, S. Drushku

Spacing Department of Industrial Chemistry, Faculty of Natural Sciences, University of Tirana, Albania
edi.lico@fshn.edu.al

Keywords: inorganic additives, polymeric fibers, physic-mechanical properties, FTIR, SEM

Abstract

The object of our work is the study of effect of inorganic additives in physical and mechanical properties of polymeric fibers. Calcium carbonate CaCO$_3$ and silica SiO$_2$ are added as fillers in polypropylene and polystyrene polymeric matrixes, within the range 5-25%. Industrially virgin polypropylene and polystyrene is supplied from recycling companies operating in Albanian market, and are identified by FTIR spectroscopy. The processing of polymeric fibers is done with the help of a modified melt flow index apparatus. Fibers with diameters varying from 1.2-2mm were formed. As physical properties are determined melt flow index, specific gravity and density, while elasticity modulus, tensile strength and elongation at break are determined using a uniaxially tensile test. Using a FTIR spectroscopy is studied additive-polymeric micro structure. The results show the effects of additives in the changes of physic-mechanical properties in polymeric fibers. Also, a good mixing procedure of additives with polymers, including fine materials used and a rigorous temperature and time control during mixing, showed to have an effect in the homogeneity of the fibers, as confirmed from the SEM micrographs.

Introduction

Polymer composites are mixtures of polymers with inorganic or organic additive having certain geometries (fibers, flakes, spheres, and particulates). Additives to polymers are materials that are added to polymers in order to improve or change their visual properties, environmental resistance and degradation process (Seth Bates, 2013). The additives may be continuous, for example, long fibers or ribbons; these are embedded in the polymer in regular geometric arrangements that extend throughout the dimensions of the product. Familiar examples are the well-known fiber-based thermo set laminates that are usually classified as high-performance polymer composites, or as macro composites based on the length of the fibers or ribbons. On the other hand, additives may be discontinuous (short), for example, short fibers (say, <3cm in length), flakes, platelets,
spheres, or irregulars (millimeter to micrometer size); fibers and flakes are usually dispersed in different orientations and multiple geometric patterns throughout the continuous matrix forming micro composites. Such systems are usually based on a thermoplastic matrix and are classified as lower performance polymer composites compared to their counterparts with continuous additives (Marino Xanthos, 2010).

The inclusion of particulate fillers in polymeric materials is an established industrial practice, which typically is aimed to enhance polymer properties such as modulus, fracture resistance and toughness while reducing the overall component cost (Landon et al, 1977).

The inorganic nanofillers have large surface area, leading to a dramatic increase in interfacial area. These nanofillers, even at very low concentrations, can strongly change the macroscopic properties of the polymer. Inorganic nanofillers include nanotubes, metal oxides (e.g., SiO₂, TiO₂, Al₂O₃, Fe₃O₄), layered silicates (e.g., montmorillonite, saponite), metallic nanoparticles (e.g., Au, Cu), semiconductors (e.g., PbS, CdS), and mesoporous silicas, etc. (Liangming Wei et al, 2010).

Polypropylene (PP) is an important commercial polymer widely used in many areas such as packaging, automotive industry, fibres and textiles. Its wide use exhibits stems from an attractive combination of low cost, low weight, easy processibility, as well as desirable end-use properties (Anna Ujhelyiová et al 2012). PP can be considered a tough material at room temperature and it also possesses good chemical resistance.

Polystyrene (PS), one of the most important materials from the modern plastic industry, has been used all over the world, due to its excellent physical properties and low-cost. (Rabie et al.2008). It is used in applications in the following major markets: packaging, consumer/institutional goods, electrical/electronic goods, building/construction, furniture, industrial/machinery, and transportation. PS is an amorphous polymer with a glass-transition temperature (Tg) between 90 to 110°C; it has the advantages of being clear, hard, easily processed and low cost. Although PS has many desirable properties, its disadvantages are low impact strength and poor chemical resistance at room temperature, especially to ketones and ethers.

CaCO₃ affects the total degree of polymer crystallinity, the crystallization rate and crystallization temperature. The mechanical properties of PP modified with nano-CaCO₃ have been increased, too. So, the thermal and mechanical properties of conventional polymers can be significantly influenced using fillers that act as artificial nucleating agents.

Silica and carbon black have been commonly used as reinforcing agents and/or fillers in rubber and thermoplastic polymers. The incorporation of such silica and carbon black as reinforcing agents and/or fillers is far more complex than might otherwise appear. One problem in wet blending of silica with lattices of such polymers arises from the fact that the hydrophilic silica has a tendency to associate with the aqueous phase and it doesn’t blend with the hydrophobic polymer uniformly (John W. Lightsey et al, 1999).

The international composites market, which is dominated by the US and Europe with approximately equal shares, continues to grow at a healthy pace. Dominating fields of applications are transportation and construction, particularly where electrical insulation and
corrosion-resistance are valued, followed by consumer products and sporting goods. (Tomas Åström, 1997)

Materials and methods

Industrial clean polypropylene PP and polystyrene PS supplied from recycling industry. The PP and PS was in granule form and was grinded in universal Cutting Mill PULVERISETTE 15. Powder calcium carbonate CaCO$_3$ and silica SiO$_2$, supplied by Merck Company. Initially the melt flow index of polypropylene and polystyrene is determined using a Ray Ran Model 6MBA apparatus conform ASTM D 1238 standard. Cylindrical dries 2mm in diameter are installed in the melt flow index apparatus, modifying it for the production of polymeric fibers containing different inorganic additives. Also a well modified controlled procedure for the better mixing of polymer with the additives is applied. Specific gravity and density for all polymeric fibers with different additives content was determined according ASTM D792, by using 50 ml pycnometer and 2-propanol.

The FTIR analysis is done on pellets, formed with the help of hydraulic Perkin Elmer press in 160$^\circ$C described in Achillias 2007. The FTIR instrument used was BRUKER Vertex 70 FT-IR spectrometer equipped with MIR and NIR source and ATR unit. The processing software used was OPUS _7_2_139. The resolution of FT-IR instrument was 4cm$^{-1}$ and the recorded wavenumber range was from 400 - 4000 cm$^{-1}$ (MID IR region). 32 spectra were taken to reduce noise.

The tensile test for the determination of mechanical properties was performed using a Model YG026B instrument with an axial attraction in one direction. Polymeric fibers were drawn with 100 mm/min speed at 27$^\circ$C temperature and relative humidity 44%. Polymeric fibers initial length was 50 mm and their diameter ranged from 1-2mm. Force-elongation graphs were taken by testing polymeric fibers. Force-elongation characteristics depend on the dimensions of the fibers. Obtained force-elongation diagrams were converted (taking into account the cross sectional area of fibers and their initial length) in stress-strain graphic in order to determine their mechanical properties in tensile strength, fracture strength, yield strength and elasticity modulus (Callister 2007).

Results and discussions

In table 1 and 2 are presented the melt flow index values for polymers with different content of inorganic additives.

<table>
<thead>
<tr>
<th>Polypropylene</th>
<th>0% additive</th>
<th>5% additive</th>
<th>10% additive</th>
<th>15% additive</th>
<th>20% additive</th>
<th>25% additive</th>
</tr>
</thead>
<tbody>
<tr>
<td>CaCO$_3$</td>
<td>25</td>
<td>24.7</td>
<td>24.2</td>
<td>23.6</td>
<td>23.2</td>
<td>22.3</td>
</tr>
<tr>
<td>SiO$_2$</td>
<td>25</td>
<td>24.4</td>
<td>23.7</td>
<td>23.2</td>
<td>22.9</td>
<td>22.6</td>
</tr>
</tbody>
</table>
Table 2: Melt Flow Index MFI (gr/10 min) of polystyrene with different content of inorganic additives (temperature 200°C and 5 kg weight)

<table>
<thead>
<tr>
<th>Polystyrene</th>
<th>0% additive</th>
<th>5% additive</th>
<th>10% additive</th>
<th>15% additive</th>
<th>20% additive</th>
<th>25% additive</th>
</tr>
</thead>
<tbody>
<tr>
<td>CaCO₃</td>
<td>7</td>
<td>6.8</td>
<td>6.5</td>
<td>6.3</td>
<td>5.9</td>
<td>5.7</td>
</tr>
<tr>
<td>SiO₂</td>
<td>7</td>
<td>6.7</td>
<td>6.5</td>
<td>6.2</td>
<td>5.8</td>
<td>5.6</td>
</tr>
</tbody>
</table>

In tables 3 and 4 are presented the specific gravity and density for polymers with different content of inorganic additives.

Table 3: Specific gravity and density of polypropylene with different content of inorganic additives (isopropyl alcohol with 0.786 g/cm³ density at 20°C is used as liquid).

<table>
<thead>
<tr>
<th>Polypropylene</th>
<th>Specific gravity</th>
<th>0% additive</th>
<th>5% additive</th>
<th>10% additive</th>
<th>15% additive</th>
<th>20% additive</th>
<th>25% additive</th>
</tr>
</thead>
<tbody>
<tr>
<td>CaCO₃</td>
<td>1.22</td>
<td>1.28</td>
<td>1.39</td>
<td>1.44</td>
<td>1.50</td>
<td>1.59</td>
<td></td>
</tr>
<tr>
<td>SiO₂</td>
<td>1.22</td>
<td>1.27</td>
<td>1.36</td>
<td>1.40</td>
<td>1.46</td>
<td>1.55</td>
<td></td>
</tr>
<tr>
<td>Density</td>
<td>0.96</td>
<td>1.01</td>
<td>1.09</td>
<td>1.13</td>
<td>1.18</td>
<td>1.25</td>
<td></td>
</tr>
<tr>
<td>gr/cm³</td>
<td>0.96</td>
<td>1.00</td>
<td>1.07</td>
<td>1.10</td>
<td>1.15</td>
<td>1.22</td>
<td></td>
</tr>
</tbody>
</table>

Table 4: Specific gravity and density of polystyrene with different content of inorganic additives (isopropyl alcohol with 0.786 g/cm³ density at 20°C is used as liquid).

<table>
<thead>
<tr>
<th>Polypropylene</th>
<th>Specific gravity</th>
<th>0% additive</th>
<th>5% additive</th>
<th>10% additive</th>
<th>15% additive</th>
<th>20% additive</th>
<th>25% additive</th>
</tr>
</thead>
<tbody>
<tr>
<td>CaCO₃</td>
<td>1.26</td>
<td>1.31</td>
<td>1.41</td>
<td>1.48</td>
<td>1.54</td>
<td>1.63</td>
<td></td>
</tr>
<tr>
<td>SiO₂</td>
<td>1.26</td>
<td>1.30</td>
<td>1.37</td>
<td>1.44</td>
<td>1.51</td>
<td>1.56</td>
<td></td>
</tr>
<tr>
<td>Density</td>
<td>0.99</td>
<td>1.03</td>
<td>1.11</td>
<td>1.16</td>
<td>1.21</td>
<td>1.28</td>
<td></td>
</tr>
<tr>
<td>gr/cm³</td>
<td>0.99</td>
<td>1.02</td>
<td>1.08</td>
<td>1.13</td>
<td>1.19</td>
<td>1.23</td>
<td></td>
</tr>
</tbody>
</table>

The determination of mechanical properties is done by using a uniaxial tensile test. The results of elasticity modulus, tensile strength and elongation at break are presented in diagrams below.

Graphic 1: elastic modulus, tensile strength and elongation at break (secondary axis-right) for polypropylene with different content of calcium carbonate.
From the results we observed that we have an increase tensile strength and elastic modulus with the increase of content of calcium carbonate and silica in polypropylene and polystyrene. So, the addition of these inorganic additives make the polymers more stronger, but less ductile.

With the help of FTIR spectroscopy we have analyze the microstructure of samples.
The presence of new peaks on the right spectrum presents the vibration peaks of CaCO₃ bonds. The intensity of these new peaks is low, based in the low content of CaCO₃. The same results are observed by using FTIR spectroscopy also for the others samples polypropylene with calcium carbonate and silica and for polystyrene with silica. These results show the entrance of inorganic additives in polymeric matrix.

Conclusions

Inorganic additives influences in the physic-mechanical properties of polymers. Calcium carbonate and silica show the decrease of melt flow index of polypropylene and polystyrene, making them more difficult in processing. The increase of content of inorganic additives in polymers makes them stronger, but less ductile. These are evident by the increasing of elastic modulus and tensile strength and the decrease of elongation at break. By using FTIR spectroscopy we have observed new peaks appeared in the microstructure of polypropylene and polystyrene, showing the presence of inorganic additives in polymeric matrix.

References


THE USE OF R FOR TEXTILE ENGINEERING DATA ANALYSIS

L. Prifti, Sh. Shehu, D. Salillari

Polytechnic University of Tirana, Faculty of Mathematical Engineering and Physical Engineering,
Department of Mathematical Engineering, Rruga “Muhamet Gjollesha”, Tirane, Albania.
luprfiti@fimif.upt.al

Keywords: R, textile data, statistics

Abstract

The evolution of computer technology has contributed to the development of many statistical programs that accelerate and facilitate the data analysis. One of them is the statistical software free of charge R. An environment within which many classical and modern statistical techniques have been implemented.

This paper aims to present some of the basic concepts of R in presenting, analyzing and interpreting the data in a textile engineering application. To realize that function calls are used as commands that apply different mathematical functions giving us more possibilities than simple statistical software.

Introduction

R is a powerful programming language that is particularly suited to statistical analysis. The striking difference between R and most other statistical packages is that it is free software and that it is maintained by scientists for scientists. Installation of the Windows version is quick and easy available from the URI: http://cran.r-project.org. R is an integrated suite of software facilities for data manipulation, calculation and graphical display [1]. This paper aims to present some of the basic concepts of R in presenting, analyzing and interpreting the data in a textile engineering application. In this study 50 samples of wool fibers from region of Delvina on which the measurements are carried out on the elongation and resistance to the wool fibers rupture are treated [2]. The Measurements are taken in the Physical-Mechanical and Chemical laboratory of Textile and Mode in Polytechnic University of Tirana, accredited above the international standard ISO/IEC 17025: 2005. A matrix database called DATA with two columns names ELONGATION and RESISTANCE is used. Some basic commands of R for descriptive statistics, graphs and goodness of fit of statistical tests [3] for DATA are selected to describe the
applications realized and the interpretation for each of them is presented.

Data entry in R

R is most easily used in an interactive manner. The promt > is used to indicate where to type. If a command is too long to fit on a line, a + is used for the continuation prompt. The assignment operator is a = or <-. The most useful R command for quickly entering in small data sets is the c() function. This function combines, or concatenates terms together.

> c(1,2,3)
[1] 1 2 3

The read.table () is used to read data from the clipboard. At the beginning the data base was organized in an excel file, so in Excel, select the data and to transfer to R use copy it to the clipboard (Excel Edit -> Copy. Then to read it in R the below command is used.

> DATA <- read.table (file = “clipboard”)

The first rows contain column headers ELONGATION and RESISTANCE to use as variable names is needed the specification of the adding header = TRUE:

> DATA <- read.table (file = “clipboard”, header = TRUE)

To save a data frame as an R datafile (*.Rdata is the default filetype) and reload it for a later session the commands used are save () or load ()

> save(DATA, file = "DATA.Rdata")

Then to load the saved data frame using load() function:

> load("DATA.Rdata")

Statistical analysis of the DATA using R.

To calculate simple summary statistics with R: the mean, standard deviation, variance, and median the command used is summary () function:

> summary (DATA)

The results achieved are:

<table>
<thead>
<tr>
<th>ELONGATION</th>
<th>RESISTANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min.       : 7.30</td>
<td>Min.       : 2.27</td>
</tr>
<tr>
<td>1st Qu.:35.38</td>
<td>1st Qu.:28.49</td>
</tr>
<tr>
<td>Median :39.70</td>
<td>Median :39.95</td>
</tr>
<tr>
<td>Mean   :38.79</td>
<td>Mean   :38.30</td>
</tr>
<tr>
<td>3rd Qu.:45.65</td>
<td>3rd Qu.:47.19</td>
</tr>
<tr>
<td>Max.    :56.60</td>
<td>Max.    :75.16</td>
</tr>
</tbody>
</table>

> sd (DATA)

<table>
<thead>
<tr>
<th>ELONGATION</th>
<th>RESISTANCE</th>
</tr>
</thead>
</table>
Components of a matrix (i.e., individual variables) can be accessed using the $ notation:

```r
> var (DATA)
```

<table>
<thead>
<tr>
<th></th>
<th>ELONGATION</th>
<th>RESISTANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELONGATION</td>
<td>93.56588</td>
<td>84.69066</td>
</tr>
<tr>
<td>RESISTANCE</td>
<td>84.69066</td>
<td>249.50488</td>
</tr>
</tbody>
</table>

To present the “boxplot”, or the “box-and-whiskers plot” for the data under study the command used is:

```r
> boxplot (DATA)
```

If multiple groups are supplied either as multiple arguments or via a formula, parallel boxplots will be plotted, in the order of the arguments or the order of the levels of the factor. The lines (“whiskers”) show the largest or smallest observation that falls within a distance of 1.5 times the box size from the nearest hinge. If any observations fall farther away, the additional points are considered “extreme” values and are shown separately.

The boxplots for DATA are presented in Figure 1.

![Boxplots for Elongation and Resistance.](image)

To sort (or order) a vector or factor (partially) into ascending or descending order it is used the `sort()` function:

```r
> sort (DATA$ELONGATION)
```

[1]  7.3 16.0 16.4 19.6 27.4 27.4 30.3 30.3 32.4 33.1 33.8 34.9 35.3 35.6 37.0  
[16] 37.0 37.4 37.9 38.1 38.1 38.5 38.8 38.8 38.8 39.5 39.9 40.2 40.2 40.6 40.6  
[31] 41.0 41.7 42.3 42.8 43.5 44.2 44.6 46.0 46.3 46.3 46.6 46.7 47.0 48.1 48.8  
[46] 49.2 51.0 52.7 53.1 56.6
To build a frequency table for a variable the table () function it is used as below:

```r
> table (DATA$ELONGATION)
7.3  16 16.4 19.6 27.4 30.3 32.4 33.1 33.8 34.9 35.3 35.6 37 37.4 37.9 38.1
  1  1  1  1  2  2  1  1  1  1  1  2  1  1  2
38.5 38.8 39.5 39.9 40.2 40.6 41 41.7 42.3 42.8 43.5 44.2 44.6 46 46.3 46.6
  1  3  1  2  2  2  1  1  1  1  1  1  1  1  2  1
46.7 47 48.1 48.8 49.2 51 52.7 53.1 56.6
  1  1  1  1  1  1  1  1
```

```r
> cut (DATA$ELONGATION, breaks=5)
[1] (36.9,46.8] (7.25,17.1] (36.9,46.8] (27,36.9] (36.9,46.8] (46.8,56.6]
[7] (27,36.9] (46.8,56.6] (36.9,46.8] (36.9,46.8] (36.9,46.8] (36.9,46.8]
[13] (36.9,46.8] (36.9,46.8] (36.9,46.8] (46.8,56.6] (36.9,46.8] (36.9,46.8]
[19] (36.9,46.8] (36.9,46.8] (46.8,56.6] (36.9,46.8] (36.9,46.8] (36.9,46.8]
[31] (36.9,46.8] (7.25,17.1] (36.9,46.8] (36.9,46.8] (27,36.9] (36.9,46.8]
[37] (27,36.9] (27,36.9] (36.9,46.8] (36.9,46.8] (27,36.9] (36.9,46.8]
[43] (7.25,17.1] (46.8,56.6] (36.9,46.8] (36.9,46.8] (46.8,56.6] (36.9,46.8]
[49] (36.9,46.8] (36.9,46.8]
Levels: (7.25,17.1] (17.1,27] (27,36.9] (36.9,46.8] (46.8,56.6]
```

To get an idea for the probability distribution of the data under study the histogram is presented in Figure 2 using: hist () function:
```r
> hist (DATA$ELONGATION)
```
The breaks = n are specified in the hist call to get approximately n bars in the histogram since the algorithm tries to create “pretty” cutpoints. The full control over the interval divisions is reached specifying breaks as a vector rather than as a number.

To overlay in the histogram the distribution line the command used is:

```r
> hist (DATA$ELONGATION, prob=TRUE, ylim=c(0,0.06))
> lines (density(DATA$ELONGATION, bw="SJ"))
```

Figure 3 presents the histogram and the distribution line for the Elongation data.

Two of the statistical tests used in R to give a final answer about the distribution line presented are: Kolmogorov-Smirnov test and Shapiro-Wilk.

The first one, Kolmogorov-Smirnov test is used to decide if a sample comes from a population with a specific distribution.

```r
> ks.test(DATA$RESISTANCE,"pnorm",mean=mean(DATA$RESISTANCE),sd=sqrt(var(DAT
```
A$RESISTANCE$))
One-sample Kolmogorov-Smirnov test

data:  DATA$RESISTANCE
D = 0.0586, p-value = 0.9915
alternative hypothesis: two-sided

Shapiro-Wilk test is one of the most powerful normality tests, especially for small samples. Normality is tested by matching two alternative variance estimates: a non-parametric estimator got by a linear combination of ordered sample values and the usual parametric estimator. The statement performing Shapiro-Wilk test is shapiro.test() and it supplies W statistic and the p-value:
> shapiro.test(DATA$RESISTANCE)

Shapiro-Wilk normality test
data:  DATA$RESISTANCE
W = 0.9901, p-value = 0.9474

The p-values achieved from two tests higher than 0.05 shows that the null hypothesis is true, so the RESISTANCE data follows a normal distribution.

> shapiro.test(DATA$ELONGATION)

Shapiro-Wilk normality test
data:  DATA$ELONGATION
W = 0.9268, p-value = 0.004199

The p-value = 0.004199 < 0.05 shows that the ELONGATION data do not follow a normal distribution.

To obtain the entire matrix of correlations between all variables in a data frame it is used cor() function:

> cor(DATA)

<table>
<thead>
<tr>
<th></th>
<th>ELONGATION</th>
<th>RESISTANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELONGATION</td>
<td>1.0000000</td>
<td>0.5542903</td>
</tr>
<tr>
<td>RESISTANCE</td>
<td>0.5542903</td>
<td>1.0000000</td>
</tr>
</tbody>
</table>

To test for association between paired samples or whether the correlation is significantly different from zero we use the cor.test() function:
> cor.test(DATA$ELONGATION,DATA$RESISTANCE)
Pearson's product-moment correlation
data: DATA$ELONGATION and DATA$RESISTANCE
t = 4.6139, df = 48, p-value = 2.962e-05
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
0.3262833 0.7213450
sample estimates:
    cor
0.5542903
The p-value = 2.962e-05 < 0.05 shows that the correlation is not equal to 0.

Conclusions

R is a powerful programming language that is particularly suited to statistical analysis. In this paper the basic concepts of R for descriptive statistics, graphs and goodness of fit of statistical tests are presented using the textile data base (DATA). The use of R to perform the calculation and to present the graphics gives more possibilities than simple statistical software. For the above applications realized the interpretation for each of them is presented.

References

THE IMPORTANCE OF BRAND’S RELATIONSHIPS VARIABLES IN BRAND EQUITY - A CASE STUDY OF SNEAKERS TO ALBANIAN CONSUMERS

I. Shyle¹, V. Panajoti Hysi²

¹ Department of Production and Management, Polytechnic University of Tirana, Albania, irmitash@yahoo.com
² Faculty of Economy, University of Tirana, Albania, email: vhysi@hotmail.com

Keywords: brand equity, brand relationships, functional attributes, non-functional attributes.

Abstract

What is evident in all studies is the fact that brand equity is considered as a key factor that can bring the following to the company: higher profits, brand extension opportunities, protection against the competition leading to a strengthening of the consumers purchasing intentions and customer loyalty. Brand relationships are not only the main aspects related to brand equity but also are key aspects of the buying process as well as loyalty to the brand. Brand relationships can be described by some sub-dimensions such as: value, personality, and their organizational dimensions, some company features that are incorporated within a brand to identify the brand with the company. Brand relationships are represented by the psychological connection with brand which is stored in the consciousness of the consumer and also represents dimensions referred to tangible or intangible such as attributes, lifestyle, usage etc. But brand relationships are also seen as a combination of brand image (i.e. functional and non-functional perceptions), brand attitude (on all brand assessment) and perceived quality (overall superiority trial). Companies use brands to differentiate, position and expand the brand, to create positive attitudes and feelings towards it, and to suggest attributes or benefits from the purchase or use of a specific brand. Consumers use brand relationships to assist in arranging, organizing and reliving information stored within their memory and use it in the purchase making decision. If a brand clearly positions itself through one or more relationships, it will be difficult for the competition to claim the lead on aspects implied by these relationships, which can lead to barriers to entry for competitors.

This paper will use the model built by Aaker (1991) to measure brand equity. Through Aaker's model this study will retest the measurement of brand equity based on the sneakers brands...
(Adidas, Puma, Nike, Reebok) selected by 344 Albanian consumers. The purpose of this paper is to study the relationship that exists between brand relationships and brand equity for the sneakers brands included in the study. Furthermore it will also aim to identify the variables of brand relationships that are considered the most important to Albanian consumers and have significant impact on brand equity.

1. Brand relations as dimension of brand equity

Brand equity is a multidimensional concept and a very complex phenomenon. Keller [1] focused on two main concepts related to two components: brand awareness and relationships. Aaker [2; 3] lumped elements associated with brand equity in five categories: perceived quality, brand loyalty, brand awareness, brand relationships and other company-owned asset such as: patents, trademarks, etc. Among these five dimensions of brand, the first four represent customers and assess their reactions to the brand and this enables a better understanding of customers [4; 5]. Numerous studies have focused on measuring brand equity based on the customer. Thus it is evident that strong brand equity means that customers have high awareness of brand name, have a positive image to the brand, perceived that the quality associated with the particular brand is high enough to warrant their loyalty.

Brand relationships are not only the main aspects related to brand equity but also are key aspects of the buying process as well as loyalty to the brand [2; 3]. Brand relationships consist of thoughts, feelings, perceptions, image, experiences, beliefs and attitudes of consumers regarding the particular brand [6]. There are three important dimensions associated with the brand image such as being friendly, powerful and unique. Numerous studies focusing on the relationship of the brand and its impact on building brand equity have highlighted three types of brand relationships.

- a relationship with the brand as a product (the value),
- a relationship with the brand as a person (brand personality)
- a relationship with the brand as an organization (organizational relationships)

The relationship with the brand as a product includes functional and non-functional attributes.

**Functional attributes** are visible and tangible product features [7]. So consumers evaluate a brand based on these characteristics associated with the brand. If a brand fails to submit those attributes and characteristics for which it is designed, it is therefore characterized by a low level of brand equity.

**Non-functional attributes** include symbolic attributes which are invisible or intangible, but for the customer are as important as functional attributes when assessing a brand. Through these dysfunctional attributes the consumer identifies and meets the needs associated with social acceptance or self-esteem [7]. We include some of the following as dysfunctional product
attributes: social image, perceived value, differentiation, country of origin as well as reliability.

**Social image** is defined as the consumer perception of the honor and respect for the social group of customers who use the particular brand [8]. All of this has to do with the attributes of a product that a consumer perceives it has, or what other consumers think of the consumers of a certain brand.

**Perceived value** is defined as the perceived usefulness of the brand associated with its cost and value drawn by the customer based on simultaneous consideration of what was benefited comparatively to the non-use of another product. Consumers choose a brand product by comparing price and all the benefits and values that they benefit from the product and its brand compared to competitors [2]. The customer is willing to pay a price even higher than compared to normal for a product which is characterized by high brand equity [8].

**Differentiation** is defined as the extent to which consumers perceive that a brand is distinct from competitors and customers believe they are reasonable in purchasing this brand over the competition [3]. A brand can have a premium price if it is perceived as very distinct from competitors [9]. Numerous studies have highlighted the importance of the distinct characteristics of the brand positioning and all this affects the success of a brand.

**Country of origin** is defined as country, region or state with which consumers perceive a brand association. Place of origin of a product as well as brand name are important elements that affect consumer perceptions [10]. Country of origin refers to the country of origin of a company or a product or a place where the product is manufactured.

**Reliability** is defined as the confidence that the customer has with your company, the communications released from the public relations department of the company and everything that done by the company to serve a consumers’ interest [2; 4]. Reliability affects consumers directly in building brand equity [8] as many cases customers admire the brand of a product just because they belong to a company that has built a positive image towards the consumer [2; 3].

2. **Brand relationships and brand equity by Aaker's model**

According to David Aaker brand relationships deal with categories of assets and liabilities that include everything related to brand remembrance. Aaker states that the dimensions of brand equity relationships usually include the dimensions of the image which are unique to the product class or brand. Brand relationships can be described by some sub-dimensions such as: value, personality, and their organizational dimensions, some company features that are incorporated within a brand to identify the brand with the company. Brand relationships are represented by the psychological connection with brand which is stored in the consciousness of the consumer and
also represents dimensions referred to tangible or intangible such as attributes, lifestyle, usage etc. 

But brand relationships are also seen as a combination of brand image (i.e. functional and non-functional perceptions), brand attitude (on all brand assessment) and perceived quality (overall superiority trial). Relations consist of brand image in functional and symbolic beliefs of the product categories which are brand specific extensions and their measurement should focus on the unique features of the brand specific categories. Attitudes towards the brand consist of a general assessment of the brand. The perceived quality is related to customer judgments about superiority or excellent quality of the brand in general. This highlights the argument that strong brands can add value to consumer purchases. Brand relationships are important for the companies and for its consumers. Companies use brands to differentiate, position and expand the brand, to create positive attitudes and feelings towards it, and to suggest attributes or benefits from the purchase or use of a specific brand. Consumers use brand relationships to assist in arranging, organizing and reliving information stored within their memory and use it in the purchase making decision.

This article will use the model built by Aaker [2] which is among the most frequently used by a great deal of the research and current studies to measure brand equity. This model has been tested empirically in a number of previous studies. Through Aaker’s model this study will retest the measurement of brand equity based on the products selected by Albanian consumers.

If a brand clearly positions itself through one or more relationships, it will be difficult for the competition to claim the lead on aspects implied by these relationships, which can lead to barriers to entry for competitors.

3. Exploratory search

The choice of brands sports sneakers was based on a preliminary test in 20 individuals. The selection of individuals was at random. Each individual was asked to specify four popular brands, desirable or preferable one. For each of the brands selected individuals were asked to give their assessment from 1 to 5. Results obtained from selected brands: Adidas, Nike, Puma, Reebok and the four most popular brands or consumer lending preference for asking.

A questionnaire constructed by Buil et al. [11] was selected as the basis for creating the questionnaire used in this research and in addition was it was completed with a series of questions to the four dimensions of brand equity used by Aaker [3]. In this questionnaire one will also find questions about the categories under the brand relationship dimension for measuring brand equity. Questions will be grouped under each dimension given by Aaker. To achieve the objectives set, the main purpose of the survey is to identify the degree of importance of each of the dimensions of brand equity. Participants in this study will be asked to determine the degree of importance of each element of brand equity. Before participants complete the questionnaire, there will be a short presentation about research so that they can be aware of the questionnaire and its purpose. People who deal with the distribution of the questionnaire will be with the
research participants in order to help ambiguous questions that they may have in enabling the accuracy of their response. People who will help with the delivery and monitoring of the questionnaires will be marketing students and to have enough knowledge about elements of the brand.

The first part of the questionnaire focuses on the variables associated with the brand capital: brand awareness, perceived quality, brand relationships and brand loyalty. Evaluation will be under evaluation Likert scales from 5: 1 - never (or at all) to 5 - always (or more). The reason that we refer to 5-tiered evaluation of Likert is because it is the most frequently used in studies made in the measurement of brand equity based on the customer.

The second part of the questionnaire focused on demographic information such as gender, age, education, income, place etc.

The questionnaire was initially tested in 60 people. We distributed the questionnaire and participants were asked to respond to questions asking them also to give their opinion and opinion questions for clarity. All respondents were encouraged to criticize the questionnaire if they see fit, and asked their opinion to specify if vague questions or questions that can be renewed.

Once responses were assessed by individuals selected by taking into consideration their opinions, the final questionnaire was constructed respectively: 5 questions for brand awareness, 5 questions for perceived quality, 14 questions about the relationship of the brand, 7 questions brand loyalty and 3 questions for the generalization of brand equity.

Malhotra [12] suggests that the minimum sample for research should be at least 200. For this reason, the sample size will be larger than 200 individuals or more accurately the number of valid questionnaires to participate in data analysis to be not less than 200. It also consulted with experts on the methodology for 95% coverage of the population. Therefore to build the sample questionnaire should be about 320. Including a supplement for not accurate or omission blank questionnaire was distributed about 370 sets of questionnaires.

To make this study a total of 370 questionnaires were distributed to students of the Faculty of Economics, University of Tirana to students of Electrical Engineering, Polytechnic University of Tirana. Students were asked to return the completed questionnaires from them, their friends or relatives within two weeks and asked that the questionnaires distributed to others, they were present during the completion of the questionnaire and the questions which may have difficulties to understand them to give appropriate explanation. Of all the questionnaires were distributed 356 questionnaires were able to gather from which 12 of them were invalid (partially completed or damaged). Thus, the numbers of valid questionnaires for survey and data analysis were 344 questionnaires.

4. Data analysis

Sample selection aimed at interviewing people over 18 years old. This category was chosen because individuals over 18 years old have their own income and make own choice of brands for
products they buy or want to buy. It was observed that the highest percentage of respondents belonged to 18-25 years (64 % or 221 individuals) who mainly had a Bachelor’s education (53 % or 183 persons). Of 344 individuals asked: 43 % (n = 147) were employed and 57 % (n = 197) were unemployed, 53 % male (n = 182) Female 47 % (n = 162). 344 selected respondents trademarks of athletes: 42 % - Adidas (n = 145); 34 % - Nike (n = 117); 13 % - Puma (n = 45); 11 % - Reebok (n = 37).

Data analysis was conducted in SPSS 17.0 statistical software. Factorial analysis was used for the first fundamental determinant variables of a factor, their structure. Statistically significant difference of a set of variables associated with capital, demographic variables regarding buyers and brand buyers were not tested by logistic regression analysis.

Pearson chi square analysis was used to make the testing of hypotheses but also to understand the meaning or connection variables with dimensions of brand equity. Having settled at the beginning of the error rate $\alpha = 5 \%$ and 95 % confidence level, using chi square test say that we will have a significant and important links in those cases where the results of testing the value $p$ ($p$ - value) will be smaller than $\alpha$. So below we will provide all the elements for each dimension that have strong links with the brand equity of $p < 0.05$.

Factorial analysis is used to find the factors of the variables studied by reducing the number of variables as it groups variables with similar characteristics together. So through factorial analysis we can produce small number of factors from a large number of variables enabling explaining the variance in a large number of variables. Reducing the number of variables can be used for further analysis.

Structural equation models (SEMs) is made of the dependent variable and the independent. Variables that have the same direction of arrows or influenced by several variables are the dependent whereas variables that are not influenced by other variables called the independent. Values that express the same direction of arrows are the regression coefficients or two arrows while not constitute direct correlation coefficients, together constitute the parameters of the model and demonstrate the relationships between the variables. SEM also shows how well the model is constructed. On the side of the SEM can see the presence of multicollinearity. For the evaluation of the model were used indicators: Goodness -of - Fit Index (GFI) which measures the relative quantity of variance - covariance, Comparative Fit Index (CFI) that takes into account the size of the sample Brand equity in the summary presented in summary questionnaire by three questions as follows:

a. Even if another brand has the same features as Y brands I prefer to buy brand Y,
b. If any other brand is no different from brand Y, then it is wise purchase buying brand Y,
c. Brand Y is more than a product of me.

Based on the answers given factorial analysis was used to check the connection of the set variables with the three questions of brand equity. According to KMO test since it has a value greater than 0.8 indicates a much better use of factor analysis. Based on chi-square test variable
"I have a clear image of the type of person who buys" with "Even if another brand has the same features as the brand I will buy my brand" and "Even if another brand is not different buying my brand is wise is "not a statistically significant connection. Also variable "This brand is secure and safe to use" with "Even if another brand has the same features as the brand will buy" and "is more than a product of me" there is a statistically about important. Variable "this brand is innovative" and "Even if another brand is not different is the smart buying" does not have a statistically significant connection.

<table>
<thead>
<tr>
<th>Question</th>
<th>Kaiser-Meyer-Olkin Measure of Sampling Adequacy = .891</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y11 This brand is innovative</td>
<td>.640</td>
</tr>
<tr>
<td>Y12 This brand is safe and harmless to use</td>
<td>.564</td>
</tr>
<tr>
<td>Y13 This brand is not simply a product of me</td>
<td>.406</td>
</tr>
<tr>
<td>Y14 This brand has personality</td>
<td>.499</td>
</tr>
<tr>
<td>Y15 I have a clear image of the type of person who buys</td>
<td>.524</td>
</tr>
<tr>
<td>Y16 I appreciate and admire people who use this brand</td>
<td>.516</td>
</tr>
<tr>
<td>Y17 This brand is interesting</td>
<td>.528</td>
</tr>
<tr>
<td>Y18 This brand is exciting</td>
<td>.479</td>
</tr>
<tr>
<td>Y19 This is the best brand to buy</td>
<td>.565</td>
</tr>
<tr>
<td>Y20 This brand is ethical</td>
<td>.430</td>
</tr>
<tr>
<td>Y21 This brand matches my style of life</td>
<td>.402</td>
</tr>
<tr>
<td>Y22 I believe the company that produces the brand</td>
<td>.598</td>
</tr>
<tr>
<td>Y23 I enjoy the company that produces the brand</td>
<td>.631</td>
</tr>
<tr>
<td>Y24 The company that produces the brand is innovative</td>
<td>.627</td>
</tr>
<tr>
<td>AY. Even if another brand has the same features as Y brands I prefer to buy Y</td>
<td>.528</td>
</tr>
<tr>
<td>BY If any other brand is no different from brand Y , then it is wise purchase buying brand Y</td>
<td>.513</td>
</tr>
<tr>
<td>CY Brand Y is more than a product of me</td>
<td>.399 *</td>
</tr>
</tbody>
</table>

Multipliers based on the correlation of all the variables positively affect the relationship of brand equity variables, where most of them at a greatly important (p-value <5%).

Based on factor analysis, correlation and SEM model, it is clear that the variables that most affect the brand equity of the sneakers are not the same and that in terms of weight or degree of importance they have on brand equity.
In summary, variable dimensions of brand equity and brand awareness respectively, according to their degree of importance of brand equity, for sneakers are as follows:

<table>
<thead>
<tr>
<th>Questions about the relationships of the elements of the sneakers</th>
<th>Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y22 I believe the company that produces the brand</td>
<td>0.67</td>
</tr>
<tr>
<td>Y23 I enjoy the company that produces the brand</td>
<td>0.66</td>
</tr>
<tr>
<td>Y19 This is the best brand to buy</td>
<td>0.66</td>
</tr>
<tr>
<td>Y20 This brand is ethical</td>
<td>0.60</td>
</tr>
<tr>
<td>Y17 This brand is interesting</td>
<td>0.60</td>
</tr>
<tr>
<td>Y14 This brand has personality</td>
<td>0.59</td>
</tr>
<tr>
<td>Y21 This brand matches my style of life</td>
<td>0.57</td>
</tr>
<tr>
<td>Y13 This brand is not simply a product of me</td>
<td>0.57</td>
</tr>
<tr>
<td>Y16 I appreciate and admire people who use this brand</td>
<td>0.55</td>
</tr>
<tr>
<td>Y18 This brand is exciting</td>
<td>0.54</td>
</tr>
<tr>
<td>Y24 is the company that produces innovative brand</td>
<td>0.54</td>
</tr>
<tr>
<td>Y15 I have a clear image of the type of person who buys this brand</td>
<td>0.46</td>
</tr>
<tr>
<td>Y11 This brand is innovative</td>
<td>0.37</td>
</tr>
<tr>
<td>Y12 This brand is safe and harmless to use</td>
<td>0.36</td>
</tr>
</tbody>
</table>

So this dimension for consumers considered most important: trust the company that produces the brand, the consent of the company by the customer, trust that bought the brand worth, as well as
the fact that it is ethical brand. For sneakers included in the study, considered unimportant or with a low coefficient of importance of brand equity variables associated with: the image of people who buy, safety and the safety of use and the fact that this brand is innovative.

5. Conclusions and recommendations

Details of the research show that consumers are very interested in the functional product attributes and the product being particularly safe and harmless to use shown by the choice of sneakers. Among the dysfunctional attributes that customers consider important for brands, is trust and consensus with the company that produces the brand. Customers, due to strong association with some operational attributes, consider the particular brand of sneakers they chose to be the best one to buy as it satisfies their consideration on the brand being ethical, interesting and with personality. They state that brand Y is the better as it corresponds with their lifestyle and not because it is the choice of other consumers. In this way it seems like a very unique customer relationships with sneaker brand Y as it was chosen without influence by other people who use these brands, furthermore consumers did not express any high degree of appreciation or admiration for people who use this brand.

The data show that the sneakers brands are not just a product for consumers. In the case of the sneakers brand Y brand relationships positively impact brand equity Y, and the extent of this impact is high in value 0.9.

From the data, for the sneaker brands, it is clear that the variables that influence this impact are some of the nonfunctional variables associated with: reliability and consent of the producer of the brand, the perceived value of the brand (the better to buy), compliance with lifestyle as well as a number of elements that relate to the personality of the brand. Despite the positive impact that these variables have, the extent of their influence is not very high.

For this reason the recommendation in connection with this conclusion is that manufacturing companies should care more about the personality of the brand but also in better understanding the personality of consumers who prefer to buy their brands. In this way the company can help customers have a clear image of the type of person who buys this brand.

Companies should be looking more to understand whether the consumers buy brands Y just to feel good about them or to better their current or ideal image. They should inform and persuade consumers that their brands Y are not only distinct and innovative, especially since this paper shows that customer’relationships with the brand as innovative, secure and safe to be used have a low impact on brand equity Y.
References

*Journal of Marketing*, 57, pp. 1-22


NATURAL DYE AND QUALITY ASSURANCE FOR WOOLEN HANDICRAFT PRODUCTS

B. Kolgjini, M. Hylli, I. Kola, E. Shehi

Polytechnic University of Tirana, Faculty of Mechanical Engineering, Department of Textile and Fashion, Sheshi “Nëne Terza” no 4, Tirana Albania
bkolgjini@yahoo.co.uk

Keywords: Keywords:  local wool products, natural dye, fastness tests

Abstract

In this study three different natural dyeing are used to provide three different colors. The test methods of color fastness to washing and color fastness to light and daylight are performed. Based on the tests result the color fastness to light is between levels 4-5 and to washing is to level 3 after 4 washings.

Introduction

Colorful textiles are strong evidences showing the desire of people to use them. The survival documents like archaeological, pictorial, written evidences and textiles, revealing the skills of using color from the ancient time [1-5] The techniques of dyeing using water based solution, grinding or macerating and heating or boiling together with fermentation are the fundamental requirements for true dyeing, where three things must happened: First, the extraction of the dye, second, the acceptance of the color by fibers and the third the retained of color [3-5]. These techniques were spread around till the time of synthetic compounds offering low cost of the products and reproducibility, facts that are important especially for continues process in textile industry. Beside these facts nowadays the interest is towards the natural dyes for several aspects like Eco aspects in terms of the colored textiles, which are skin friendly, but also to the remains elements after the process of dyeing [6-7]. Therefore in this paper it will be discussed about the possible natural dye elements in Albanian rejoin applied for local fiber wools. The focus is to determine precisely the fastness properties of the dyed wool products in order to consciousness the local artisans for the benefits of natural dyes.
Materials and Methods

Not colored yarns from 100% local wool fibers are collected from local artisans. The yarn has finesses of 2.66Nm. The dyed yarns were carried out on the laboratory conditions. The extracts for three different products (walnuts shell husk, peel pomegranate and peel of fraxinus tree). The procedure of dyeing is performed according to dyeing procedure method on home condition. As mordant is used sea salt (NaCl) and acid acetic (CH₃COOH).

The fastness test were performed according to the EN ISO 105-B01:1999 [8-10] standards by using artificial light: Xenon arc fading lamp test (ISO 105-B02) and on natural light. At the end the numerical rating is reported for color fastness to light and washing compare to grey scale.

Results

The obtained results from the measurements are graphically presented on figure 1. According to the results of washing and light fastness of the products dyed from three different products show good properties. However the yarns dyed from the pomegranate shell show better results in comparison to the other product. These differences could be to the condition of the dyeing process or to the mordant that are used.

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>Pomegranate shell</th>
<th>Fraxinus shell</th>
</tr>
</thead>
<tbody>
<tr>
<td>5h56'</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>9h8'</td>
<td>4.5</td>
<td>4.5</td>
</tr>
<tr>
<td>17h31'</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>24h39'</td>
<td>3</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Properties of Color Fastness to Light

<table>
<thead>
<tr>
<th>Properties of Color Fastness to Washing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluation</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
</tbody>
</table>
However more analyses are needed in order to understand the reasons of differences on color fastness properties between three different colors.

Conclusions

It was found from the study that the natural dyes from pomegranate shell, fraxinus and volnut shell can be successfully used for dyeing of wool to obtain a wide range of soft and light colors by using natural mordant. Based on the obtained results, to color fastness test, samples exhibited excellent fastness on natural and artificial lights. These data are helpful for textile industries and for the artisans in particular.

References

[8] EN ISO 105-B02 Test for color fastness: Part B02: Color fastness to artificial light : Xenon arc fading lamp test.
PARTICLE SIZE EFFECTS OF A FLAME RETARDANT FORMULATION FOR TEXTILES

M. E. Ureyen\textsuperscript{1}, E. Kaynak\textsuperscript{2}, A. S. Koparal\textsuperscript{3}

\textsuperscript{1}Anadolu University, Faculty of Architecture and Design, Dept. of Fashion Design 26470, Eskisehir, Turkey
\texttt{meureyen@anadolu.edu.tr}

\textsuperscript{2}Anadolu University, Faculty of Engineering, Dept. of Chemical Engineering, 26470, Eskisehir, Turkey

\textsuperscript{3}Anadolu University, Faculty of Engineering, Dept. of Environmental Engineering, 26470, Eskisehir, Turkey

Keywords: flame retardant, polypropylene fabric, back coating, zinc borate, Tri-phenyl phosphate, magnesium hydroxide

Abstract

Polypropylene; despite its widespread use in textile products has low resistance to fire. Polypropylene textiles may be flame retarded by the application of additives (mineral, halogen, phosphorus, nitrogen, silicone based additives or nanoparticles etc.) on the fabric surface by finishing techniques. In order to obtain the desired level of fire resistance use of two or more of such additives can be preferred. In this study a novel flame retardant formulation of three chemicals namely; tri-phenyl phosphate, zinc borate, magnesium hydroxide was used. The varying particle size of the additives used in such formulation is a major challenge that impairs the homogeneity of the mixing medium. In order to overcome this side-effect zinc borate was subjected to a size reduction process in attritor mill. The effect of a stabilizing agent, namely Tri Sodium citrate dihydrate on the particle size and zeta potential after 1-hour-milling was studied by the addition of the stabilizing agent to the zinc borate-water mixture at weight percentages varying from 1 wt\% to 5 wt\% of the total sample weight and without any addition of stabilizing agent. The effect of stabilizing agent added during milling process was studied by zeta-size measurements parametrically. Tri-phenyl phosphate, zinc borate, magnesium hydroxide additives were mixed with an acrylic copolymeric binder and back-coated on pre-washed PP woven fabrics. The limit oxygen index value of the fabric sample coated by the resin containing additives with a reduced particle size was measured as 25.6\% which is higher than the value (25.2\%) measured for the sample coated by the same composition of materials that are larger in size. Thermal behaviour of the samples was investigated by thermal gravimetric analysis. The
distribution of the additives on the fabric surfaces were evaluated by Scanning Electron Microscopy.

Introduction

Polypropylene (PP) fibers have long been used in textile industry thanks to their high tensile strength and low cost features [1]. However the high flammability of PP limits their use at risky areas. A great number of researches have been conducted to develop flame retardant materials to improve the fire resistance of polypropylene [2-7]. However the application of those to textiles is more challenging since the aesthetic properties and durability must be considered for textiles [8] whereas the amount of flame retardants required is high for efficient flame retardancy. Brominated compounds have been developed and effectively used as flame retardants for textiles [9]. However there have been recent concerns regarding the widespread production and use of brominated flame retardants due to their toxic effects to human health and environment [10-14]. Therefore phosphorus compounds have been suggested as efficient replacements to brominated compounds [15]. Phosphorus compounds may present flame retardancy action either in the gas phase or the condensed phase [16]. Phosphorus compounds such as phosphate esters may be effective in the vapor phase through flame inhibition. PO, P and P₂ radicals react with H and OH radicals and thus inhibit the flame propagation reactions [17]. Triphenyl phosphate (TPP) that is the ester of phosphoric acid and phenol, may act in the condensed phase by generating phosphoric acid which results in the formation of pyrophosphoric acid that can act as a char catalyst in oxygenated polymers [18]. TPP is a very volatile compound and may volatilize in the gas phase to produce active radicals [19]. In this study the combination of three additives namely; zinc borate (ZnB) which decomposes endothermically between 290°C-400°C and leads to the formation of a vitreous layer above 500°C, magnesium hydroxide (MDH) which decomposes endothermically at approximately 300°C [16] were used together with TPP for the first time to increase the fire resistance of PP. Furthermore; the effect of the homogeneity of size distribution of particles on the flammability of fabrics were reported by means of stabilizing agent composition.

Materials & Method

Zinc Borate (ZnB, Great Lake Chemicals, USA) was used as a synergist to triphenyl phosphate (TPP, Merck, Germany) and magnesium hydroxide (MDH, Sigma Aldrich Co., USA). ZnB was subjected to a size reduction process in order to provide homogenous particle distribution in the FR formulation by attrition milling. Wet milling was performed at equal volume ratio (50%-50%) of dispersing medium (distilled water) and dispersed agent (ZnB powder) ratio. The effects of stabilizing agent, namely trisodium citrate di-hydrate (Merck, Germany) added during milling and the milling period on the zeta potential and size distribution of ZnB particles were measured by Zeta-Sizer Instrument (Malvern, Zetasizer Nano ZS 3600).
The formulation details regarding the back-coating applications on a dry basis are presented in Table 1. The viscosities of FR resins were adjusted to approximately 7000-8000 cP by the addition of thickener and measured by viscometer (Brookfield, RVDV-E). The FR resin was back coated on pre-washed PP fabric samples with the density of 293 g/m² by laboratory type back-coating device (Atac RKL 40). The add-on rate to the fabrics was maintained at approximately 25% on dry basis by keeping the coating thickness constant at 0.2 mm. The coated fabrics were then dried/cured at 125°C for 3 minutes. The thermal behaviour of FR coated PP fabric samples were analysed by thermal-gravimetric analysis (TA Instruments, Universal V4.7A). The LOI values of fabric samples were measured by LOI test device (Dynisco) in accordance with ASTM D2863. The surface images of the fabric samples were obtained by Scanning Electron Microscopy (SEM) (Zeiss, Supra 50V).

<table>
<thead>
<tr>
<th>Sample</th>
<th>ZnB [wt. %]</th>
<th>MDH [wt. %]</th>
<th>TPP [wt. %]</th>
<th>Stabilizer [wt. %]</th>
<th>Resin [wt. %]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A S1</td>
<td>-</td>
<td>4.95</td>
<td>42.5</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>F S2</td>
<td>4.95</td>
<td>0.6</td>
<td>0.2</td>
<td>0.05</td>
<td>50</td>
</tr>
<tr>
<td>G S3</td>
<td>4.95</td>
<td>9.6</td>
<td>2.5</td>
<td>42.5</td>
<td>50</td>
</tr>
</tbody>
</table>

*The particle size of additives are denoted with letters “PS”.

**Results**

The particle size of commercial MDH and TPP were measured without any preliminary treatments and the particle size distribution graphs are shown in Figure 1 and Figure 2 respectively. The average particle size measured for MPP and TPP are 0.6 µm and 0.2 µm that indicate existence at sub-micron scale.

![Figure 1 Size distribution graph of MDH](image-url)
The change in average zeta potential and particle size values of ZnB powders after attrition milling with respect to the increasing stabilizer weight percentage can be seen in Table 2.

<table>
<thead>
<tr>
<th>Stabilizer [wt. %]</th>
<th>Particle size [d.nm]</th>
<th>PdI</th>
<th>Zeta Potential [mV]</th>
<th>Conductivity [mS/cm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1023</td>
<td>0.674</td>
<td>2.15</td>
<td>0.0934</td>
</tr>
<tr>
<td>1</td>
<td>563.2</td>
<td>0.527</td>
<td>-31.8</td>
<td>0.0108</td>
</tr>
<tr>
<td>2</td>
<td>580.7</td>
<td>0.693</td>
<td>-31.8</td>
<td>0.0139</td>
</tr>
<tr>
<td>3</td>
<td>590.2</td>
<td>0.655</td>
<td>-37.5</td>
<td>0.0173</td>
</tr>
<tr>
<td>4</td>
<td>621.9</td>
<td>0.720</td>
<td>-38.2</td>
<td>0.0180</td>
</tr>
<tr>
<td>5</td>
<td>562.3</td>
<td>0.751</td>
<td>-51.1</td>
<td>0.0280</td>
</tr>
</tbody>
</table>

When the milling process was performed without the addition of stabilizer the particle size of ZnB was reduced from 9.6 µm to about 1 µm. Addition of stabilizer further reduced the particle size from 1 µm to 0.5 µm-0.6µm range. The non-homogenous milling medium that was considered as a major challenge was therefore overcome by the addition of stabilizer. The zeta potential measurements were used to verify such phenomenon. The value measured for the sample that doesn’t contain stabilizer is 2 mV whereas the value measured for the sample that contains 5 wt% stabilizer is -51.1 mV. Obviously; addition of stabilizer contributes to the size reduction of ZnB, however the increasing weight percentage of the stabilizer didn’t change the average particle size values significantly. Therefore the suitable percentage of stabilizer to be added was determined as 1 wt% when the significant reduction in size is considered. Particle size distribution and zeta potential graphs of ZnB subjected to size reduction in attritor mill for 1 hour with the addition of 1 wt% stabilizer are shown in the following Figure 3 and Figure 4 respectively.
The LOI value of the reference fabric was measured as 19% which is exactly the same as LOI value measured for the fabric back-coated with binder (S1). Therefore the binder used was concluded to have no effect on the fire resistance of PP fabric.

The LOI value for the sample S2 and sample S3 were as 25.2 and 25.6 respectively such increase in the LOI value can be attributed to the homogenous distribution of ZnB particles. The TGA plot of untreated PP fabric is shown in Figure 5. This plot indicates a typical mass loss curve with respect to temperature for PP. In this figure where no mass loss is witnessed until 400°C the
material is decomposed between 400°C and 500°C without any residue. The initiation of mass loss at lower temperatures for sample S2 (Figure 6a) and S3 (Figure 6b) addresses the activity of tri-phenyl phosphate which decomposes at lower temperatures. Even though similar trends were witnessed for both samples; the initiation temperature of the principal mass loss that is 440°C for the sample containing ZnB particles greater than 1µm was increased and reached up to 448°C for the sample containing additives less than 1 µm in size.

The SEM image of reference (untreated) fabric sample by 1000 times is shown in Figure 7a. The impurities observed on the surface of smooth spinned untreated PP fabric sample are possibly washing originated calcium based detergent particles. The SEM image of the sample S3 magnified by 5000 times is shown in Figure 7b in which it’s obvious that the gaps between individual fibers are filled with FR additive containing resin.
Conclusion

In this study PP was flame retarded by a flame retardant formulation that consists of TPP (42.5%), MDH (2.5%) and ZnB (~5%). The thermal degradation path of the flame retarded samples (S2, S3) changed slightly when compared with that of reference fabric. The homogenous particle size distribution of the constituents of the FR composition further contributed to the fire resistance of the fabric as the LOI value increased from 25.2 to 25.6. Despite the fact that TPP is a promising replacement for halogenated FRs, it must be used with synergist agents in order to obtain the desired level of fire resistance at low add on levels.

Acknowledgement

This study was supported by Anadolu University Scientific Research Projects Commission under the grant no: 1104F076.

References


ADVANCED CAD/CAM SYSTEMS FOR GARMENT DESIGN AND SIMULATION

T. Spahiu¹, E. Shehi¹, E. Piperi²

¹Faculty of Mechanical Engineering, Textile and Fashion Department in Polytechnic University of Tirana
tspahiu@fim.edu.al

²Faculty of Mechanical Engineering, Department of Production and Management in Polytechnic
University of Tirana,

Keywords: CAD systems, clothing design, virtual fit, 3D body model, 3D body scanning.

Abstract

Garment designing is the first stage on garment production. The advancements of 3D technology and computer graphics have changed the way of garment designing. Before garment designing has been made by hand using sketches drawn in paper or draping fabric on a dress form. But now fashion designers use software tools to express their ideas. Using computer systems give them the possibility to make two-dimensional and three-dimensional product illustration and visualizations, also testing the fit in one environment. There are several CAD systems for garment visualization introduced in the clothing industry. Using 3D virtual mannequin has mostly replaced the use of physical mannequin in the fashion industry.

In this paper we are going to provide a short review on CAD systems used by fashion designer. We have done a garment simulation process using software for virtual design Marvelous Designer and the avatar used is imported from 3D body scanning system Konica Minolta VIVID 910. This is an easy, accurate and feasible way to design garments for consumers seeking personal fit garment.

1 Introduction

CAD/CAM systems are used in various fields of application. Their main scope is increasing productivity of the designer, improving quality of the design. Now, a lot of CAD programs make possible the creation of three-dimensional models, which can be viewed in different directions [1].

The process of creating garments includes different steps. The first step of garment production is designing. Before garment designing has been made by hand using sketches drawn in paper or
draping fabric on a dress form.
In the classic technology of clothing design using industrial system, the basic patterns are designed for bodies that make up the dimensional typology model for a given population [2]. The widespread use in the clothing industry of CAD systems to design patterns along with database resulting from 3D scanning technology of the human body, are perquisites to extend virtual modeling of the dimensional correspondence body-dress in the work of finalizing the 2D patterns after the concrete body dimensions [3].

Fashion being a huge field, computer-aided garment design has grown into an industry of its own, as evidenced by myriad companies producing garment CAD products; spanning the five inhabited continents such as AGE Technologies, AMSSystems, Browzwear, CADTERNSCustom Clothing Inc., Fashion CAD, Fashion Matters, Gemini CAD, GRAFIS, Investronica Systems, Marvelous Designer, Mechanix, OptiTex, Pad Systems, Pattern Works Int’l, and others provide a variety of tools focusing on 2D pattern creation and/or 3D draping for garment design [4].

2 From 2D to 3D CAD systems in garment designing

The importance of fashion in human history cannot be ignored. The garment industry has influenced countless lives and cultures with its notions of which styles and concepts become popular. Furthermore, fashion today is certainly a matter of taste -- a mechanism for expressing an individual’s sense of self with a certain flair [5].

Introducing anthropometry (studying and collecting human variability in faces and bodies) in computer graphics made possible the creation of a parametric model defined as a linear combination of templates [6].

In general, clothing CAD systems usually involve one or more of five key processes which are: 2D pattern design, pattern prepositioning, e virtual sewing process (also called virtual try-on), drape simulation and design modification in 2D or 3D [7]. The base of the 3D garment digital technology is the 3D body measurement [8]. With the advance of 3D scanning techniques, the individualized human body can easily captured and modeled with a mesh model [9].

The 3D pattern design system (PDS), developed for 3D pattern designing, originates from the shape of the body. It is possible to apply not only a standard mannequin within the system, but also models selected or created by the user. Thus, more suitable body measurements can be applied for made-to-measure garments [10].

2.1 Virtual garment creation and simulation

Research into virtual garments began to gain momentum during the 1980s, when the film industry became interested in 3D computer generated images [11]. Since then, different systems for 3D visual garment simulation have been developed form different perspectives and with various objectives [12]. In the field of computer graphics, the first applications for mechanical
clothing simulation appeared in 1987 with the work of Terzopoulos [13]. The so called virtual-try-on solutions have gained importance in the last few years in different areas of the fashion industry [14]. Virtual prototyping is a technique in the process of garment development that involves application of computer aided design intended for garments development and virtual prototyping of them [15]. When the virtual prototyping is accurate the garment fit to the body model reflects and combines characteristics of the garment style, garment pattern design, virtual body model and mechanical properties of textiles [16].

Many pattern makers use 3D garment simulation to test their pattern blocks and basic shapes while they are drafting the pattern, to make sure that the balance and slopes of the garment are correct [17]. Clothing virtual characters entails three problems: designing the clothes (tailoring), placing them on the character (dressing), and making them look physically [18].

3 Methodology

In this paper we have taken the 3D data captured from 3D laser scanning system Konica Minolta VIVID 910, implemented for full body scanning. All the procedure and steps for body scan are not part of this work, but they are explained deeply in another work made by authors. An inspection of 3D data scans for any inconvenience or error remained from scans, was performed in other software. This software used for data inspection and manipulation is Geomagic Studio [19].

After creating a watertight 3D body model, we can import them in designer software. For 3D pattern design we have used Marvelous Designer 3. This software is used in fashion industry for creating garments from conception meaning the pattern designing to the garment visualization and simulation in the 3D avatar. Positioning the imported 3D body (avatar) with the coordinate system of the 3D window is the previous step. The process of designing is done on 2D window over the figurine of the personalized avatar. All these procedure are shown in the workflow diagram in Fig. 11.
3.2 3D garment design and testing garment fit

In the garment industry the process of garment designing relies on designer’s skills and experience. After finishing the garment design, it should be constructed. Generally, this process is done in 2D using CAD software. Often there are many problems between the designer and the pattern makers; the reason is the process of translating or reading the garment design. Nowadays, using the new technology of 3D designing has helped in problem solving, arising from misunderstanding during this important phase of garment production. For testing the garment fit in the scanned body we have imported the 3D model taken from 3D body scanning in the Marvelous Designer software [20], as is showed in Fig. 12.

The 3D models or avatars can be parametric or 3D body models taken from 3D body scanning. Parametric models are part of the software’s library.
Designing of the patterns is done on pattern window over the 2D view of the body model. During the designing process, can be used different tools for pattern designing, as polygon, rectangle, circle, etc. By activating synchronization command, which is the first step to drape patterns on the 3D model, will bring all the patterns designed on the 3D Avatar Window. The patterns are placed around the 3D virtual body. For simulating the garment fit on the virtual body we choose the virtual sewing of all the 2D patterns. This means defining seaming lines on the borders of the patterns. They are polygon edges that are to be joined during the initial garment construction process. Using the simulation tool all the patterns will be draped on the body. The 3D garment simulation can be viewed in different positions and can be rotated 360°. We can see how well the garment fits by changing the rendering style to “Pressure” texture surfaces view. This stress map shows the exert on the fabric, which shows in different color and number on the garment. By choosing different type of fabric, we can assess the garment fit. The main steps followed for 3D garment design in the personalized 3D body model or avatar is shown in Fig. 13.
4 Conclusions

The new techniques of virtual-try-on, called virtual prototyping are becoming more and more useable in fashion industry. These new 3D techniques has a lot of advantages such as fast time, allowing consumers use their own 3D model to virtually design and try on clothing. Using the new technologies has made easier the development of individualized garments.

Using 3D body scanning technology is a new trend in fashion industry for custom garment design. The 3D model of the human body is captured and using software, part of the 3D scanning systems, the critical measurement of the digital image can be integrated to a pattern alternation system. This technology is helping the process of garment designing, by speeding up process of garment design. 3D environment helps designer to check quickly the problems related to fabric draping on the 3D avatar and assessing the garment fit. These will help shortening the time between pattern changes which are reflected on the 3D window.

References

[13] F. C. N. M.-T. Pascal Volino, "From early virtual garment simulation to interactive fashion
EXPLORING OF NEW NATURAL FIBERS APPLICATIONS FOR TECHNICAL TEXTILES

A. Demir, T. Gülümser, E. Özdoğan, N. Seventekin

Ege University, Textile Engineering Department, Izmir, Turkey
asli.demir@ege.edu.tr, tulay.gulumser@ege.edu.tr, esen.ozdogan@ege.edu.tr,
necdet.seventekin@ege.edu.tr

Keywords: natural fibers, milkweed fiber, akund fiber, technical textiles

Abstract

Environmental awareness and an increasing concern with sustainable development have stimulated many industries to replace the conventional synthetic fibers. Therefore, a growing attention on the use of natural fibers instead synthetic ones has been focused by both the academic world and several industries including composite industry. The main reasons of this interest are related to the specific properties, price and low environmental impact of this kind of fibers. Natural fibers are renewable resources and have marketing appeal. These fibers can be extracted from different parts of the plant such as stem, leaf, petioles, roots, fruits and seeds. The advantages of natural plant fibres, such as low abrasion, multi-functionality, low density, low cost, ready availability and relative ease of waste disposal, encourage their application in composite materials. Natural fibres such as banana, coir, sisal and jute, linen have attracted the attention of scientists and technologists for application in consumer goods, low cost housing and other civil structures in composites. These composites possess high strength and stiffness, good thermal and acoustic insulating properties and high resistance to fracture.

A natural fiber composite with an outstanding combination of properties is not a dream today. Use of proper processing techniques, fiber types, fiber treatments, and compatibilizers/c coupling agents can lead to composites with optimum properties for a particular application. Today, a renaissance in the use of natural fibres as reinforcements in technical applications is taking place mainly in the automobile- and packaging industries (e.g. egg boxes). In the automotive industry, textile waste has been used for years to reinforce plastics used in cars. Local European renewable fibres, such as flax and hemp, were used for these cars. Ramie-fibres are examined too, because of their specific properties, etc.

In this paper, the information of milkweed and akund fibers is given for finding of the different usage areas of textile industry.
1. Introduction

Over the last decade, a growing attention on the use of natural fibers instead synthetic ones has been focused by both the academic world and several industries. The main reasons of this interest are related to the specific properties, price and low environmental impact of this kind of fibers. A great variety of different natural fibers are actually available as reinforcements of polymer composites. The most widely used are flax, hemp, jute, kenaf and sisal, because of their properties and availability. Some recent scientific works advance the feasibility to use less common natural fibers as reinforcement for composite materials. Natural fibres such as banana, coir, sisal and jute have attracted the attention of scientists and technologists for application in consumer goods, low cost housing and other civil structures. Natural fibres have many advantages compared to synthetic fibers like low density, cheaper, acceptable specific properties and also they are renewable and biodegradable. These kinds of composites possess high strength and stiffness, good thermal and acoustic insulating properties and high resistance to fracture. However, the main disadvantage of these natural fibre/polymer composites seems to be the compatibility between the hydrophilic natural fibres and the hydrophobic matrix that makes necessary to use compatibilizers or coupling agents in order to improve the adhesion between fiber and matrix.

Although conventional natural fibers such as jute and kenaf have been widely used to develop consolidated composites, the new fibers like milkweed and akund has emerged and growing rapidly.

2. Milkweed fibers

Byproducts of agricultural crops are being considered as cheap, abundant and sustainable sources for natural cellulose fibers. The increasing cost and decreasing availability of petroleum resources and limitations in the availability of land, water and other resources required to grow natural fibers, could restrict the availability and/or increase the price of common fibers, making them unaffordable for commodity applications.

Milkweed, a perennial plant that can adapt to adverse soil conditions is being developed as an alternative crop. Milkweed belongs to genus Asclepias. The genus Asclepias contains over 100 species of of which 45 are indigenous to the USA. Types of milkweed species are;

1. Incarnata-Swamp milkweed
2. Speciosa-Showy Milkweed
3. Syriaca-Common Milkweed
4. Tuberosa-Pleurisy Milkweed

Asclepias syriaca

This type, also known as common milkweed, is a herbaceous plant species. This species is prairies. The best time to gather milkweed pods is late summer.
Asclepias incarnate
This type is an herbaceous, perennial plant species native to North America. Swamp milkweed is an upright, 100-150 cm tall plant, growing from thick, fleshy, white roods. The seed floss is used to stuff pillows, etc. or mixed with other fibers to make cloth. It has also been used as a baby’s nappy. The seed floss is kapok substitute, used in life jackets or as a stuffing material. It is very water-repellent.

Asclepias speciosa
Asclepias speciosa is a species of milkweed known commonly as the showy milkweed. It is native to western half of North America. This fiber can be used for cord and cloth, food, chewing gum, and numerous medicinal uses. A good quality tough fiber is obtained from the bark and used in twine, coarse cloth, paper, etc.

Asclepias tuberosa
Asclepias tuberose is a species of milkweed native to eastern North America. It is 0.3-1 m tall, clustered orange or yellow flowers from early fall. This plant favors dry, sand or gravel soil, but also has been reported on stem margins.

2.1. Properties of milkweed fibers
It was found that the fibers best suited for use as a substitute for kapok was milkweed fiber. Both kapok and milkweed have similar properties. They have the same lumen and thin walls. Insulating properties of the milkweed fibers are slightly superior to those of kapok. Neither fiber retains moisture nor is readily wetted liquids and both are vermin proof.

The light airy fibers on the common milkweed plant have been used for textile structures. The limited uses of milkweed fibers are strongly related to their unique structural features. A disadvantage is the high moisture regain of milkweed, which can cause the fiber masses in these items to become damp and clump together. The fibers also have a waxy coating that makes the water resistant.

The smooth, straight fiber contour of milkweed makes the fiber difficult to spin into yarns. They may be blended with other fibers to increase cohesion in the blended yarns. Since they also have low strength because of thin fiber wall, there is little incentive to produce such yarns. The diameter to these fibers ranges from 30 to 50 mm and the fiber length ranges from 9.5 to 30 mm [1].

2.2. Potential applications of milkweed fibers

2.2.1. Insulative materials in jackets
Milkweed floss is a loose material for jackets and comforters. It can be blended with down has insulative properties similar to down. Down is superior to milkweed floss in loftiness and
compressibility, which influence product performance but the properties of milkweed floss can be enhanced by blending with down.

2.2.2. Superabsorbent fiber
The milkweed fibers can absorb 75 g/kg pick-up of saline solution after treatment with surfactant. An equal number of fibers of wood pulp or floss would absorb about the same volume of liquid.

2.2.3. Fluid carrier fiber
The milkweed fiber absorbs fluid readily but retains only about 5 % by weight of these liquids tightly. This property can be used as a chemical carrier in nonwoven products to produce a biodegradable package or oil spill cleanup.

2.2.4. Self-bonding fiber
The fiber has a thin wax coat which allows weak bonding with adjacent fibers when under heat and low pressure. The outer cellulosic layers of these fibers are very thin. This allows easily bonding of inner ligneous material of adjacent fibers when subjected to more heat and greater pressure.

2.2.5. Bio-active fabrics
The milkweed fibers have been utilized for the growth of bacteria inside the hollow spaces of the fiber.

2.2.6. Light weight composites
The hollow weight seed fibers can be utilized as a reinforcing material in the manufacturing of light weight composites. The stem fiber of giant milkweed can be a valuable renewable natural resource for composite production and could be utilized as a substitute for wood in composite production as a reinforcing agent [2].

3. Akund floss

Akund floss is obtained from Calotropis procera and Calotropis gigantea plants of Apocynaceae family. Calotropis is a shrub or tree. It is also known by various names in different region such as Ak (Punjabi), Akarda (Hindi), Alarka (Sanskrit), Bois-la-soie (French).

3.1. Fiber characteristics
The length of akund floss fiber is about 31-40 mm and its linear density is about 1 dtex. Its diameter is about 12-42 microns. It contains relatively large amount of lignin. Crystallinity is about 28.92 %. The fiber has a large hollow structure with a thin wall looks like an air filled pipe
3.2. Spinnability of the fiber
The tensile strength of 3.42 cN/dtex makes akund fiber accurate for spinning. But its hollow structure (80 % of its structure is hollow) make it light and frail. Its smooth surface mostly influences its processing because it does not cause sufficient inter fiber friction force to hold the fiber in the yarn. High quality slivers from this fiber can be produced by using new card wires, low speed card elements and proper content of akund fiber in blended yarn. Akund floss is used primarily as upholstery stuffing, sometimes mixed with the seed kapok.

3.3. Mechanical properties
Breaking strength and breaking elongation is larger than kapok but smaller than cotton fiber. The breaking strength is about 3.42 cN/dtex. The water absorption of fiber leads to the improvement of unevenness of macromolecular force and increase in the number of fracture molecular chain.

3.4. Moisture absorption behavior
The moisture content of akund fiber is about 10.44 % and moisture regain is about 13.8 %. It has the same moisture absorption hysteresis quality as cotton and kapok in which the moisture content in absorption balance is smaller than that in release balance. The moisture hysteresis of akund fiber is 1.77 %. It was observed that akund fiber has a quick moisture release and slow moisture absorption performance in comparison to others.

According to the regression analysis and comparison with cotton and kapok, the initial water absorption rate of akund fiber is a little lower, its balance moisture regain is bigger, and moisture releasing rate is faster. This feature shows that the akund fiber has less absorption moisture which is absorbed by hydroxyl directly and contains more indirectly absorbed moisture. This phenomenon may be decided by its chemical content, which has less cellulose content, and its big hollow structure.

An effort has been made to study the moisture absorption and release behavior of akund fiber and its mechanical performance at relative air humidity ranging from 0% to 100%. The gain and loss in moisture content in akund fiber due to water absorption and release were measured as a function of exposure time under the environment, in which temperature is 20°C and humidity is 65 %. The moisture absorption behavior makes it suitable as a raw material for apparel and as well as composites [3 4, 5].

4. Conclusion
In recent days, there is a growing interest for the usage of natural fibres in technical textiles and as reinforcement for composites due to an increasing environmental awareness, international policy and regulations. The use of natural fibers, e.g. in technical applications, needs to be in line with sustainability, economy, ecology and society. The attractiveness of natural fibres as an
alternative reinforcement comes from its relatively high specific properties (strength and stiffness) and its good eco-friendly performance when compared to traditional fibres [6]. Composite materials reinforced with natural fibres, such as flax, hemp, kenaf and jute, are gaining increasing importance in automotive, aerospace, packaging and other industrial applications due to their lighter weight, competitive specific strength and stiffness, improved energy recovery, carbon dioxide sequestration, ease and flexibility of manufacturing and environmental friendliness besides the benefit of the renewable resources of bast fibres.

Although cotton has a primary importance for apparel manufacturing, some new fibers has some properties that can compete with cotton for technical applications. As an example for these kinds of fibers, akund and milkweed can be given. These fibers are relatively new ones and some researches should be made especially for their use in composite industry and technical textiles.

References

GREEN LOGISTICS ACTIVITIES IN THE CONTEXT OF
FASHION RETAIL INDUSTRY

M. Küçük, M. Güner

1 University, Faculty of Engineering, Department of Textile Engineering, Izmir, Turkey,
mehmet.kucuk@ege.edu.tr

Key words: Green logistics, fashion industry, textile industry, sustainability, fashion retail

Abstract

The role of logistics in sustainable supply chain management in the context of the fashion industry and green thinking is analyzed in this study. The applications in order to optimize the logistics activities of fashion companies for instance greenhouse gas emission, occupancy rate of trucks implications are examined. The factors which encompass fashion retailers’ competitive strategies in such a dynamic institutionally constrained homogenized system will be explained. The review of theories which are behind the concept of market orientation including an extended view of logistics and supply chain management also will be stated by the authors.

1. Introduction

Green logistics, in the context of humanist logistics encourages all stakeholders to consider the impact of their actions on the environment. The main objective of green logistics is to coordinate the activities within a supply chain in such a way that rewarding needs are meet at "least cost" to the environment. In the past “cost” has been defined in purely monetary terms, where-as "cost" can now also be understood as the external costs of logistics associated with; climate change, air pollution, dumping waste (including packaging waste), soil, degradation, noise, vibration and accidents, as illustrated below [1].

Green or sustainable logistics is concerned with reducing environmental and other negative effects associated with the movement of goods. Sustainability looks for new ways that will ensure that decisions made today do not have an undesirable impact on future generations. Green supply chains seek to reduce negative impact by redesigning sourcing, distribution systems and managing logistics so as to minimize and avoid inefficiency, unnecessary freight movements and dumping of packaging.

As consumers have become more environmentally-conscious, retailers’ green credentials are
becoming a more important competitive differentiator. Environmental initiatives, therefore, can generate higher revenues and provide customer loyalty in turn [2]. They can also yield cost savings, for example, by cutting energy consumption and packaging waste.

Figure 8: Where as cost Source: http://log.logcluster.org 2011

By happy coincidence, greening retail operations can represent best business practice both economically and environmentally.

According to McKinnon et al. (2010), green logistics activities include measuring the environmental impact of different distribution strategies, reducing the energy usage in logistics activities, reducing waste and managing its treatment. In recent years there has been an increasing concern about the environmental effects on the planet of human activity and current logistic practices may not be sustainable in the long term. Many organizations and businesses are starting to measure their carbon footprints to facilitate the environmental impact of their activities to be monitored. Governments are considering targets for reduced emissions and other environmental measures. There is therefore increasing interest in green logistics from companies and also governments.

Traditional logistics models for production and distribution have concentrated on minimizing costs subjected to operational constraints. But consideration of the wider objectives and issues connected with green logistics leads to new methods and models, some of which ensure interesting new applications for operational research models of various types.

2. Environmental Effects of Fashion Retail Logistics

Earlier, many of fashion retailers often had very long opening hours and in large cities it was common for some shops being open 24 hours a day. This trend together with just in time
systems, result in reduction of stock levels and minimize operating capital and reduce the risk of unsold fashion goods, leading to more frequent and smaller deliveries. This had also translated into lower loading factors and finally more vehicle kilometers. Therefore in many urban areas there is so much traffic and congestion affecting efficiency and increasing costs of the freight transport operations. But now, with the legislations these negative issues have started to be less harmful for the environment [3].

If it is considered that, the supply system of these retailers, suppliers of many large retail chains make deliveries to distribution centers operating by ‘quick response’ principles, where goods for each store are consolidated and transported as complete lorry loads at a pre-arranged time, often before the shop opens. Advantages are also experienced by retailers’ suppliers who appreciate cost reduction associated with ability to deliver in bulk to depots offering excellent facilities and operating 24 hours a day, 7 days a week. No need for entering busy city centers is an important advantage as well since delays caused by congested roads within urban areas which significantly increase companies’ operating cost, affect their profitability and market competitiveness.

2.1. Environmental effects of fashion retail logistics

It is not possible to escape from the effects of the environment that have on fashion retail logistics. Environmental strategies being made by retailers need to work out ways of transporting goods in a way that is more environmentally friendly. There are 6 main effects that are being closely monitored right now [4].

2.1.1. Greenhouse Gas (GHG) emissions

Numerous gases present a global warming effect with varying degrees of intensity. Carbon dioxide, produced by the burning of fossil fuels in power generation and vehicles, is the most important GHG emitted by retailers, though heavy users of temperature control equipment also release refrigerant gases which can have global warming potential, thousands of times greater than CO₂ [2]. Some large fashion retailers have measured their carbon-footprints and disaggregated their CO₂ emissions in accordance with their activities. Marks & Spencer, for instance, has estimated that the logistics operations account for 11 per cent of its total CO₂ emissions roughly.

2.1.2. Noxious Gases

Pollutants including nitrogen oxide and sulphur dioxide have negative effects on the quality of the air. These gases can have negative effects on humans, vegetation and on the buildings as well [2]. Tightening controls on exhaust emissions over the past 20 years have significantly reduced the release of these pollutants.
2.1.3. Noise

Vehicles and distribution centers cause a lot of noise. With new vehicle technology, it is possible to reduce the noise. Therefore, retailers need to invest in their vehicles to ensure they have quieter engines. The noise occurs mainly from vehicles and distribution centers as well. As a result of improvements in vehicle technology and the imposition of tougher regulations on vehicles noise, it is obvious that new trucks today are much quieter than those of 10-15 years ago [4].

In fashion retail logistics, noise reduction not only involves investing in newer vehicles with quieter engines. The sound of refrigeration equipment, the rattling of the goods inside vehicles and even in-cab radios can cause annoyance. The hooter noise of these vehicles as well. The range of activities performed in and around a retail distribution centre can also disturb local residents, particularly as these premises typically operate on a 24-hour/seven-day cycle.

2.1.4. Accidents

Freight transportation can cause traffic accidents and the cost of injuries or fatalities as well as property damage and use of emergency services are considered to be environmental costs [4]. Beside the traffic accidents, in retail shop, it can be seen some occupational accidents that may give damage to personnel, product or shop. This also means a kind of environmental costs. Therefore some precautions should be taken.

2.1.5. Waste

Fashion retail logistics operations generate large quantities of waste normally, mainly in the form of packaging material [2]. In the past much of this waste went into ovens, occupying air and creating serious environmental problems (such as the release of green-house gases and so on). Today retailers must stick to strict controls on the recycling and reuse the packaging and other waste.

2.1.6. Visual Intrusion

Many people do not like to see huge trucks and warehouses in their community and believe that they reduce the quality of the local environment, quality of life and so on [4]. Large trucks are often considered out of place and even intimidating in sensitive urban and rural environments, while large warehouse ‘sheds’ are often criticized for dominating the landscape. It is very difficult, however, to quantify and cost these subjective judgements and so, for this reason, they tend to be excluded from formal environmental assessments.
2.2. Transport Modes Used in Fashion Logistics

In the context of fashion retailing, companies can switch their traffic flows to cleaner transport ways for both movements into their distribution centers (DC) and outbound deliveries to shops. When there is a need of supplying goods from other parts of the world, the main choices of shipment are usually air freight and deep-sea container services. However, according to the Swedish Network for Transport and Environment, long-haul air freight services emit on average around 30 times more CO₂ per ton-km than ocean shipping [5]. Accordingly, all of the main transport modes have different specialties over the others that lead them to have advantages while the movement of the goods. For instance, rail and waterborne freight have natural advantages in the movement of bulk products because of their ability to carry large quantities in a single train or vessel. By contrast, the flexibility and convenience of road transportation enables it to become very preferable for the movement of manufactured goods. According to McKinnon et al. (2010), rail and water movements are more preferable in case of large flow volumes and relatively low value compared to their weight. Road transportation caters for the majority of distributing products, where consignment values per ton are higher and flows are of smaller volumes. When the countries that use rail transportation frequently are considered, rails become hard to compete for shorter distance flows.

In recent years, major retailers have begun to use alternative modes. In the United Kingdom, for example, Tesco, Asda and IKEA have switched significant volumes of longer-haul traffic from road to rail [4].

On the other hand, although air transport is significantly more expensive than movement by sea, the difference in rates does not reflect the huge difference in environmental costs. This is because any tax is not currently imposed on the fuel consumed by air freight and deep-sea shipping services. The air freight takes the advantage of this tax-free status. In spite of being a much more energy-intensive mode, air freight derives much greater economic benefit. As a first step in this issue, the European Commission proposed to include aviation in the Emissions Trading Scheme from 2012. According to Browne et al. (2007) when combined with steeply rising oil prices, the imposition of higher environmental charges will strongly discourage retailers from using air freight for the highest value, most time-sensitive products.

Therefore, combining the transport options is a good alternative rather than choosing only one type of transport modes in order to help the operations to be more cost-effective, efficient, sustainable and enable the companies to be more competitive in the world of fashion industry.

3. “Greening” The Activities of Fashion Logistics

3.1. “Greening” the transport modes

According to the academicians, the new technology will contribute to the greening of companies’ freight transport operations. It will also be adopting a cross-modal perspective, considering the
opportunities for technologically improving the environmental performance of trucks, vans, freight trains, ships and planes. While there is a strong commitment to de-carbonize freight transport across all modes, individual modes can have particular environmental priorities. The shipping industry, for example, is under strong pressure to reduce sulphur emissions, while the use of ultra-low-sulphur fuels is now the norm in the trucking systems of developed countries [6].

According to literature, Advances in vehicle technology in general can reduce the environmental impact of freight transport in three ways;

- Increasing vehicle carrying capacity,
- Improving energy efficiency,
- Reducing externalities.

As a result, technical innovations are adopted rapidly in some freight modes than others. Over 20-30 year time horizon, however, the development and diffusion of clean vehicle technology is likely to reduce the externalities from all of the main modes of freight transport [1].

3.2. Operational Perspective

Increasing transport costs and the prospect of oil prices rising steeply in the future are giving companies a strong encouragement to improve their vehicle loading. Raising vehicle load factors is one of the most sustainable distribution measures for companies because it yields important economic as well as environmental benefits [7].

Operators are sometimes unsure whether to classify as empty vehicles returning various types of handling equipment. While a truck carrying only enough wooden pallets for the next load may be considered empty, another returning empty roll cages from retail stores to a distribution centre could be considered loaded. There is a need for more precise definitions of what types of trip should be classified as empty. The interpretation of empty running requires some qualification in statistics. There is a common perception that empty running is the result of a wasteful use of transport capacity and a clear evidence of inefficiency [6].

The environmental impact of freight transport is closely related to the amount of energy consumed. This link is particularly close in the case of carbon dioxide emissions. Retailers and logistics service providers working on their behalf can improve the energy efficiency of transport and warehousing operations in many ways. Such as; providing drivers with training in fuel-efficient driving; offering incentives for fuel-efficient driving; purchasing more fuel-efficient vehicles; raising standards of vehicle maintenance; imposing tighter speed limits [4].

Another option of greening the logistics operations is using alternative fuels such as bio-fuel which is produced from renewable plant materials (feedstock) or organic waste oils and fats, and when blended with standard diesel or petrol can, depending on the source, deliver reductions in greenhouse gases emissions [8].

Using electric vehicles is another option for sustainable logistics activities. These vehicles have
the advantage of being almost pollution-free and also extremely quiet. They are therefore particularly well suited to home delivery operations which might be a good and suitable option for deliveries of fashion goods in the context of e-commerce [2].

4. Conclusion

Urban freight transport operations are responsible for a range of negative social and environmental impacts as stated afore. These include fossil fuel consumption, greenhouse gas emissions, air pollution, noise, visual intrusion, road safety and accidents, and road traffic congestion/disruption and so on.

In order to green the logistics activities operated by the companies, there are some ways to realize this purpose. For instance, public policy makers who make changes to urban freight transport operations through the introduction of policy measures that force or encourage companies to change their behavior. Freight transport companies that implement initiatives to reduce the impact of their freight operations may derive some benefits from this change. These benefits can give companies some internal economic advantages such as improved economic efficiency or enhanced market share from operating in a more environmentally or socially efficient manner. On the other hand, company-led initiatives including increasing the vehicle load factor, making deliveries before or after normal freight delivery hours, the implementation of IT for communications or planning purposes, improvements in the fuel efficiency of vehicles, operational agreements between parties (e.g. vehicle routings, delivery times, etc.), consultation based on one party requesting the others views in written form (i.e. not a conversation but feedback to ideas, comments on a proposal etc.) may be beneficial for both their economic state and also for the surrounding environment. Additionally, taking the advantage of software programs such as enterprise resource planning (ERP) will be favorable to optimize the logistics activities.

The apparel industry has always been at the top of unstable demands of customers who want the latest design with low cost while they are still in fashion along with uncontrollable parameters such as weather and economic conditions. Additionally, the fashion market today is marked by ever-changing characteristics of consumers, competition and technologies. On the other hand, this situation has accelerated the competition among fashion businesses. In order to be up to date in the context of green activities, companies should use proper ways both ecologically and monetarily. Acting with this perception, companies can improve their economical status and their company image and also help consumers to live in a better surrounding environment.
References


LIFTING THE TEXTILE MATERIAL BY VACUUM GRIPPER

G. Čubrić

Department of Clothing technology, Faculty of textile technology, University of Zagreb, Zagreb, Croatia,
gcubric74@gmail.com

Keywords: textile, vacuum, gripper, automation

Abstract

A vacuum grippers did not yet found its wide application in the catching and transferring the textile materials in textile and clothing industries. Therefore, we initiate the research of enhancing the use of vacuum gripper for textile materials manipulation. The investigation showed satisfactory results of lifting the textile material using a vacuum gripper especially when a inlet pressure is higher then 5 bar.

1. Introduction

Any assembly process requires defined positioning and orienting of the workpieces to be mated. As the response of non-rigid parts to handling forces is less predictable, specific requirements emerge with respect to workpiece properties, type of placement, types of specific handling processes, as well as general process characteristics [1]. A gripper is a specific element that is made for a specific purpose and are used to capture and hold e.g. packaging, workpieces, tools, devices, materials, etc. and transmits them to a pre-programmed (desired) place. During the execution of complex and sensitive business operations, grips are equipped with different types of senses such as visual, tactile, sensor for force, momentum, spin, etc. Grippers are divided by type of capture principle, as determined by their purpose: mechanical clamp (pliers) mechanical fingers, mechanical gripper with needles, griper that used attachment force (vacuum, magnetic, freezing, adhesive, electrostatic, etc. [2]. Because of the air permeability of textile materials, the application of vacuum grippers in garment technology is limited. Impermeable or less permeable materials such as plastics, impregnated materials, tightly woven polyester, paper, labels, etc. and workpieces of multiple layers after thermoplastic adhesive (called a head-fixation), etc. can be transferred by vacuum grippers. Because of the need to achieve a vacuum (the problem of leakage of material) gripper
should cover as large an area of the workpiece in order to achieve a force sufficient to hold it, and it is necessary to design grippers (form) for a specific workpiece [3]. Transferring the textile material with vacuum, such as taking out of bundle and transfer to another location, has practical problems. Namely, the separation of individual textile material for various reasons is not achieved easily. The parts are held together by static electricity, partly due to the vacuum created between them, and in textile materials due to its permeability, vacuum engages the textile material below the uppermost of which catches [4].

2. Experiment

For the purpose of the experimental part of the work, were collected several samples of textile materials, and were cut to the dimensions of 15x15 cm. Furthermore, the thickness and surface mass of each sample were defined. In this way the prepared samples are ready to transfer the vacuum gripper manually by lifting up textile articles with vacuum gripper. With this method was determined an appropriate operating pressure of suction elements and for each sample separately. The examinations were performed so that the vacuum gripper is set in the middle of sample. Inlet pressure to catch is changing from 2 to 6 bar, figure 1. It was observed if in a given pressure sample can be lift up to a height of 15 cm. To lift the fabric samples it is using the vacuum gripper company Norgren M/58102/20 type.

![Textile material lifting with a vacuum gripper](image)

Figure 1. Textile material lifting with a vacuum gripper

Table 1 shows the measurements results of samples thickness and surface mass. On each sample were performed 5 measurements. Based on these measurements the mean thickness of the textile
material is shown. For testing were selected 10 samples of textile materials, 5 woven fabrics (W1-W5) and 5 knitted fabrics (K1-K5).

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>Sample thickness [mm]</th>
<th>Surface mass [g/m²]</th>
</tr>
</thead>
<tbody>
<tr>
<td>W1</td>
<td>0.156</td>
<td>52.53</td>
</tr>
<tr>
<td>W2</td>
<td>0.370</td>
<td>118.22</td>
</tr>
<tr>
<td>W3</td>
<td>0.654</td>
<td>866.39</td>
</tr>
<tr>
<td>W4</td>
<td>1.376</td>
<td>111.81</td>
</tr>
<tr>
<td>W5</td>
<td>1.654</td>
<td>266.88</td>
</tr>
<tr>
<td>K1</td>
<td>1.518</td>
<td>173.43</td>
</tr>
<tr>
<td>K2</td>
<td>1.744</td>
<td>246.88</td>
</tr>
<tr>
<td>K3</td>
<td>2.510</td>
<td>290.33</td>
</tr>
<tr>
<td>K4</td>
<td>1.086</td>
<td>294.81</td>
</tr>
<tr>
<td>K5</td>
<td>3.338</td>
<td>397.63</td>
</tr>
</tbody>
</table>

3. Results and discussion

Table 2 present the results for the lifting the textile material by vacuum gripper at a pressure of 2, 3, 4, 5 and 6 bar. Vacuum gripper is positioned in the middle of the sample.

<table>
<thead>
<tr>
<th>Sample</th>
<th>2 bar</th>
<th>3 bar</th>
<th>4 bar</th>
<th>5 bar</th>
<th>6 bar</th>
</tr>
</thead>
<tbody>
<tr>
<td>W1</td>
<td>-</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>W2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>B</td>
</tr>
<tr>
<td>W3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>W4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>W5</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>K1</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>K2</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>K3</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>K4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>K5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

Legend: + material is lifted, - material is not lifted, B gripper is stick to the base
Considering table 2 it can be seen that at 2 and 3 bar no sample could not be lifted. The lifting of materials manages to accomplish just when the inlet pressure of the vacuum gripper is 4 bar. At this pressure samples W5 and K1 was managed to lift. Increasing the inlet pressure to 5 bar gripper four materials was lifted, but by three samples the vacuum gripper was stuck to the working surface. By raising the pressure to 6 bar the results are the same as in 5 bar. From the above it can be concluded that the materials that have a small surface mass (less than 118 g/m²) can not be lifted with vacuum gripper. Also, it can be concluded that materials which have a surface mass greater than 250 g/m² are easy to lift.

4. Conclusion

The results showed that the inlet pressure of 2 or 3 bar is too small to lift up the textile material. Only at 4 bar vacuum gripper manages to lift the material. For materials with low surface mass (less than 120 g/m²) gripper is stuck to the working surface.

Reference

THE INFLUENCE OF DOMESTIC WASHING ON THE PROPERTIES OF FABRIC WORK CLOTHES FOR CITY WORKERS CLEANER

E. Laçi, G. Guxho, I.Kazani

Polytechnic University of Tirana, Textile and Fashion Department
enila_a2@yahoo.com

Keywords: work clothes fabric, physical & mechanical properties, domestic washing, ISO standards

Abstract

The clothes are our second skin and when it comes to working clothes we need to wear them every day, which means that they need to be washed often. Moreover these textiles will face chemical used and mechanical movements during their maintenance. The raised question here is how will be their influence on their properties?

The purpose of this paper was the study of the domestic washing effects on physical and mechanical properties of fabric used for work clothes. The behaviour of two fabrics with different composition, 100% CO and CO/PES, was analyzed based on ISO standards. The properties of the fabrics were determined before and after washing, such as: thickness, textile strength, and colour fastness. Furthermore the physical and mechanical properties of the samples were examined after 1, 5, 10, 15 and 20, 25 and 30 washing cycles. It was observed that the properties of the fabrics after 20 washing cycles were decreased, especially those on of textile strength.

1. Introduction

The work cloth is exposed to intense wear, tear and soiling, and hence needs frequent care and maintenance to ensure that protection, comfort, style, image and hygiene properties continue to be provided over the entire lifetime of the garment. To do this in a safe and effective way, specialised garments and specialised processing of these garments is fundamental. Therefore, industrial laundry processes have been developed to meet these needs, while preserving the style and appearance so valued by end-users. There are different organizations such as ETSA, which have drawn up this set of recommendations and requirements to offer guidance to garment manufacturers, designers and other parties involved in the supply chain. The ultimate purpose of these requirements is to help increase efficiency throughout the supply chain.
Based on different recommendations work cloth will continue to meet the end-users needs, after repeated use, regular care and maintenance in domestic washing guaranteeing their better performance [1]. The aim of this work was to evaluate the influence of washing condition and mechanical properties of two different textile materials.

2. Method and materials

2.1 Materials

The textile materials used in this research were tested using Candy domestic machine [2]. The first fabric was 100% CO and the second 65% CO + 35% PES [4]. The tests are done based on standards [1]: Quantitative chemical analysis: ISO 1833-11:2006, Tensile strength ISO 13934:1999 and Thickness ISO 5084:1996.

2.2 Methods

There were chosen two different fabrics, which were washed in domestic conditions with Candy domestic machine at 40°C temperature, using dixan liquid (50ml/1 in one washing cycle). The samples were dried out in a horizontal position. The specimens for determination of mechanical properties such as: thickness, textile strength and colour fastness, were cut out from washed and rinsed samples. The parameters were determined using the electronic fabric strength tester YG 026B, fabric thickness gauge YG 141N, balance APX-200. The change and stability of the investigated parameters were evaluated relatively by comparing them to the parameters of the control specimen which was equal to 1. Two different fabrics were tested for the tensile strength and the percentage elongation before and after every washing cycle [3]. The processes of fabrics sampling and conditioning were done according to EN ISO 13934 [5]. Moreover the specimens were conditioned for 24 hours in a standard atmosphere at a temperature of 20 ±2°C and a relative humidity of 65±2%. After being conditioned the fabric samples, the fabric thickness measurements were performed [6].

3. Results and Discussion

The results of domestic washing test for two different fabric compositions: 100% CO and 65% CO+35% PES are shown in the tables below:
Table 1. Color fastness of Fabrics

<table>
<thead>
<tr>
<th>No. of Laundry Cycle</th>
<th>Color Shade</th>
<th>Fabric 100 % CO</th>
<th>Fabric 65% CO+35% PES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>4-5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>4-5</td>
<td>4-5</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>3-4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

The table 1 shows that the color of 100% CO fabric has resisted to 10 cycles of washing, after that the color changed. Whereas the color of 65% Co+35% fabric has resisted longer till 20 washing cycles and after that the color changed. Comparing the data of color fastness, results that the most appropriate fabric for work cloth was 65% Co+35% Pes (gray fabric).

Figure 1. Effect of the washing cycles on fabrics thickness

From the figure 1 results that after every washing cycle the fabric exhibit decline in the thickness values.
In the figures below are shown the results of the evaluation of tensile strength and elongation of 8 specimens.
Figure 2 Effect of the washing cycles on Tensile strength of 100% CO fabric

Figure 3. Effect of the washing cycles on Elongation of 100% CO fabric

Figure 4. Effect of the washing cycles on Tensile Strength of 65%CO+35%Pes
Figure 5. Effect of the washing cycles on Elongation of 65%Co+35%Pes

Conclusion

The tests, of two different fabrics chosen, were carried out according to the requirements set out by ETSA (European Textile Services Association). Based on the obtained results was conclude that the textile, which shows less changes in its physical-mechanical and chemical properties (tensile strength, thickness, elongation) is the one composed of 65%CO+35% PES. This textile fulfills the criteria to be used for work clothes for city workers cleaner.

References

[1] ETSA requirements for workwear garments, February 2011
STUDY ON JUVENILE DELIQUENCY AND NATIONAL SITUATION IN ALBANIA

S. Fortuzi

Polytechnic University of Tirana
sfortuzi@yahoo.com

Key words: Juvenile justice, focus groups, social integration, delinquent juvenile

Abstract

Albania is a country with youth population; 1/3 of the population is at age of 1 – 18 years old. The trend of minor individuals to get involved on the criminal acts it’s an indicator of the great number of social problems. According to the existing statistics, more than 1 million minor or youth individuals are in the penitentiary institutions all around the world. A big number of relevant specialists work in this area.

The main purpose of the study is to deeply explore the juvenile delinquency and finding out the importance of alternative sentences (probation service) in the re-socialization process and the negative impact to some extend of the penitentiary regime. The desired end-result is a normal personality development of children and youth.

The study is based on basic legal documents as well as to the previous studies and works mostly supported by international programs of advocacy and trainings. The delinquent juvenile has received some assistance services through social workers and psychologists as well as education service within institutions. In addition, there has been provided some assistance from the personal who work at penal institutions dealing with children’s rights. The study includes data analysis of focus groups information. After that, immediate challenges and issues that delinquent juvenile is facing were identified. At the end, some results of the study and conclusions fro improvements.

1. Introduction

This study covers the issue of juvenile committed a delinquency and are doing their penitentiary period as well as their integration in the society. The study covers capacity and will of our society for the social integration of these individuals. The existing social, psychological and legislative studies have not paid any special attention to this problem. An important issue is how
sensible are relevant governmental structures for creating minimal conditions for this part of the society, taking necessary measures related with alternative sentences, different services and programs available during detention, prison and after sentence periods.

Regarding the juvenile justice situation in Albania, there has been an increase at the ration between the age and crime in the transition years. In general, the maximal age of crime commitment is higher for the male individuals compared with females ones. After the ‘90s, the crime actions among juvenile individuals are increased in Albania; hence, it is important to identify all reasons and needs in order to intervene in the early phases to prevent and avoid the recidivism.

An important fact is that Albania has a young population compared with the other countries of Europe; 1/3 of the population is at age of 1 – 18 years old. The trend of the juvenile individuals to get engaged on the criminal activities it’s an indicator of the social problems. Poverty, the lack of financial resources, internal families’ conflicts, parents’ divorces, school abandonment, emigration of family members, drugs, etc., are some of the major problems which have helped in increasing the criminality among the juvenile individuals. A major progress has been on approaching the Albanian legislation and practices with the international standards and best practices. This is a continuous dynamic process being in place but still needs to be done. Some positive developments include the creation of the specialized section within district courts, specialized prosecutors and specialized unit at the police, renewal and elimination of the overcrowding in some institutions of detention, greater access of juvenile prisoners to education, and social workers and psychologists services, positive orientation towards children’s rights of the directors at the penal institutions. These positive developments are as the result of several trainings supported by the international organizations and programs whose beneficiaries were Albanian partners and civil society.

Juvenile justice system in Albania has continuously been under a reforming process. The changes have been significant especially after the year 2001. These changes include legal and administrative measures in infrastructure and human resources based on the best interests of the children.

Being in accordance with international commitments, a special attention has been paid to drafting and implementation of principles, standards and strategies which address the children’s role and status in the penal justice being as author, as victim or as witness.

Even the implementation has been humanized still the law remains essentially punitive. Further efforts are necessary to decrease the use of detention. The legal reform on juvenile justice has been proceeded slowly and there is no clear and inclusive plan. Compilation and publication of the juvenile justice database will help the reform process and monitor the achieved results of this reform. The coordination between involved actors in juvenile justice is focused on the program implementation; there is no tool for permanent coordination. The alternative sentences should be drafted on a strong legal basis and its implementation should be broader. In addition, the second prevention needs more attention and the drafting of programs which focus children engaged on crime activities under the age of 14.
2. The purpose of the study

Based on the children’s best interests, “The UNO’s Convention on Children’s right” which is considered as a universal code on children’s right protection, emphasize the proper decision making and administrative measures for the children’s rights protection. The main purpose of the study is the deep knowing of the juvenile delinquency and identification of the method of how alternative sentences contribute in re–socialization of delinquent youth individuals and the negative impact of penitentiary regime on their personality development. Some of the social factors which lead on the increased the number of children in conflict with the law are as follows:

a) Disorganization of the traditional family and the decrease of the family role as socializing agent.

b) School failure displayed through school abandonment in different levels of education.

c) Negative attribute of detention sentence which leads in recidivism.

d) Low appreciation for school studies based on the professional uncertainty of youth population.

e) Increase of the neighborhood criminal groups which include children and youth individuals out of the parental supervision during the free time.

Focus group

To complete the research described above, a focus group activity took place. The aim of this focus group was to make evident specific aspects of juvenile delinquency in the contest of applying an alternative sentences regime. The focus group were set up based on champion with relevant specialists of social workers and. The focus group is defined as a research tool which is based on wide discussions with small groups of individuals on a certain subject. The group interview has the advantage of avoiding the “atomistic error” that is collective psychological status deduction caused by statistical agreement.

The focus group’s interview is a qualitative method of research as it foreseen the interaction among group members during their discussions, opinion and ideas exchange, rising issues, etc. Part of this information cannot be provided by the quantity methods (questionnaires).

Some of the main topics are:

a) The indication of juvenile delinquency main features and reasons of illegal actions.

b) The psycho-social assessment of delinquent youth/children individuals.

c) The assessment of alternative sentences system; advantages and disadvantages compared with detention sentences.

d) Specific experiences of delinquent individuals.

e) Issues related with implementation of alternative sentences system.
Focus groups objectives:

a) Finding out the way each group identify problems regarding juvenile delinquency.
b) Estimation of advantages of “Probation period” versus “detention” and how it will result in lower risk of recidivism.
c) Identification of delinquencies on which the sentences is made; for the same delinquency are occurred both alternative sentences and detention.
d) Identification problems in the implementation of the probations periods.
e) Describing of alternative sentences implementation and the appealing process.
f) Estimation of the necessity of the establishing the delinquent juvenile institutions.
g) Estimation of the necessity of specialized staff at probation service.
h) Estimation of rehabilitation feature of penitentiary system.
i) Identification of preventing measures of juvenile delinquency.
j) Identification of challenges faced by focus groups members working with delinquent individuals.
k) Presentation of suggestions for specific activities of each structure dealing with delinquent juvenile individuals.

Research hypothesis of focus group is based on general hypothesis of research:

a) Re-socialization of delinquent juvenile is more probable to happen through alternative sentences than penitentiary regime.
b) The respective families support increases the re-socialization and integration possibilities of the delinquent individual.
c) Active involvement of the community on the designing and implementation of the control and prevention of juvenile delinquency policy brings social integration of the delinquent youth individuals.

The verifying of hypothesis resulted in:

a) Defining the part of alternative sentences on the system of the sentences.
b) Drafting a set of proposals which aim the improvement of alternative sentences implementation.

The technique used is “content analysis”

According to B. Berelson the “content analysis” is a researching technique which provides objective, systematic and quantitative descriptions of the content of communication. That is a method which refers quantitative analysis of the facts pointing out topics, trends, etc. some its specifics are as follows:
a) Defines the documentation/facts interpretation in the first sight.
b) Content analysis has a specific relevance in the analysis of scientific products with double senses: as a second analysis of the data on psycho-social studies, and clearly specify which topics are being studied on the scientific studies.

c) The content analysis provides the internal trends of the documents in a certain time as well as the evolution of different variables in different moments.

d) This is a preferable method by the researchers as it provides information not gained by other methods.

e) Relatively low cost compared with other methods of studying.

f) There is no standard scheme of application and development of content analysis, thus each researcher has own system of codification.

The main functions of content analysis are:

a) The description of communication: tendency indication, comparison of different resources, comparison of contents.

b) Description of the language and message style.

c) Indication of the correlation of content nature, form of the text and text receptor.

d) The conclusion about nature and objectives of the information resource.

e) Methodology basis of the ways of interpersonal message exchange in order to study its effects on the process of perception.

The technique of content analysis offers a wide variety of procedures such as the frequency analysis and computerized analysis of content. The frequency analysis represents the classical procedure of the content analysis. It finds out the frequency of happening of a unit of registration and its quantitative value. Example: count the most effective words or hard ones occurred in a document or speech.

The trends analysis starts from the frequency analysis and try to find out the positive, negative or neutral attitude in communication of the sender of the message towards a person, an idea, a social fact, etc. The analysis of the communication trend it is performed through math and statistical formulas. As in case of frequency analysis, it starts with topics identification and each topic is classified according to the positive, negative or neutral attitude. From the total content, it is extracted the content units which have correlations with the topic. Then, the amount of frequencies is divided with their total number. After the topics identification, they are classified according to the attitude.

The trend is found out through following formulas:

When we count only the content units related with the topic, the following formula is used:

\[ AT = \frac{F - J}{L} \]

When we count the total number of content units, the following formula can be used:

\[ AT = \frac{F - D}{} \]
For counting the trend of content analysis, a more developed formula can be used. This formula which takes simultaneously into account the content related with the topic and total content.

\[ \text{AT} = \frac{F - D}{L} - \frac{F - J^2}{L} \]

Relevant specialists’ perception on the implementation of alternative sentences in general and especially in the juvenile justice sector (focus groups)

The increasing number of the delinquent minors and its consequent problems makes decision makers and government to continuously improve the juvenile justice system. Based on this fact, it’s important to know the opinion of the relevant specialists which are directly or indirectly implicated with the legal framework and implementation of the alternative sentences in Albania. The focus groups were composed by the following specialists:

1. Psychologist and social workers (university professors).
2. Justice system specialists (prosecutors, lawyers, representatives from the Ministry of Justice).
3. Education specialists of the psycho-social field (representatives from rehabilitation centres and probation service).

The discussions were focused on the following issues:

- Juvenile delinquency phenomenon in Albania.
- Current juvenile sentences system.
- Probation service in Albania.
- Penitentiary sentences versus alternative sentences/probation service.
- Media involvement in promoting probation service on juvenile justice system.

4. Conclusions

The perception by three focused groups on the issue of delinquent juvenile has to do with the implicit consequence of structural modifications happened during the last years in Albania. The specialist (Social workers, psychologists, educators, probation service staff) dealing directly with this phenomenon in their jobs, think that this is a normal challenge each society is facing. According to them, it will be a problem if the phenomenon exceeds its normal limits.
That will be the time to take reforms, draft strategies and adjust social policies. The groups share almost the same idea regarding the sentences to apply for the delinquent juvenile: it should be in correlation with the weight of the actions committed; only actions resulted with the hurt and suicide should be sentenced in the penitentiary regime.

The alternative sentence should help individuals to rehabilitate, socially integrate and general awareness about the actions done. Social tags and penitentiary sentences in a very early stages of life where the family role is crucial, could result in a big traumas accompanied with antisocial behavior by the youth or minor individuals. If a minor or youth individual share the same time and space in a rehabilitation center with other individuals who have committed crime, enable the creation of connections with these individuals and increase the recidivism and worsen their behavior.

The penitentiary regime should be replaced with alternative sentences especially in cases of minor crimes; that’s the majority of the opinion of academic representatives at the focus groups. The lawyers are more partial regarding this topic and their opinion is that the probation service helps the youth and minor individuals to spend more time with their families and to normally continue with respective education process. On the other hand, they think that penitentiary regime plays an important role in discouraging individuals to get involved in crime actions and thus cannot be totally replaced.

According to the specialists who work directly with the delinquent youth individuals such as those of rehabilitation centers and probation services, the penitentiary regime and probation service should co-exist considering the current situation in Albanian which lacks the specific institutional infrastructure (there is only one probation service institution in all over the country located in Tirana).

An addition reasons that justify the existence of both institutions is the insufficient information of the public about the difference between two of them. Especially the probation service is something new for Albania. Specialists who work directly with the delinquent juvenile, especially those of probation service, think that the lack of information directly influence rehabilitation and integration of delinquent juvenile in the society.

The academic representatives think that institutions can set up proper strategies through relevant specialists in order to increase capacities of the institutions to manage this phenomenon and to complete the process of rehabilitation and integration.

Lawyers think that there is no such a specialist in the relevant institutions even that the existing capacities can carry on properly the process.

The third focus group conclusion is that existing institutions cannot manage well most of the issues as they lack the specialized staff, insufficient rehabilitation center (only one) and probation service, low interest from the community, inadequate legal provisions which hinder the development of this process.

According to the opinion of all members of the focus groups, the challenges regarding alternative sentences/probation service are dealt with inadequate or the lack of legal coherent provisions adapted with the Albanian social background. The result is the nonfunctioning of the delinquent
juvenile justice and the prevention of the crime at this age.
Some of the measures on this regard are: education improvement, adaption of education system to the specific needs of youth and minor individuals, public information, parents and school community involvement, in different social projects, set up of the proper strategies to fight the phenomenon, social adaption of the delinquent juvenile.
Social adaption is considered as a corner stone of the social integration. Organizations who work children’s right protection are actually informing and lobbying on reintegration concept. The formula of delinquent juvenile integration should be improved giving the priority to the concept of social adaption. With other words, offering opportunities to the delinquent juvenile based on the age, cases’ specifics, and culture. This will result in a better and more natural integration of the delinquent juvenile.

References

[5] B.Berelson Content Analysis in Communication Research (1952)
LIST OF AUTHORS
# AUTHOR INDEX

## A

Atılgan T. 163, 188

## B

Barbier G. 28
Boci I. 270

## C

Caslli Sh. 215
Čubrić G. 209, 326

## D

De Mey G. 113
Declercq F. 113
Demboski G. 92
Demir A. 38, 312
Drushku S. 60, 270
Dumishllari E. 148

## E

Erdoğan M. Ç. 50

## F

Fagu A. 4
Fagu M. 4
Fortuzi S 335

## G

Galantucci L. M. 131
Gassara H. E. 28
Gjana F. 258
Gülümser T. 38, 312
Güner M. 318
Guxho G. 18, 60, 81, 113, 123, 148, 330

## H

Hertleer C. 113
Hylli M. 60, 142, 294

## I

Ivanovska A. 70

## J

Jordanov I. 92
Jordeva S. 46, 247

## K

Kaçani J. 131
Kanat S. 163, 188
Kasmi S. 123
Kaynak E. 297
Kazani I. 113, 231, 330
Kenny P. 172
Kiekkens P. 76
Kola I. 81, 294
Kolgjini B. 76, 142, 294
Koparal A. S. 297
Küçük M. 318

## L

Laçi E. 330
Liço E. 270

## M

Mangovska B. 70, 92

## O

Özdoğan E. 38, 312

## P

Panajoti Hysi V. 284
Piperi E. 102, 131, 305
Prifti L. 277

## R

Rambour S. 76
Rogier H. 113

## S

Salillari D. 277
Salopek Čubrić I. 209, 229
Şamli B.E. 50
Schoukens G. 76
Seventekin N. 38, 312
Shabani A. 123
Shakaj F. 4
Shehi E. 76, 102, 131, 142, 240, 294, 305
Shehu Sh. 277
Shyle I. 258, 284
Sinoimeri A. 28
Spahija S. 240
Spahiu T. 102, 131, 305

## T

Teta J. 254
Tomovska E. 46, 247
Toshikj E. 92
Trajković D. 46, 247

## U

Ureyen M. E. 297

## V

Van Langenhove L. 113

## W

Wagner Kocher W. C. 28

## X

Xhafka E. 254

## Z

Zafirova K. 46, 247
Zavalani O. 123