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PROCEEDING OF THE 27TH TEXTILE RESEARCH SYMPOSIUM AT MT. FUJI

SHIZUOKA, JAPAN, AUGUST 3~5, 1998

FROM FIBER SCIENCE TO APPAREL ENGINEERING,
TEXTILE STRUCTURE AND TEXTILE PROCESSING,
DESIGN OF HIGH QUALITY TEXTILES

ORGANIZED BY

THE ORGANIZING COMMITTEE
OF THE TEXTILE RESEARCH SYMPOSIUM AT MT. FUJI,
CHIRMAN: SUEO KAWABATA, THE UNIVERSITY OF SHIGA PREFECTURE

UNDER THE CO-OPERATION
WITH

THE TEXTILE MACHINERY SOCIETY OF JAPAN,
THE SOCIETY OF FIBER SCIENCE AND TECHNOLOGY, JAPAN
THE TEXTILE INSTITUTE , JAPAN SECTION,
THE JAPAN SOCIETY OF HOME ECONOMICS,
THE JAPAN SOCIETY FOR COMPOSITE MATERIALS
AND
THE JAPAN RESEARCH ASSOCIATION FOR TEXTILE END-USES

PREFACE OF THE SYMPOSIUM PROCEEDINGS

Dr. Sueo Kawabata, Professor, the University of Shiga Prefecture
The Organizer of the 27th Textile Research Symposium at Mt. Fuji, 1998

The 27th Textile Research Symposium at Mt. Fuji was held on August 3~5, 1998. The symposium was held at the Fuji Kyouiku Kenshusho (Fuji Educational Conference Center). Papers presented at this symposium increase in quality each year. This year, 50 excellent papers were presented, covering a wide range of textile technology from fiber science to apparel engineering. One advantage of this symposium is the opportunity to discuss textile science and engineering throughout a single session. This single session system is based on the idea that we must not subdivide textile technology, that it is a single technology. Discussions were very active as usual. In addition to the lecture room, symposium participants also held discussions in the social rooms while enjoying drinks and refreshments in the evening, as usual. "One point lecture" session were also held in the evening on the second day, as usual. The following is a list of the "One-point Lecture" session.

1. Dr. J. Militky, "Abuse of Correlation"
2. Dr. L. Hess, "Recycling Textiles"
3. Dr. Yi Li, "Traditional Chinese Wisdom in Selecting Fabrics for Summer Wear"
4. Dr. J. Fan, "A failed idea or is it?"
5. Dr. S. Mukhopadhyay, "Neuro-Science vs Fibre Science"
6. Dr. S. Kawabata, "A Short Report from the Kyoto Seminar on the Background of Creativity"
7. "My Country" and "My University", by various participants from around the world

Finally, we would like to express our appreciation for the co-operation of the following organizations.

The Textile Machinery Society of Japan,
The Society of Fiber Science and Technology,
The Textile Institute , Japan section,
The Japan Society of Home Economics,
The Japan Society for Composite Materials,
and
The Japan Research Association for Textile End-uses.

December 17, 1998

Participants at the front of the conference hall,
(some participants are unfortunately missing). 4th August 1998.

CONTENTS
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INFLUENCE OF FIBER PROPERTIES AND PROCESS ON THE YARN QUALITY

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ABSTRACT

There are many factors affecting the yarn quality in the spinning mill, namely the raw material and the process.
In this paper we describe an industrial oriented study carried out in order to determine the influence of carded and combed processes in the yarn quality and the influence of raw material properties in a rotor spinning frame. This quality was evaluated by means of a statistical analysis, using the mean value comparison method (t Student tables). We finish by drawing some conclusions regarding the influence of the different parameters under study in the yarn quality.

1. INTRODUCTION

In previous works [1, 2] it was demonstrated that raw material is of an extreme importance to the determination of the final yarn cost (Figure 1). It is generally assumed that a very high economy in raw material does not usually reduce costs; on the contrary it can contribute to a rise due to a more complex spinning process, increasing the number of operations and therefore decreasing the yarn quality.

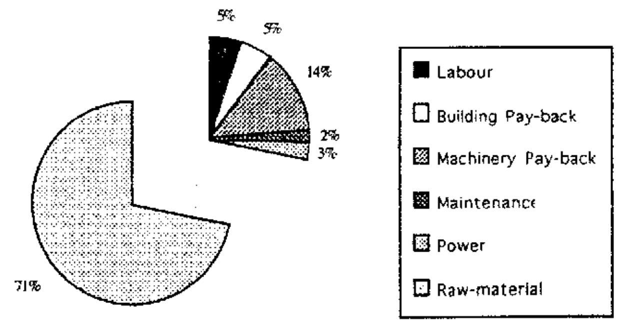

Figure 1 - Costs in a Spinning Mill

Technological developments, namely in electronics and computer science [3], contributed to achieving an increase in productivity and quality of the yarn. This has been accomplished by the use of an on-line control in most of the machines.
A considerable amount of research work [4, 5, 6] has been dedicated through the years in order to identify and quantify which fiber properties play a more important role in the spinning process and in the quality of the final yarn. Several attempts were made to quantify these effects and establish mathematical equations (theoretical or empirical) among fiber properties, on one side, and the spinning process, on the other. However a

universal model could never be established, certainly because the process was not taken into consideration.
The main objective of this work is to study the influence of raw material and process, used separately, in the yarn properties. This study was limited to a statistical analysis in order to determine which are the yarn properties influenced by the use of a different raw material or a different process

2. METHODOLOGY

This work was developed along two different lines:
First we studied the influence of the process (combed and carded) in the yarn properties. The methodology was based on the production of a 30 tex ring-spun yarn from a 737.5 tex combed and carded rover from the same blend.
Second we used an open-end spinning process to assess the influence of drafting parameters as well as different raw material characteristics. In order to study the drafting influence we produced two yarns, 50 tex and 42 tex, using the same sliver (4920 tex). To assess the influence of raw material, two types of cotton blends were used to produce a 59 tex yarn.
Raw materials were tested using HVI from Spinlab. This is based on fiber bundle testing, i.e., many fibers are checked at the same time and their average values determined. It can measure in a short time and at a rate of up to 180 samples per hour the following properties: span length (as a measure of fiber length), length variation, strength, elongation, micronaire (as a measure of fiber fineness), colour, reflectance and trash content (optical determination).
Yarn characterization was performed using Uster Dynamat II for strength and elongation values. Testers based on capacitance (Uster Tester III) enable, as a fraction of the yarn's mean value, a mean deviation (U%) or standard deviation (CV%) to be determined. We also used this instrument to detect: thin spots (<50%), thick spots (>50%) and neps (>200%).
In order to assess the influence of the parameters used in this study, a statistical analysis was carried out in parallel with the theory used to support it.
All the samples were taken from the production line of a spinning mill to make this study useful for industry.

3. STATISTICAL BACKGROUND

Being A and B two samples of the same magnitude, but from different sources, and taking n_A and n_B measurements, with mean values M_A and M_B and standard deviation sd_A and sd_B, the determination of significant statistical differences between A and B samples is achieved using the following equations:[7]
Standard deviation for the total sample A and B is given by:

$$sd_{(A+B)} = \sqrt{\frac{(n_A - 1)sd_A^2 + (n_B - 1)sd_B^2}{n_A + n_B - 2}} \qquad \text{(eq.1)}$$

and the standard error,

$$\varepsilon_{S(A+B)} = sd_{(A+B)} \cdot \sqrt{\left(\frac{1}{n_A}+\frac{1}{n_B}\right)} \qquad \text{(eq.2)}$$

and the t value is obtained from:

$$t = \frac{|M_A - M_B|}{\varepsilon_{S(A+B)}} \qquad \text{(eq.3)}$$

The t value must be compared with t Student distribution values for 95% and 99% probabilities with $n = n_A + n_B - 2$ degrees of freedom.
If $t < t_{(95\%)}$: Samples A and B are not different
If $t_{(95\%)} < t < t_{(99\%)}$: Undefined situation
If $t > t_{(99\%)}$: Samples A and B are different
Since the number of tests were always 10 to all the parameters under analysis, t Student values for $\nu = 18$ are $t_{(95\%)} = 1{,}7341$ and $t_{(99\%)} = 2{,}5524$.

4. EXPERIMENTAL WORK

4.1 Influence of the process

In order to study this parameter we used the same rover count (735,5 tex) produced from the same cotton blend. The characteristics of the raw material are given in table 1.

Table 1 – Raw material characteristics

Raw material properties	Mean	Sd	CV (%)
Strength (cN/Tex)	22.26	1.38	6.2
Elongation(%)	8.69	0.78	8.9
2,5% Span length (")	28.10	0.37	1.3
Length Uniformity Index (%)	44.69	0.50	1.1
Micronaire	4.18	0.08	1.9
Reflectance(%Rd)	75.31	0.87	1.2
Yellowness(+b)	9.21	0.42	4.6

The rovers were obtained from different processes, combed and carded in order to verify which characteristics the process influences. Both rovers underwent similar drafting and twisting operations as given in table 2.

Table 2 – Process parameters

	Combed	Carded
Drafting constant	877	877
Total Drafting	25.0	25.0
Drafting wheel	33	31
Twist (tpi)	14.0	15.3
Twist wheel	50-46	47-49

The resulting yarns were tested and their main characteristics are listed in table 3.

Table 3 - Carded and combed yarn characteristics

Properties	Carded Yarn			Combed yarn		
	Mean	Sd	CV (%)	Mean	Sd	CV (%)
αNe	3.47	-	-	3.14	-	-
Yarn count (tex)	29.44	0. 37	1.8	29.65	0.34	1.7
Strength (g)	394.98	20.55	5.2	365.44	14.71	4.0
Elongation (%)	5.85	0.22	3.8	5.55	0.16	3.0
CVUster	14.85	-	-	10.16	-	-
Thin spots/1000m (<50%)	7.1	-	-	0.2	-	-
Thick spots/1000m (>50%)	284.7	-	-	22.2	-	-
Neps/100m (>200%)	136.1	-	-	38.3	-	-

4.2 Influence of raw material

We wanted to compare the properties of two Open-End yarns of the same count produced from two different blends. Therefore we used a drawframe sliver from blend 01 to produce one of the yarns and another produced from blend 23.The characteristics of the different blends are given in table 4.

Table 4 – Raw material characteristics

Raw material properties	Blend 01			Blend 23		
	Mean	Sd	CV(%)	Mean	Sd	CV (%)
Strength (cN/Tex)	26.01	1.33	5.1	25.39	1.36	5.4
Elongation(%)	8.27	0.94	11.4	13.54	2.76	20.4
2,5% Span length (")	27.88	0.40	1.4	26.29	0.29	3.5
Length Uniformity Index (%)	45.43	0.56	1.2	42.22	1.82	4.3
Micronaire	4.19	0.12	2.9	4.04	0.19	4.7
Reflectance(%Rd)	76.19	0.55	0.7	75.01	0.78	1.0
Yellowness(+b)	9.06	0.28	3.1	9.18	0.38	4.1

The parameters of the process were the same for both yarns. After testing the yarns produced according to the previous conditions the results are listed in table 5.

Table 5 – Yarn characteristics

Properties	Blend 01			Blend 23		
	Mean	Sd	CV(%)	Mean	Sd	CV(%)
αNe	3.58			3.56		
Yarn count (tex)	60.27	0.17	1.7	60.14	0.13	1.3
Twist (tpm)	440.2	11.26	2.6	439.4	8.13	1.9
Strength (g)	543.33	18.67	3.4	533.31	14.90	2.8
Elongation (%)	6.79	0.06	0.8	6.71	0.12	1.9
CVUster	10.5	-	-	13.0	-	-
Thin spots/1000m (<50%)	0	-	-	1.0	-	-
Thick spots/1000m (>50%)	2.2	-	-	18.2	-	-
Neps/100m (>200%)	4.9	-	-	38.1	-	-

4.3 Influence of drafting and twisting

We wanted to compare the properties of two Open-End yarns 59 and 42 tex produced from the same raw material (blend 23). To obtain these yarns we used a 4920 tex sliver. The obtained yarns properties are listed in table 6.

Table 6 – Yarn characteristics

Properties	42 tex			59 tex		
	Mean	Sd	CV (%)	Mean	Sd	CV (%)
αNe	3.75			3.56		
Yarn count (tex)	42.29		1.8	60.14		1.3
Twist (tpi)	552.0	22.83	4.1	439.4	1.9	8.1
Strength (g)	337.9	33.85	10.0	533.31	14.90	2.8
Elongation (%)	5.82	0.39	6.7	6.71	0.12	1.9
CVUster	13.85	-	-	13.0	-	-
Thin spots/1000m (<50%)	10.3	-	-	1.0	-	-
Thick spots/1000m (>50%)	48.0	-	-	18.2	-	-
Neps/100m (>200%)	69.2	-	-	38.1	-	-

5. DISCUSSION

We organized the discussion according to two different lines: First we compared the obtained results in terms of USTER statistics [8] in order to analyze the yarn quality used in this study. Second we carried out a statistical work to determine the possible influence of the parameters under study.

5.1 Influence of the process

In tables 7and 8 we present the results obtained from the Uster tables and the statistical study in terms of t value.

Table 7- Uster values

Characteristics	Carded	Combed
CVUster	40%	<5%
Thin spots/1000m (<50%)	65%	5%
Thick spots/1000m (>50%)	65%	50%
Neps/100m (>200%)	20%	40%

From table 7 we conclude that the quality index of the combed yarn is better than the carded one except for the neps index. This indicates that the yarn being produced can be classified in terms of quality as a medium-high for the combed and medium-low for the carded.

Table 8- t value determination

Yarn parameters	t value
Yarn count (tex)	0.881
Twist	7.138
Strength (g)	3.698
Elongation (%)	3.489
Thin spots/1000m (<50%)	3.922
Thick spots/1000m (>50%)	12.197
Neps/100m (>200%)	8.305

As we expected, the statistical results agree with the general practice, showing that the process used influences all the parameters of the yarn with the exception of the yarn count that is obviously the same.

5.2 Influence of raw material

In tables 9 and 10 we present the results obtained from the Uster tables and the statistical study in terms of **t** value.

Table 9- Uster values

USTER values	Blend 01	Blend 23
CVUster	5%	80%
Thin spots/1000m (<50%)	<5%	80%
Thick spots/1000m (>50%)	15%	50%
Neps/100m (>200%)	-	

Table 10- **t** value determination

Yarn parameters	t value
Yarn count (tex)	0.296
Twist	0.182
Strength (g)	0.939
Elongation (%)	1.333
Thin spots/1000m (<50%)	2.244
Thick spots/1000m (>50%)	8.105
Neps/100m (>200%)	12.216

From the analysis of table 9, we conclude that the yarn produced from blend 01 gives a better yarn in terms of USTER quality. This takes us to the conclusion that raw material plays an important role in the quality of the final yarn.
From table 10 we draw the conclusion that, statistically, that raw material influences only the number of thick spots and neps in the yarn. The results regarding thin spots do not allow any positive conclusion.

5.3 Influence of drafting and twisting

In tables 11 and 12 we present the results obtained from the Uster tables and the statistical study in terms of **t** value.

Table 11- Uster values

USTER values	42 tex	59 tex
CVUster	50%	80%
Thin spots/1000m (<50%)	85%	80%
Thick spots/1000m (>50%)	50%	50%
Neps/100m (>200%)	-	

Table 12- **t** value determination

Yarn parameters	t value
Yarn count (tex)	46.483
Twist	14.700
Strength (g)	16.716
Elongation (%)	6.901
Thin spots/1000m (<50%)	5.950
Thick spots/1000m (>50%)	11.270
Neps/100m (>200%)	4.919

In terms of USTER data both yarns can be classified of poor quality. This was certainly due to the use of poor quality raw material, confirmed by data of table 4 (blend 23).
Comparing the t values obtained with t Student tables we conclude that drafting and twisting influences all the yarn characteristics.

6. CONCLUSIONS

In this study we used yarns produced from three main different processes namely, carded, combed and open-end rotor.
The influence of the process was studied using carded and combed yarns. The influence of the raw material and drafting were studied using an open-end process.

From the previous results it is possible to draw the following conclusions:

• To obtain a quality yarn, both in the carded and combed process, the raw material is not the only important factor. From the Uster analysis, we conclude that machine set-up plays a very important role.

• As the results from the statistical study demonstrates, the process influences all the parameters of the yarn.

• In an open-end yarn the use of different blends largely affects the Uster values. Only thick spots and neps are, in this study, clearly influenced by the raw material.

Acknowledgments

We gratefully acknowledge Terezinha Campos, final year student of Textile Engineering at the University of Minho for collecting the data used in this work.

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PROJECT PROPOSAL IDENTIFICATION SHEET

EUREKA TUBITAK

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Type of Act: Research

Major Fields of Org'l Expertise
1) Spinning systems
2) Fibers
3) Performance testing

R&D Involvment: National; EU

No. of employees inv'd and/or exp'd in R&D:

No. of employees directly involved in techn. mngt.:

Size of Organiation:

PARTNER(S) SOUGHT

Partner's Major Fields of Expertise (preferred)
a) Integrated production machinery
b) Spinning systems
c) Consumer requirements

Act. Type of Partner(s) Sought: Manufacturing; Research

PROJECT

Project Title: YarnSense - High Resolution Yarn Evenness Sensing

Phase: Research

Demo Mtrl.: Slides; Transparancies

(please note that the duration of project presentations in workshop sessions will be quite short, around 5 min)

Description of the Project

The advance and spread of microelectronics and microprocessors technology enables the manufacturers to include standard quality control techniques on the production line equipment.

In yarn production, there are presently under use several sensors that allow some production control. Nevertheless, traditional capacitive sensors with its minimum length around 8 mm, do not allow direct measurement of evenness in the 1 mm range needed to an accurate detection of NEPs.

Optical sensors, while providing a good resolution measurement, do not achieve a fully correct detection of all irregularities. Moreover, they give a measure that is not directly related with the mass of the yarn. They, however, provide a good hairiness measurement.

To achieve a measurement of at least 1 mm long, we propose a new acquisition method, using 2 sensors with 1 mm length difference.

Along with this technique, we intend to combine different sensor types (namely, optical sensors) to get different measures that allow the detection of all relevant parameters of the yarn. Although they are currently in operation in combined sensors, the target of 1 mm length resolution mass measurement is still an innovative solution.