USTER® *STATISTICS*

Application Report

The common quality language
for the textile industry

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USTER®
Think quality

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1 Introduction

The new edition of the unique USTER® *STATISTICS* quality benchmarks continues the long history of USTER® service to the textile industry. Over the past 55 years, USTER® *STATISTICS* have earned legendary status throughout textiles – and their value is more significant than ever in the globalized trading environment today and in the future.

The release of USTER® *STATISTICS 2013* underlines their benefits as a vital success factor for textile companies, providing a common language to define precise quality factors along the entire production chain. Yarn producers, buyers and retailers all rely on USTER® *STATISTICS* as the basis for trading and a foundation for industry-wide quality improvement. Spinners can trust USTER® *STATISTICS* to signpost better competitiveness, cost-optimized quality disciplines and avoidance of expensive claims and rejects. Within the broader framework of the Total Testing concept developed by USTER, spinners can plan for sustainable business growth and profitability, confident that USTER® *STATISTICS* benchmarks guarantee they are in tune with worldwide trends and standards.

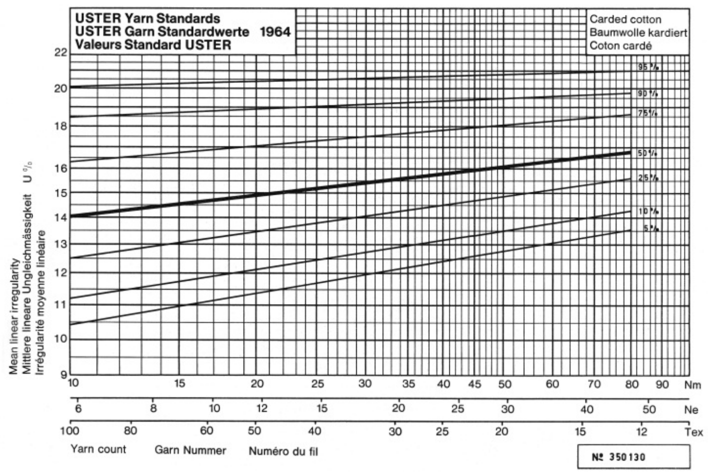


Fig. 1
USTER® STATISTICS for 100% CO, carded yarns from 1964

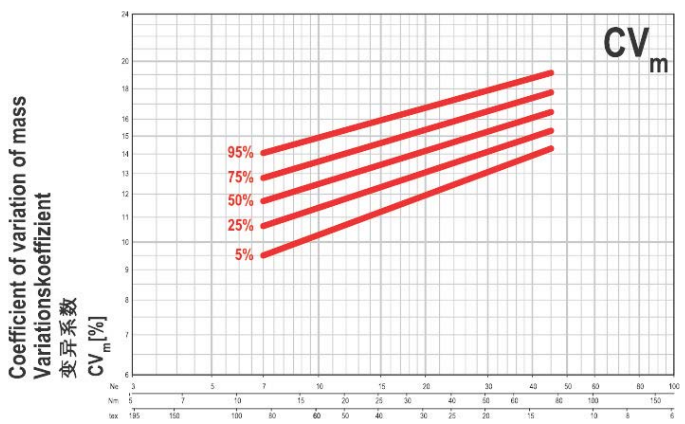


Fig. 2
USTER® STATISTICS for 100% CO, carded yarns from 2013

1.1 Multiple benefits for yarn producers

Yarn producers benefit in several ways with USTER® *STATISTICS.* For instance, USTER® *STATISTICS* make it simple for a mill to set its own quality targets – whether using the CD or online version (www.uster.com) – aided by the integral correlative quality parameters. Spinning mills must also compare objectively in-house performance versus global best practice. With the help of USTER® *STATISTICS,* mills can identify performance gaps and pinpoint key performance indicators for optimization of the production process. A further benefit enables a spinning mill to enhance its competitive position, since USTER® *STATISTICS* make it possible to describe yarns in a totally objective way, substantiated by real parameters.

Yarn quality tested on USTER® equipment is provable, thanks to direct comparison with USTER® *STATISTICS.* This data gives the mill a factual quality description, which can be used in case of a claim. This will improve the mill's competitive position, as well as providing an attractive message for marketing purposes.

1.2 The language of quality and how to optimize costs

It is obvious that globalization has changed the trade channels in the textile industry significantly in the past 20 years. In many cases, personal relationships between suppliers and buyers no longer exist. Products such as yarn and fabric are often traded on spot-markets, so quality cannot be trusted to a firm handshake or an experienced touch of the material. These changes have frequently led to a serious deterioration in the quality of garments or other textile goods.

USTER® *STATISTICS* allow all members of the textile supply chain to speak 'the global language of quality' – needing no translation and easily understood by all.

Yarn producers can benchmark and optimize their production processes and objectively prove the quality of what they are selling.

Yarn buyers can have full transparency on what they are buying and a clear indication of what to expect, when processing the yarn, or in the finished fabric appearance.

Retailers can optimize the costs in their supply chain by defining their specific needs according to the quoted values, compare yarns from different suppliers and classify them into quality groups.

1.3 The highlights of USTER® *STATISTICS 2013*

The new USTER® *STATISTICS 2013* will be especially appreciated by producers and buyers as a common quality language.

The updated USTER® *STATISTICS* – featuring new parameters such as the established S3 value measured by the USTER® *ZWEIGLE HL400* and the new classification standards such as outliers and better defects detection (classified by the recently launched USTER® *CLASSIMAT 5*) – will create new benchmarks.

Another highlight of the USTER® *STATISTICS 2013* is that they reflect world production in the most representative way. The overall geographical profile of the material tested was designed to match the actual textile production situation. In this way, USTER® *STATISTICS 2013* are more relevant than ever.

USTER® *STATISTICS 2013* consist of 82 chapters, including added statistics for plied yarns. The fiber processing section is extended, with more graphs. A new chapter has been created – yarn processing – which shows the correlations between bobbins and cones.

The 2013 edition will remain the essential tool for comparing key parameters along the entire value chain, from raw fiber through sliver and roving to the final yarn and beyond, continuing to offer weavers, knitters, yarn traders and retailers the essential framework to specify and obtain the quality they need.

Fig. 3
The new USTER® CLASSIMAT 5

USTER® *STATISTICS 2013* are available via the USTER website, on CD and on every USTER® laboratory instrument.

Fig. 4
The new USTER® ZWEIGLE HL400

2 History

For about 150 years, until the 1950s, the textile industry had only a few very simple instruments to measure the quality of fibers and yarns. The introduction of the first evenness tester in 1948 brought a revolution in the field.

The first quality parameter measured (besides the mass diagram) was the U%, the statistical value representing the percentage variation of a yarn. This figure was very helpful in understanding the evenness of yarns, because in practice it established a mill-specific quality control system.

But it was still not possible to compare the quality level of one mill with another's. It was this need which led to the development of the first benchmarks in the textile industry.

The first internal paper on standards was written in 1949 and the first tables covering the entire band of evenness measured by the evenness tester were published in 1957 by the German textile magazine Melliand.

At that time, they called the benchmarks USTER® *STANDARDS* and classified the quality figures into good-medium-bad. This classification was not accepted by all, especially by those mills which were producing 'bad' quality according to the USTER® *STANDARDS*.

That was when USTER® decided to change the concept, establishing graphical benchmarks called USTER® *STATISTICS*. In this way, each mill could compare its quality against others and benchmark itself without qualifications such as good-medium-bad. The first publication in the new format was in 1964, using nomograms and percentile lines, as today.

USTER® *STATISTICS* have proven to be an excellent tool over all these years, because they have not only been used by spinning mills but also by professors and students, by research institutions, by machine manufacturers, by yarn traders, knitters, weavers and retailers – all seeking to understand quality characteristics and establish specifications along the textile value chain.

Up until 1948 the unevennes of yarns was checked visually

1948
Introduction of the first evenness tester for yarns. Determination of the unevenness based on a diagram.

1949
Introduction of an analog computer for the determination of yarn unevenness. First attempt to compare figures with the world production with 3 categories: good, medium and bad. These "Standard" wee used for internal purposes only and for discussions with customers

1957
Collection of more unevenness results throughout the textile industry. Publication of the first USTER® *STANDARDS* via the German textile magazine Melliand. Results: unevenness only. The values were published as numeric figures.

1965
First publication of benchmarks for unevenness and imperfections as graphical presentation. Designation: USTER Yarn Standard Values within the scope of the USTER® *NEWS BULLETIN No 5* in 1965. With this Bulletin benchmarks for carded and combed cotton yarns and worsted yarns were published.

1966
The first USTER® *STANDARDS* on synthetic and blended yarns were published in the USTER® *NEWS BULLETIN No 9*. The following yarns were covered: Cotton/Polyester, Wool/Polyester, Acrylic, Polyamide, Polyester/Viscose

1970
As a result of conflicts with the textile industry the term "Standards" was not used any more. The figures published in 1970 and onwards were called "USTER® *STATISTICS*". This Bulletin contained the same yarns as in 1965.

1972
The USTER® *NEWS BULLETIN* of 1972 has dealt with the USTER® *STATISTICS* of synthetic fiber yarns with the following selection criteria: fiber fineness, long staple and short staple. For the first time it also covered benchmarks for rovings and slivers.

1975
The USTER® *STATISTICS* of 1975 was a complete set of benchmarks for most important yarn types of that time. It also contained the unevenness of slivers and rovings, the strength, variation of strength and elongation.

1982
The USTER® *NEWS BULLETIN No 31* was a collection of benchmarks for all important yarn styles.

1989
With the introduction of a new evenness tester generation in 1987 Uster Technologies introduced a new hairiness testing system of a high repeatability. With the USTER® *NEWS BULLETIN No 36* the first USTER® *STATISTICS* on hairiness in addition to all the known benchmarks were published.

1997
With the USTER® *NEWS BULLETIN No 40*, the first USTER® *STATISTICS* for fiber bundle and single fiber testing systems were published. This Bulletin already had benchmarks for 15 different yarn types. It also included the strength and elongation characteristics of a high speed strength tester with a test speed of 400 m/min. Particular benchmarks in this Bulletin were the isolated weak places generated by this new strength tester.

1999
The benchmarks of USTER® *SLIVERDATA* were published in the USTER® *NEWS BULLETIN No 42* and *No 43* .

2001
New release of USTER ® *STATISTICS 2001*

2007
In the most complete collection of benchmarks for quality characteristics of yarns was published. This release was a collection of comparison figures for 36 different yarn types.

2013
New release of USTER® *STATISTICS 2013*

Fig. 5 The timeline of the USTER® STATISTICS release

3 Role and Importance of USTER® *STATISTICS*

The role of USTER® *STATISTICS* over the subsequent years since their introduction has been vital – for many reasons and for different users – as a means of adding value. However, the spirit of the USTER® *STATISTICS* pioneers has remained unchanged: “Compare the quality level of one spinning mill with another’s” is still the core motivation for every edition of USTER® *STATISTICS* so far.

In all the developments affecting spinning mills listed earlier, quality control had a key role: progress would be impossible without measuring and comparing quality at each and every production stage and with each and every different spinning mill setup.

The main users of USTER® *STATISTICS* are the yarn producers, the yarn users and the machinery manufacturers. In a nutshell, the role of USTER® *STATISTICS* for each is (Table 1):

For the yarn producers	– Set spinning process Key Performance Indicators – Achieve operational excellence – Specify and communicate quality objectively – Guarantee the quality of yarn being produced and sold
For the yarn users	– Specify the quality needed (quality profile) – Select yarns with the appropriate quality – Optimize the portfolio of the yarn producers – Pay the right price for the right quality
For the machine manufacturers	– Develop spinning machinery achieving both production and quality targets – Develop the right spinning components – Develop appropriate maintenance plans – Link productivity with quality

Table 1
Summary of the role of USTER® STATISTICS for the various user groups

As a cross-function benefit, the role of USTER® *STATISTICS* was, is and will be to add clarity to a critical issue along the textile value chain:

Develop an acceptable and common way of assessing and understanding the quality level of the yarns that are being traded.

In the following paragraphs, there is a detailed explanation of the specific benefits of USTER® *STATISTICS* to each user group.

3.1 What are benchmarks?

By definition, benchmarks are standards, or a set of standards, used as references for evaluating the level of quality or performance. Benchmarks may be drawn from a firm's own experience, from the experience of other firms in the industry, or from legal requirements such as environmental regulations. In almost every industry, benchmarks are established and known.

The concept known as 'best practice benchmarking' or 'process benchmarking' is used in strategic management to evaluate the performance of various aspects of an organization's processes in relation to best practices from other companies' processes, usually within a peer group defined for the purpose of comparison. This then allows the organization to develop improvements or adapt specific best practices, usually with the aim of improving some aspect of performance. Benchmarking may be an on-off event, but is often treated as a continuous process in which organizations seek to improve their practices.

In textiles, and specifically in the area of fiber-to-fabric processing, the unique USTER® *STATISTICS* represent a truly comprehensive survey of the quality of textile materials produced in every part of the world. In the long history of USTER® *STATISTICS,* since the first USTER® *STANDARDS* in 1957, they have been accepted throughout the entire textile supply chain as a process benchmarking tool, as well as authoritative standards for quality evaluation of textile materials.

3.2 Benefits for yarn producers

For spinning mills, it is essential to compare objectively in-house performance versus global best practice. With the help of USTER® *STATISTICS,* the spinning mill can identify performance gaps. The parameters can easily be used as key performance indicators for spinning process optimization.

The quality of the yarn produced during the past 60 years has improved significantly. The following graph shows how characteristic this improvement is (Fig. 6).

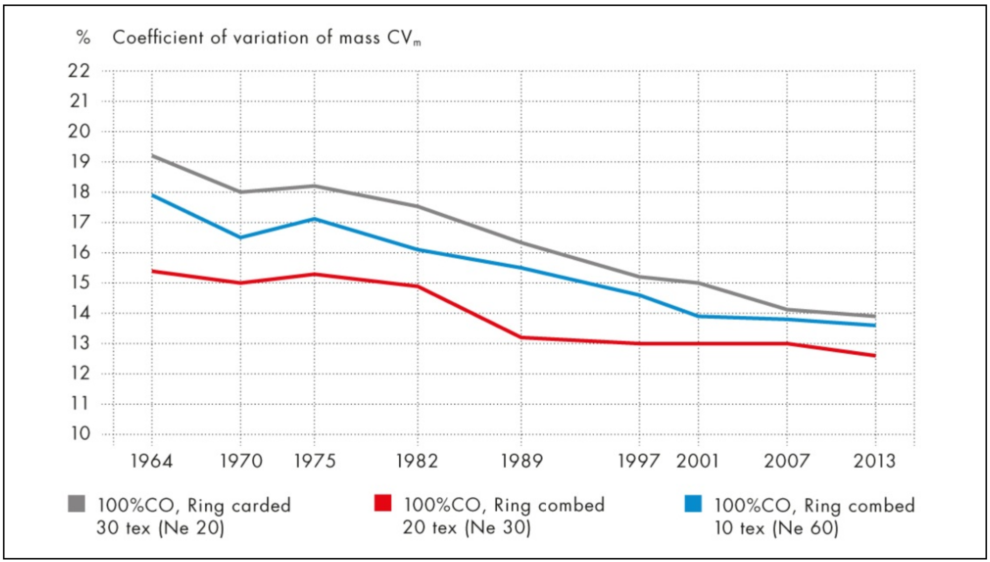


Fig. 6
Long-term development of yarn quality

At the same time, in terms of productivity, the number of production positions per kilo of yarn produced has been significantly reduced.

The task of managing this higher productivity and improved quality has become more complex and has been achieved by:

- Improving spinning machine technology
- Introducing better materials and best practices, especially in machine maintenance
- Selecting and using the available raw materials optimally

All the above became possible and produced the expected results because of the existence and continuous development of better quality control tools and systems – helped by the availability of appropriate testing methods, accepted benchmarks and reliable improvement practices. More information and details are available in USTER® *NEWS BULLETIN No. 39* ('Quality management in a spinning mill'). USTER® *STATISTICS* have been a vital element in this development.

USTER® *STATISTICS* can also be used to guide the spinning mill to achieve operational excellence. This means not only improving the quality of the spinning process or the products being made – but also taking account of the associated costs and learning from what other mills have achieved.

Selection of the yarn twist multiplier, setting of optimum comber noil and determining ideal yarn clearing limits for remaining defects are a few examples of choices which strongly affect both quality and cost in yarn production (Fig. 7).

Fig. 7
USTER® STATISTICS based on the production process

Another benefit for the spinning mill is an increase in its competitive position, since USTER® *STATISTICS* enable mills to declare objectively what quality they are producing and selling. Spinning mills can prove yarn quality levels when tested on USTER® equipment, because of direct comparison with USTER® *STATISTICS.* This data provides mills with objective quality facts in case of a claim.

Today, consumers are more sensitive and spinning mills face more demanding quality challenges regarding issues such as foreign fiber contamination, remaining disturbing defects, barré, warp breaks and uneven fabric appearance. These are only some of the most frequent causes of claims in mills. Clearly, it is impossible to establish the 'right quality level' unless there is an agreed and accepted benchmark.

3.3 Benefits for yarn users

As mentioned already, changes in the industry through globalization have been dramatic. In yarn trading, this has meant that personal relationships between suppliers and buyers often no longer exist. Manufacturing costs are much higher, while one or other well-known supplier may not be in business any more. Fashion is changing fast and quick deliveries are needed. Quality costs at all levels of the textile supply chain have increased.

Such changes have often resulted in substantial deterioration in the quality of garments or other textile goods. For many retailers, this has reflected negatively in operating profit, because of claims received or because dissatisfied customers did not return.

One of the most effective ways of managing increased quality costs and its related implications is to provide a better quality specification for yarns or fabrics. Leading retailers have taken this path and they can see the results already. USTER® *STATISTICS* have been essential in this approach, enabling them to become familiar with the important quality parameters, so they can specify precisely what they need.

Increased quality costs may be caused not only by wrong selection of the yarn for a certain article but also by poor performance of the yarn. USTER® *STATISTICS* are traditionally used to predict the quality of the fabric at an early stage, to avoid expensive additional costs due to seconds.

In Fig. 8, Fig. 9 and Fig. 10 there are only few examples of problems with fabrics due to poor yarn quality, which could have been avoided using quality specifications based on USTER® *STATISTICS.*

Fig. 8 Knitted fabrics with pilling made from yarns with high hairiness

Fig. 9 Knitted fabrics from yarns with high CV_m

As well as these examples, there are many other defects which are disturbing for the human eye. More examples can be found in USTER® *NEWS BULLETIN No. 47* (`Origins of fabric defects-and the ways to reduce them´). Better specification of the product to be manufactured is a critical tool to avoid such faults.

Many retailers have concluded that their existing system of ordering garments was not sufficient to guarantee the production of final products of constant quality. To achieve consistency, they have started specifying the products of each process in their supply chain.

However, yarn users may not necessarily understand quality in the same way as yarn producers, which creates a major communication gap.

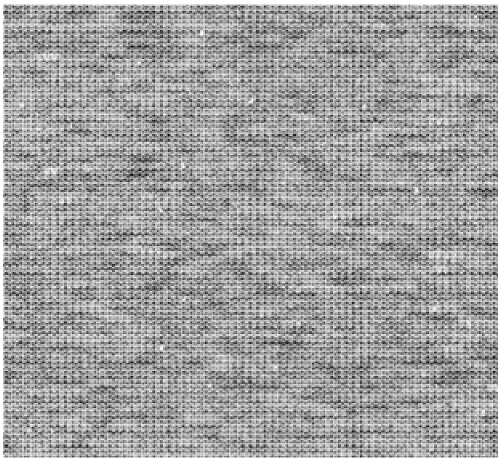


Fig. 10
Simulation of knitted fabric from yarn with high imperfections

USTER® *STATISTICS* bridges that gap between yarn producers and yarn users, enabling them to talk about quality in a way that is understood by all. This practice is now commonly accepted by manufacturers, merchants, and processors of yarns.

Fig. 11 illustrates the principle of setting up a yarn quality profile.

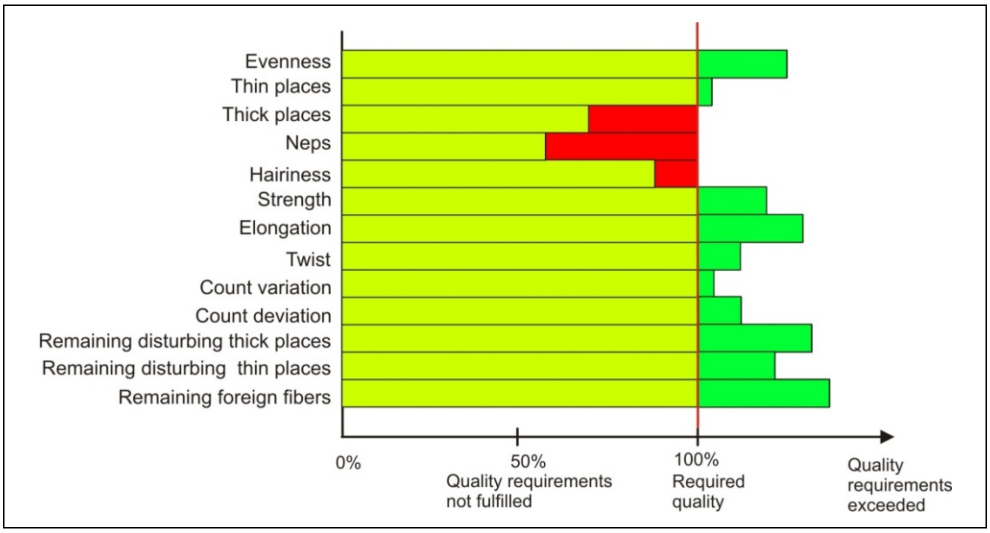


Fig. 11
Principle of a yarn quality profiles

Many yarn spinners, weavers, knitters, and retailers have formulated quality requirements in what are called 'yarn quality profiles', based on USTER® *STATISTICS*. Experience has determined the quality levels appropriate for each application.

Table 2 shows one such detailed specification – the yarn profile – of a weaving yarn. The quality characteristics are linked to USTER® *STATISTICS*. The USTER® *STATISTICS* Percentile (USP™) column here indicates that the retailer has higher requirements for yarn tenacity and yarn elongation, since the yarn is to be used for weaving. It is also notable that in this example the hairiness needs for the yarn are high, due to the process that will be used.

Yarn Quality Profile

USTER® Think quality

Material	Cotton, 100%
Spinning Technology	ring, combed, cone, weaving
Count (Ne)	48.0
Profile key	----
Profile	Quality Level 1A: New Style

Parameter	Unit	Description	USP range	Value range
Count Variation - USTER® *TESTER*				
Count deviation	%			+/-2.0
CVcb	%	Coefficient of variation of count between	25% - 50%	1.0 - 1.4
Mass Variation - USTER® *TESTER*				
CVm	%	Coefficient of variation of mass	25% - 50%	12.3 - 13.4
Imperfections - USTER® *TESTER*				
Thin -50%	1/1000m	Thin places per 1000 m	25% - 30%	3 - 3
Thick + 50%	1/1000m	Thick places per 1000 m	25% - 30%	24 - 27
Neps + 140%	1/1000m	Neps per 1000 m	25% - 30%	324 - 350
Neps + 200%	1/1000m	Neps per 1000 m	25% - 30%	59 - 64
Hairiness - USTER® *TESTER*				
H		Hairiness	5% - 25%	3.8 - 4.2
Diameter Variation - USTER® *TESTER*				
CV2D	%	Coefficient of variation	20% - 30%	13.4 - 13.8
Tensile Properties - USTER® *TENSORAPID*				
RH	cN/tex	Breaking tenacity	5% - 20%	24.6 - 26.8
EH	%	Breaking elongation	5% - 20%	6.0 - 6.4
Tensile Properties - USTER® *TENSOJET*				
RH	cN/tex	Breaking tenacity	5% - 20%	26.9 - 29.0
EH	%	Breaking elongation	5% - 20%	5.7 - 6.1
Twist Properties - USTER® *ZWEIGLE TWIST TESTER*				
Twist direction				Z
Tm	T/m	Twist	5% - 10%	968 - 980
CVTm	%	Coefficient of variation of twist	5% - 10%	2.5 - 2.7

Table 2
Extract for a typical yarn profile. This specific example is for a 100% combed cotton ring yarn for weaving a certain article.

The yarn profile is the ideal basis for discussion with the yarn producer. The yarn profile can be defined in detail after investigating both the requirements of the retailer and the performance of the yarn supplier. The profile may need reviewing after the first one or two years of implementation.

The whole process of specifying the quality of the yarn and linking it to the end-product automatically serves to optimize the supplier's portfolio related to the retailer or yarn user. Not all spinning mills offer the same quality, but with yarn profiles, the yarn from each mill can be assigned by the user for certain articles. This transparency leads to benefits including:

- Easier management of yarn suppliers
- Optimizing specialization for spinners, as well as for yarn users
- Paying the right price for the right yarn

The last factor, although apparently simple, is actually quite complex in practice. There have been numerous cases where retailers have used a wide range of qualities from different suppliers to produce the same final product – and for all the yarns they have paid the same price!

3.4 Benefits for machine manufacturers

Textile machinery manufacturers have used USTER® *STATISTICS* since the beginning. They have used them as a benchmark to assess the impact of their new developments in machine technology, parts and systems. Despite the fact that machine performance regarding productivity and efficiency is easily expressed in absolute numbers, USTER® *STATISTICS* are used when it is necessary to examine the quality aspects of performance.

Another use of USTER® *STATISTICS* is when machine manufacturers are providing a guarantee for their machinery performance. Often, in the contract between machine manufacturer and spinning mill, USTER® *STATISTICS* percentile values are specified. These will depend on the type of machine: so, for example, with a new carding machine the nep level in the sliver will be defined as one of the guarantee criteria.

Requirements for fiber usage can also be applied: for example, with a fiber length of >25% and a nep level of <25% a level of 25% USP™ in the card sliver might be guaranteed.

Machinery manufacturers also, of course, operate in a competitive environment. The wide variety of raw materials available, the broad spectrum of yarn types produced, ever increasing operating speeds and the constant pressure to reduce operating costs are only few of the factors involved. So, machine manufacturers are constantly battling to improve the performance of their machinery, both production- and quality-wise. The tool that is traditionally used to demonstrate these improvements is USTER® *STATISTICS*.

4 Interpretation of USTER® *STATISTICS* – what do the levels mean?

As mentioned already, the way in which USTER® *STATISTICS* describe the different levels of quality has changed since the earlier editions.

At first, yarn quality was classified into three distinct groups, namely good, medium and bad. That system was too difficult for the industry to accept, especially for those spinning mills classed as producing 'bad' quality – and actually it was an unfair system. That was the trigger to change the classification method to the one currently in use.

Today, we use graphs (introduced initially as nomograms) with percentile curves. These graphical cumulative frequency representations statistically indicate the extent (as a percentage, called USTER® *STATISTICS* Percentile or USP™) by which yarns are above or below a certain value. This method does not characterize yarn quality levels directly but offers the opportunity for users to compare their own quality against a global reference value.

The 5% limit line means that 5% of the spinning mills are producing yarn with the same or better quality (for the respective quality characteristic). The same applies for the other limit lines: at 25%, 50%, 75% and 95%.

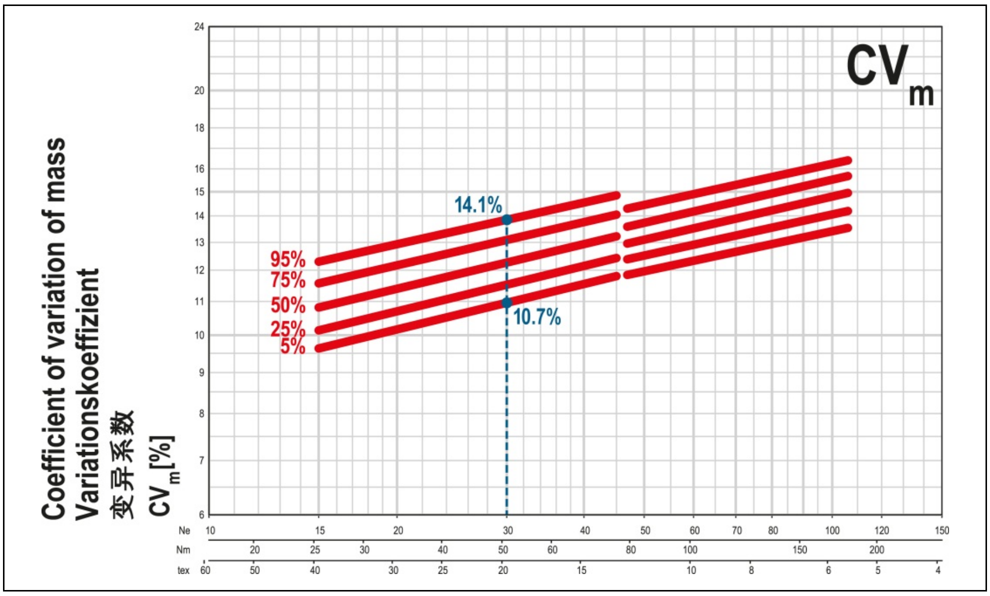


Fig. 12
USTER® STATISTICS graph

At the example above (Fig. 12), we see that for a combed cotton yarn, 20 tex (Ne 30), the CV_m of the majority of the world production is between 10.7% (5% line) and 14.1% (95% line).

The 50% percentile curve, commonly referred to as the 50% line, corresponds to the median. In general terms, the median is the middle number when the measurements in a data set are arranged in ascending (or descending) order. So, 50% of all observations exceed this value and the remaining 50% are below it.

A detailed explanation of how to navigate and use the various elements of USTER® *STATISTICS* is available on our webpage or in the CD version, under 'Easy User Guide'.

5 Interpreting USTER® *STATISTICS* – the textile application viewpoint

Yarn testing in a modern spinning mill is carried out for three main reasons.

Firstly, in the context of a closed-loop quality control system, the spinner has to determine which faults at which processing stages are affecting the final yarn quality, take the right measures to eliminate them, and, with further testing, ensure that the results are as expected.

Secondly, the spinner needs information in advance about how the yarn will behave in the subsequent processes, i.e. in warping, sizing, weaving, knitting etc. With this knowledge, the processes after spinning can be adapted accordingly, either to minimize the risk of failures or to select the most appropriate methods and materials to process the yarn.

Thirdly, as far as possible, the spinner needs to determine from yarn test results how the final fabric structure will appear.

The third task is the most difficult, since it is impossible to set out general rules or directives, because of the decisive influence of subsequent yarn processing stages. In addition, the woven fabric structure, the yarn count in weft and warp, the number of picks and ends down and the knitted fabric structure are all variables which affect fabric appearance. In a similar way, the dyeing and finishing processes also have a major impact on fabric appearance.

However, it is proven that testing of some of the most important physical characteristics of a yarn can give a good indication of the appearance of the finished fabric. For example, a very uneven yarn can never result in a perfect fabric, at least as far as appearance is concerned.

The following pages show practical examples highlighting the relation between different quality levels and different USTER® *STATISTICS* levels. The examples cover yarn quality, as well as in-mill preparatory products and their influence on final quality.

For each example there is a table with the quality data as measured with the laboratory instruments and the USTER® *STATISTICS* values shown as USP™ 13.

USP™ 13 = **U**STER® ***S**TATISTICS* **P**ercentile 20**13**

Finally, there are pictures showing how the fabrics made from those yarns look.

5.1 Yarn evenness and fabric appearance

Numerous studies and trials have been conducted in an effort to link fabric appearance with yarn evenness. As mentioned, the impact of yarn and fabric processes is strong and comes on top of any yarn quality influence. To avoid the risk of losing track of the root causes of fabric appearance differences, we have here compared only the influence of yarns of different quality levels of USTER® *STATISTICS,* excluding any influence from the knitting or weaving machine.

The most important parameter impacting the fabric appearance is the yarn evenness. In the new USTER® *STATISTICS* we have added CV_m figures for longer cut lengths (1m, 3m and 10m) to the regular CV_m data in order to support and strengthen the fabric appearance prediction.

In all cases we see that the yarns with CV_m and CV_m of various cut length values of about 50%, or lower, than the USTER® *STATISTICS* level display a characteristically better appearance compared to those that are at 75% and above.

Example 1

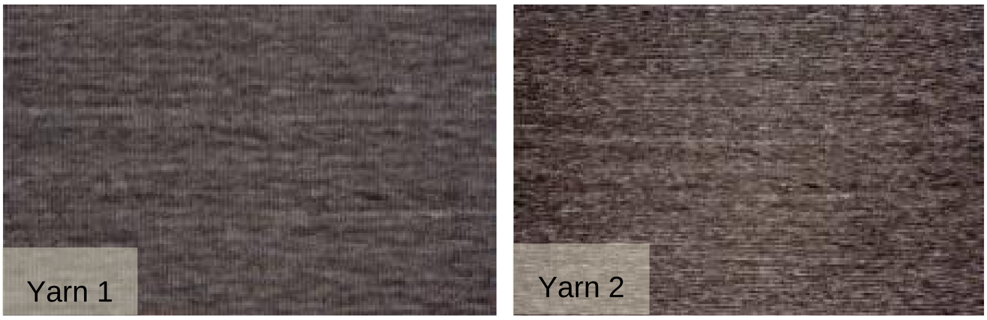


Fig. 13
Knitted fabrics from different qualities of cotton yarn 16 tex (Ne 36).

	CV_m [%]	CV_m 1m [%]	CV_m 3m [%]	CV_m 10m [%]	Thin -50% [1/km]	Thick +50% [1/km]	Neps +200% [1/km]	H
Yarn 1	12.6	3.1	2.3	1.9	1	33	72	5.2
USP13	30	15	20	25	5	30	52	25
Yarn 2	14.9	3.7	2.9	2.2	19	148	149	4.9
USP13	95	53	55	40	>95	>95	93	15

Table 3
Quality results from USTER® TESTER 5 – 100% cotton ring spun yarn 16 tex (Ne 36) with different CV_m.

In the example of Fig. 13 and Table 3, the knitted fabrics are made of 16 tex (Ne 36) 100% cotton ring yarn. The fabric on the left, made from yarn with an evenness of around 30% USP™, has a better appearance compared to the fabric on the right, which was produced from a yarn with an evenness of 95% USP™ level. Table 3 shows the numeric values of both yarns and their USP™ values.

Directly comparing the CV_m values of these two yarns shows a difference of 18% between them. This difference is significant for CV_m and this is reflected in the fabrics, making it more visible and transparent. USP™ *STATISTICS* values have illustrated clearly that these two yarns are considerably different in quality.

Example 2

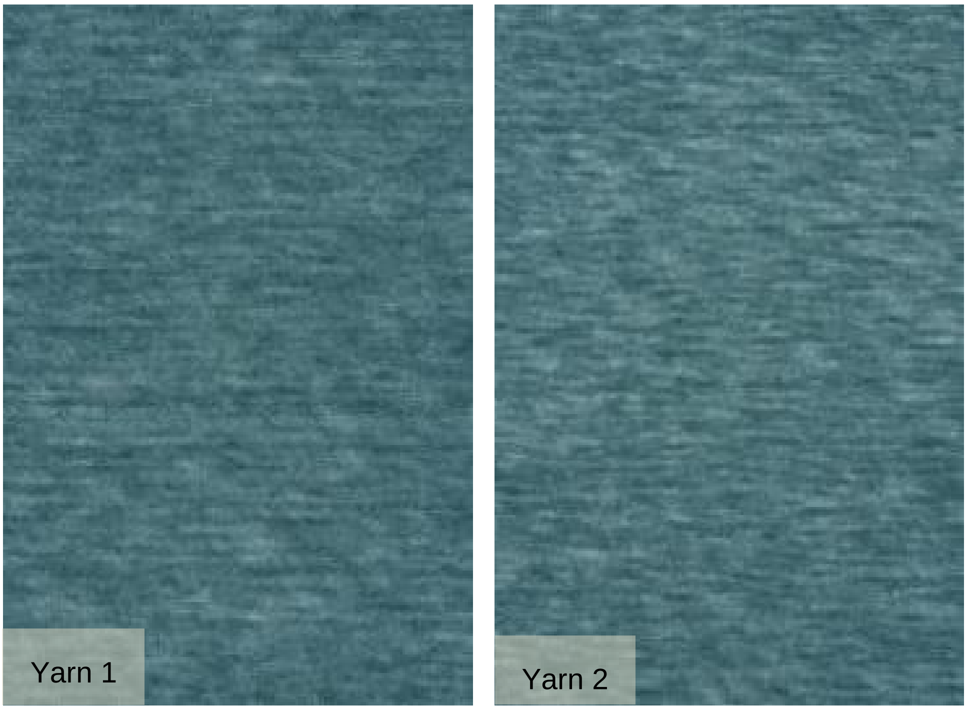


Fig. 14
Knitted fabrics from different qualities of cotton yarn 20 tex (Ne 30).

	CV_m [%]	CV_m 1m [%]	CV_m 3m [%]	CV_m 10m [%]	Thin -50% [1/km]	Thick +50% [1/km]	Neps +200% [1/km]	H
Yarn 1	12.7	3.6	2.9	2.3	1	34	66	4.6
USP13	50	50	60	50	20	55	70	<5
Yarn 2	13.9	4.8	3.9	2.9	4	69	89	4.8
USP13	80	>95	>95	95	60	90	80	5

Table 4
Quality results from USTER® TESTER 5 – 100% cotton ring spun yarn 20 tex (Ne 30) with different CV_m.

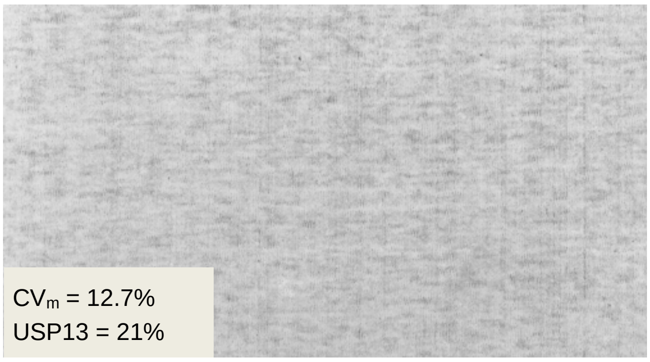
In the above example of Fig. 14 and Table 4, the knitted fabrics are made of 20 tex (Ne 30) 100% cotton ring spun yarn. The fabric on the left, made from yarn with an evenness of around 50% USTER® *STATISTICS,* has a better appearance compared to the fabric on the right, produced from a yarn with an evenness of 80% USTER® *STATISTICS.*

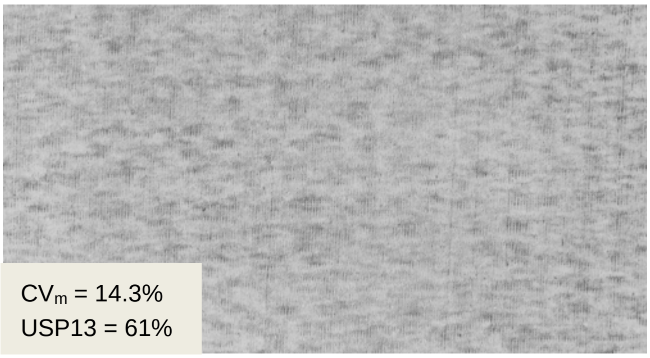
Again, the big difference in USTER® *STATISTICS* has reflected the quality difference that the real fabrics have produced, in terms of appearance.

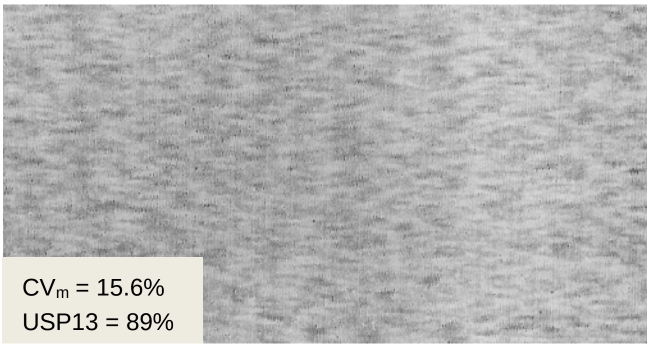
Example 3

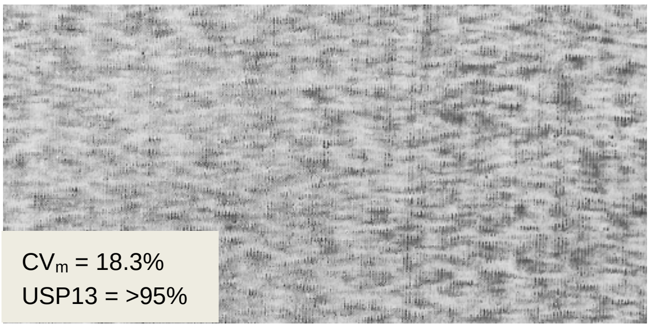
The examples below consist of two sets of yarns, one carded and one combed. All yarns have been knitted into single jersey fabric and their appearance has been assessed. These examples are very characteristic because they reflect real-world conditions and the challenges that a sourcing manager of a weaver or knitter is facing.

30 tex (Ne 20), 100% cotton, carded, for knitting, ring spun

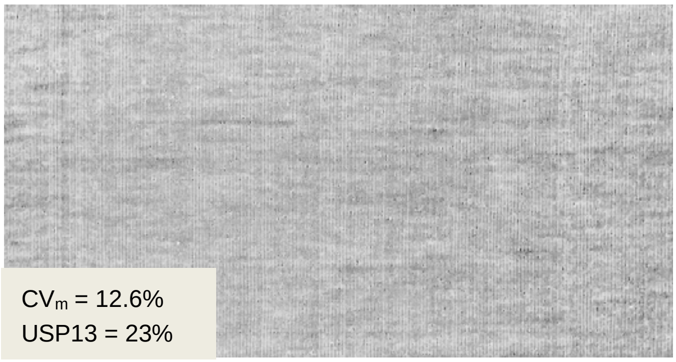


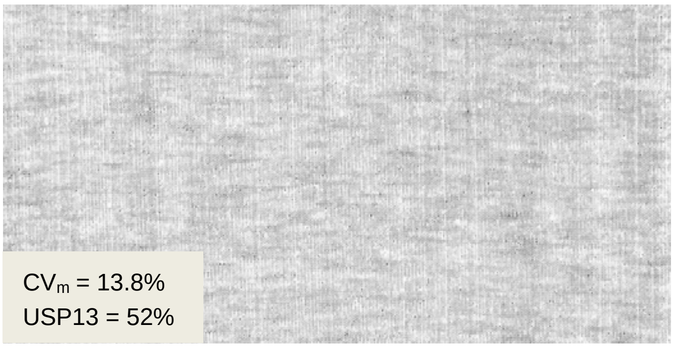


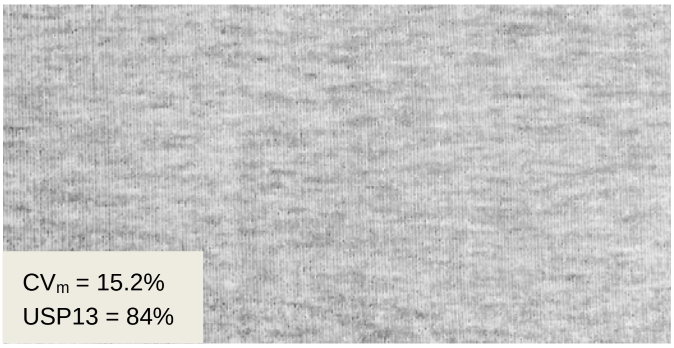




15 tex (Ne 40), 100% cotton, combed, for knitting, ring spun







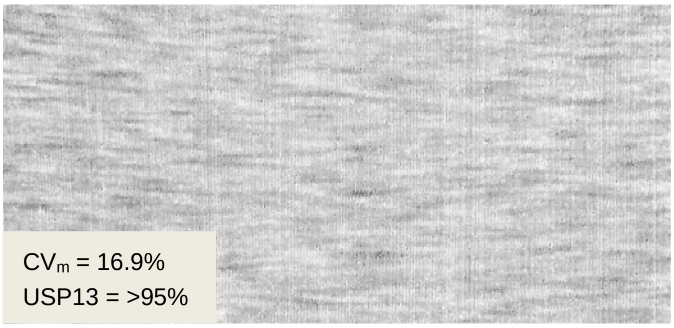


Table 5 Samples of knitted fabrics made from yarns of different qualities. The left hand column is with 30 tex carded ring yarn; the right hand column is with 15 tex combed ring yarns. In both columns, the quality ranges from good to bad starting from the top to the bottom.

The fabrics of the first set have been produced from 100% carded cotton ring yarn of 30 tex (Ne 20) and for the second set the fabrics are made out of 15 tex (Ne 40) combed cotton ring yarn.

To take a realistic analogy using this test, imagine that a knitter is sourcing yarn for a certain article – a single jersey fabric – from four different suppliers. The use of USTER® *STATISTICS* levels, as a quality specification tool, will save a lot of time and risk because they can link the expected fabric quality with the yarn quality he is sourcing and make the appropriate decisions or price adjustments.

Note for all the examples

The yarns examined and compared in all cases mentioned above had no periodic variations, which would affect the fabric appearance, independently of the yarn evenness itself.

Conclusions

The USTER® *STATISTICS* level is a strong indication of expected fabric appearance when comparing yarn mass evenness (CV_m, CV_m 1 m, CV_m 3 m, CV_m 10 m)

Practically speaking, levels of around 50% USP™ can result in acceptable fabric appearance, excluding periodicities.

With critical woven or knitted structures, this limitation moves towards to the 25% level. With less critical fabric structures, yarns with values around the 75% line might be accepted. However, mixing the 25% and 75% materials from two suppliers might again produce a barré fault.

With yarns having levels of more than 75%, the risk of problems with the fabric appearance is high.

The strong link between USTER® *STATISTICS* CV_m levels and fabric appearance is decisive.

5.2 Yarn hairiness and fabric pilling

In the following example, we have compared two yarns with different hairiness levels.

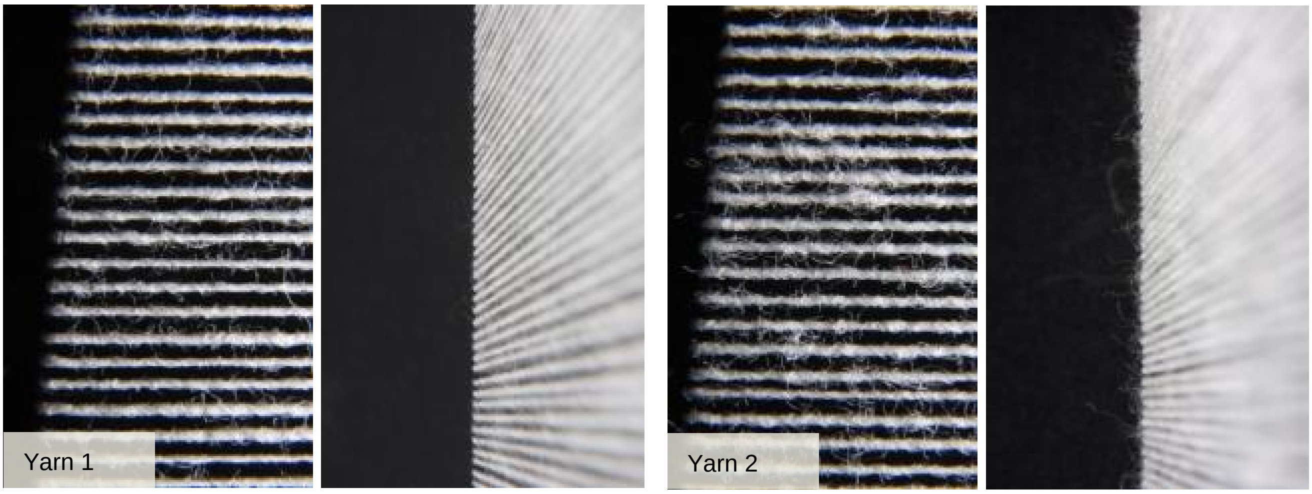


Fig. 15 Two yarn samples with different yarn hairiness levels and the way they are looking in a yarn board.

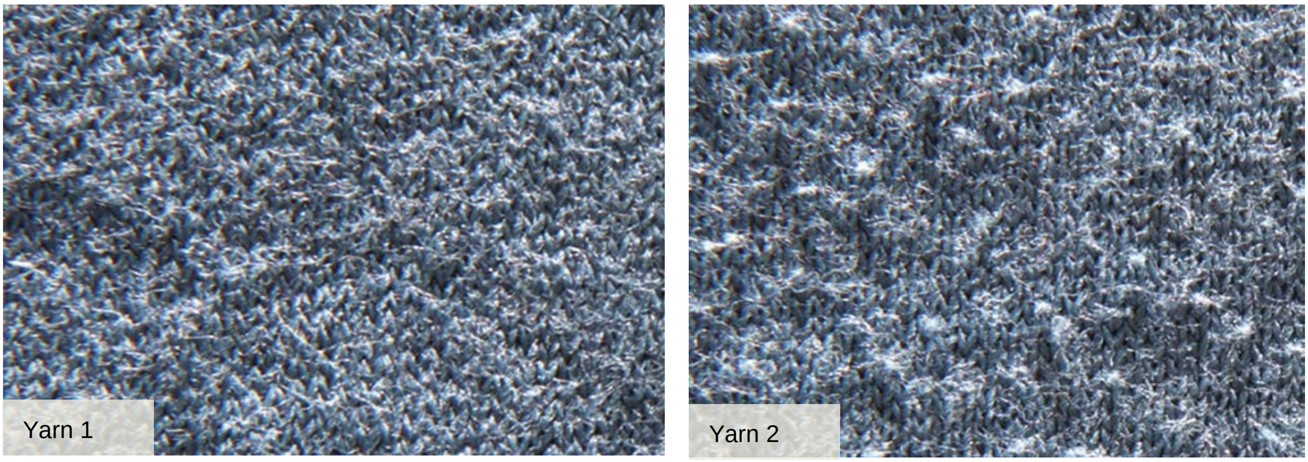


Fig. 16 Different pilling from yarns of different hairiness

	CV_m %	H	sh	S3
Yarn 1	12.06	5.66	1.61	363
USP13	5	40	30	75
Yarn 2	12.39	7.71	1.83	594
USP13	25	95	70	>95

Table 6 Quality results from USTER® TESTER 5 and USTER® ZWEIGLE HL400 – 100% cotton OE rotor yarn 49 tex (Ne 12) with different hairiness.

Fig. 15 and Table 6 show two yarns, both 49 tex (Ne 12) 100% cotton OE-spun, but with substantial differences in yarn hairiness. As can be seen from the yarn photos, the hairiness differences are easily visible. This leads to differences in pilling in the fabrics made from them. Fig. 16 shows an example of two yarns with different yarn hairiness levels and the produced pilling.

We should also emphasize that such differences in hairiness are an indication against mixing the yarns, since this would definitely lead to fabric barré.

Conclusion

We have seen that yarns with hairiness levels of 80% and above have a clearly higher tendency to create pilling compared to yarns with 40% hairiness and below.

It is also worth mentioning that yarns with higher hairiness levels tend to generate more fly in the knitting machine, affecting its performance by creating stops and breaks, as well as fabric defects.

5.3 Imperfections and fabric appearance

In terms of imperfections, we have compared the influence of yarns with different nep levels on woven fabrics. In woven fabrics, the second most important yarn characteristic after yarn tenacity is the level of neps, since this adversely affects fabric appearance.

Example 1

In this example, we have compared the fabrics of two yarns, both 100% cotton 10 tex (Ne 60) having different imperfection and nep levels.

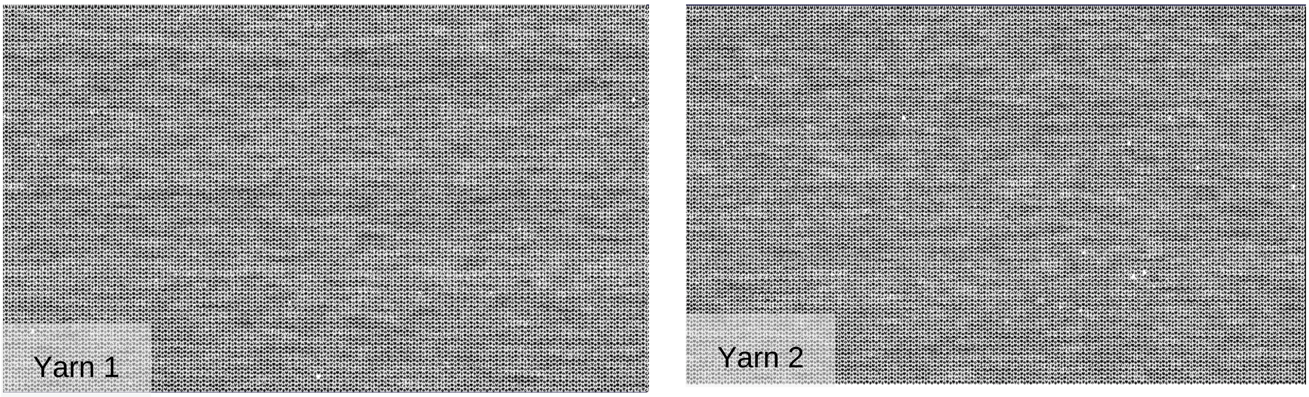


Fig. 17 Fabrics samples from different qualities of 100% cotton yarn 10 tex (Ne 60). Higher neps levels seen in yarn 2 have a direct impact on the fabric appearance, leading to a so-called neppy fabric which is characterized by the appearance of small disturbing spots on the fabric.

	CV_m [%]	CV_m 1m [%]	CV_m 3m [%]	CV_m 10m [%]	Thin -50% [1/km]	Thick +50% [1/km]	Neps +200% [1/km]
Yarn 1	13.9	3.9	3.1	2.4	10	40	65
USP13	30	50	75	50	30	25	25
Yarn 2	13.9	4.6	3.6	2.9	13	60	170
USP13	30	95	95	95	50	50	90

Table 7
Quality results from USTER® TESTER 5 – 100% cotton ring yarn 10 tex (Ne 60) with different imperfection neps levels.

Example 2

In this example, we have compared the fabrics of two yarns, both 100% cotton 7 tex (Ne 80) having different imperfection and nep levels.

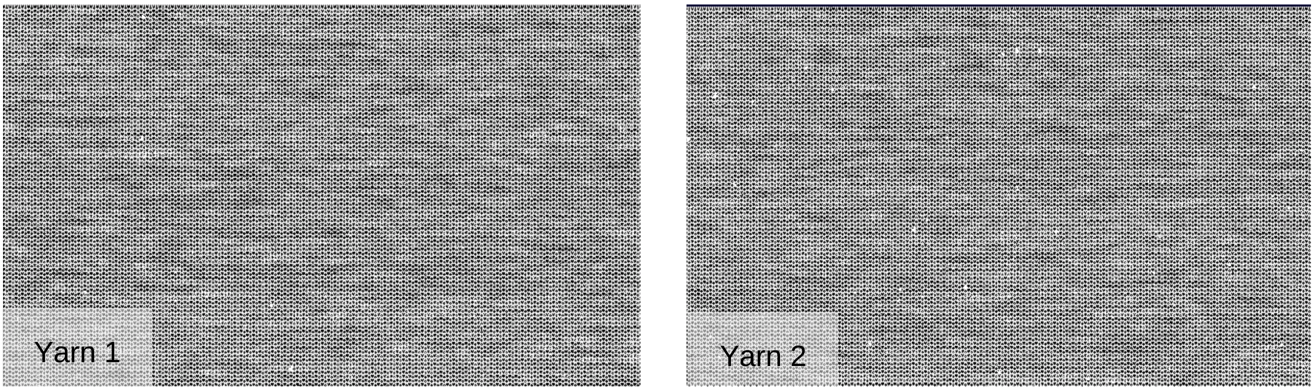


Fig. 18 Fabrics samples from different qualities of 100% cotton yarn 7 tex (Ne 80). Higher neps levels seen in yarn 2 have a direct impact on the fabric appearance, leading to a so-called neppy fabric which is characterised by the apperance of small disturbing spots on the fabric.

	CV_m [%]	CV_m 1m [%]	CV_m 3m [%]	CV_m 10m [%]	Thin -50% [1/km]	Thick +50% [1/km]	Neps +200% [1/km]
Yarn 1	14.3	3.6	2.6	2.1	23	51	87
USP13	30	25	45	30	30	5	26
Yarn 2	13.9	3.9	3.0	2.5	9	78	227
USP13	10	50	65	70	<5	25	90

Table 8
Quality results from USTER® TESTER 5 – 100% cotton ring yarn 7 tex (Ne 80) with different imperfection neps levels.

Conclusion

We have seen that yarns with USTER® *STATISTICS* levels for neps of 75% and more tend to have bad fabric appearance. This problem is even more disturbing with fine yarns and compact yarns, due to their finer and more even structure.

The link between fabric appearance and USTER® *STATISTICS* levels is very strong and definitely an indicator to distinguish and classify yarns into different categories with fabric quality in mind.

5.4 Short Fiber Content and comber noil

USTER® *STATISTICS* include reference values for short fiber content in slivers from various cotton processing stages, as measured with USTER® *AFIS*. These values are very important for the spinning mill, because they are linked with the most important cost and quality factor in spinning of combed yarns: the comber noil.

Various studies and trials have been made linking the measurement of short fiber content with comber noil and its impact on the quality of the yarn and the resultant fabric. In the trial shown below, we examine yarns produced from slivers that consist of short fibers of different levels of USTER® *STATISTICS*. The yarns have finally been knitted into single jersey fabrics.

The material we used is cotton with 4.2 Micronaire, fiber strength of 31 cN/tex, length uniformity of 82%, staple length of 29.4 mm and 300 neps per gram. It was then combed with three different comber noil levels and the combed sliver processed in three parallel lines spinning a 15 tex yarn (Ne 40).

		Test 1	Test 2	Test 3
Comber noil	[%]	15.4	17.5	19.7
SFC(n) comber sliver	[%]	12.1	10.1	8.9
	USP13	75	40	25
Yarn CVm	[%]	13	12.1	11.9
	USP13	30	5	>5
Yarn Thin -50%	[/km]	0	0	0
	USP13	>5	>5	>5
Yarn Thick +50%	[/km]	38	21	16
	USP13	25	>5	>5
Yarn Neps +200%	[/km]	124	93	86
	USP13	75	55	50

Table 9
Quality data results from USTER® AFIS and USTER® TESTER 5 from the slivers and the yarns produced with three different comber noil levels.

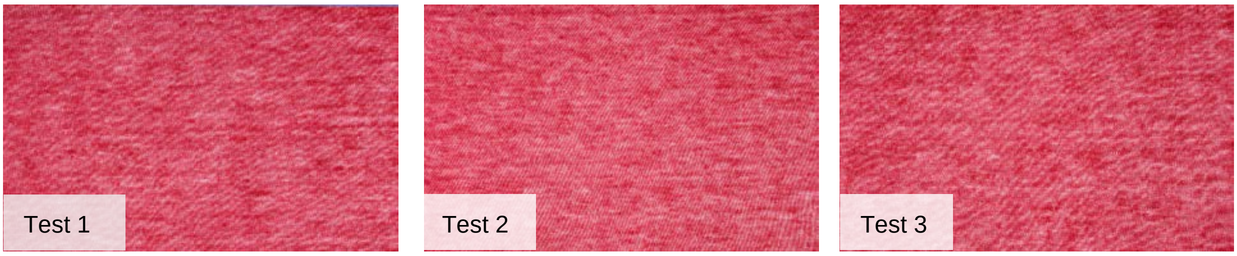


Fig. 19 Knitted fabrics from different qualities of cotton yarn 15 tex (Ne 40).

Conclusion

In the example shown above, we can see that for the same process and raw material type, differences in comber noil linked to differences in short fiber content in the comber sliver tend to lead to poor fabric appearance (tests 1 and 2).

However, overdoing comber noil removal (test 3) does not lead to a major improvement in the short fiber content or in fabric appearance. On the contrary, in this example as well as in other trials, we noticed that excessive comber noil extraction actually leads to even poorer fabrics.

The consequences of overdoing comber noil extraction are also felt in the 'bottom-line' performance of the mill, since this higher removal of fibers increases production costs.

5.5 Yarn tensile properties and breaks in weaving

The role of yarn strength and yarn elongation is known and well documented. What we sometimes overlook is the importance of the variation level in both the tensile strength and the elongation, and its relationship to yarn breaks in weaving.

In weaving, yarn elongation is a very important yarn characteristic, as also is its degree of variation. We need to keep in mind that the loss of elongation during sizing varies from a minimum 0.6 % for a ring spun cotton yarn to 1.5 % for an OE cotton yarn, even with ideal sizing machine settings.

The residual elongation is important, because during weaving each warp end has to withstand, in most cases, well over a thousand cycles of extension and relaxation, during which no breaks should happen. Depending on the fabric construction (number of heald frames), the peak elongation during weaving may reach up to 2% or more. To keep warp breaks within acceptable levels, the residual elongation after sizing should never be lower than 3 – 4%.

The examples (Fig. 20 and Fig. 21) show the differences between yarns that look quite similar at first glance – but in fact are not – and the impact their differences may have on downstream processes.

Example 1

Here we compare two yarns obtained from different suppliers by a weaver. Both are 100% combed cotton, ring spun, 20 tex (Ne 30).

Nr	B-Force cN	Elong. %	Tenacity cN/tex	B-Work cN.cm
Mean	335.2	5.35	17.03	501.7
s	26.80	0.36	1.361	59.57
CV	7.99	**6.70**	7.99	11.87
Q95	0.525	0.01	0.027	1.17
USP07	68	**25**	77	53
UTRexp*	335.6	5.57	15.66	476.9
P0.01 (1)	176.2	2.28	8.949	124.4
P0.1 (10)	246.0	4.03	12.50	303.4
P1.0 (100)	271.2	4.38	13.78	361.7
P5.0 (500)	289.9	4.70	14.73	402.7

Nr	B-Force cN	Elong. %	Tenacity cN/tex	B-Work cN.cm
Mean	350.9	4.62	17.83	458.4
s	31.26	0.34	1.588	62.10
CV	8.91	**7.30**	8.91	13.55
Q95	0.613	0.01	0.031	1.22
USP07	63	**90**	66	71
UTRexp*	334.5	4.74	16.75	427.3
P0.01 (1)	213.8	3.08	10.86	237.1
P0.1 (10)	258.4	3.43	13.13	263.9
P1.0 (100)	278.9	3.76	14.17	312.7
P5.0 (500)	299.8	4.04	15.23	357.2

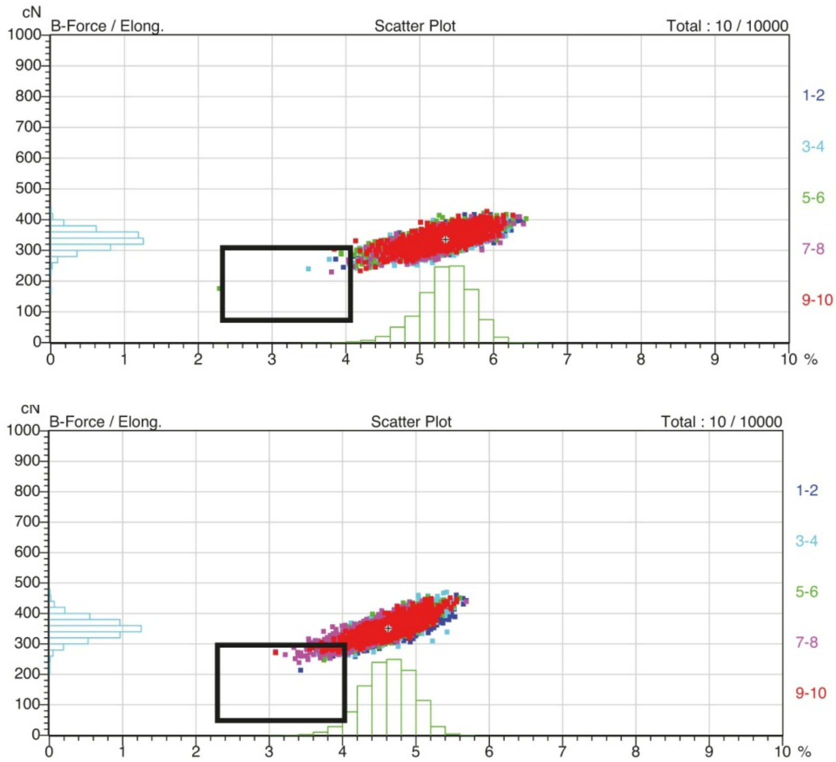


Fig. 20 Comparison of the USTER® TENSOJET results of two yarns 20 tex (Ne 30)

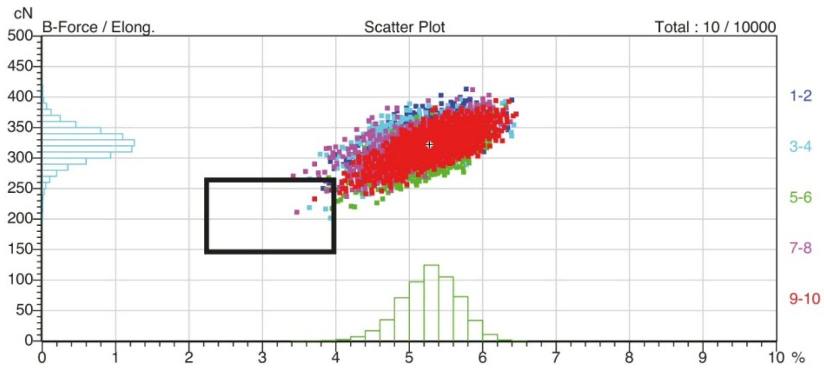
In the first example both yarns show similar values for tenacity – but completely different values for elongation. The comparatively low elongation of yarn 2 in combination with the relatively high CV of elongation led to the weaver's decision to use this yarn for the weft only, to avoid the risk of high warp end breakages. Yarn 1, on the other hand, can be processed in both warp or weft.

This difference in performance is exactly reflected in the USP™ levels. In this specific example, the 25% level in elongation is expected to behave much better than the 90% level, in terms of performance for warping.

Example 2

Here we compare two yarns obtained from different suppliers by a weaver. Both are 100% combed cotton, ring spun, 15 tex (Ne 40).

Nr	B-Force cN	Elong. %	Tenacity cN/tex	B-Work cN.cm
Mean	321.8	5.27	21.80	458.8
s	24.66	0.40	1.671	58.06
CV	7.66	**7.52**	7.66	12.66
Q95	0.483	0.01	0.033	1.14
USP07	9	**34**	15	16
UTRexp*	322.0	5.49	21.11	505.7
P0.01 (1)	201.6	3.42	13.65	213.3
P0.1 (10)	231.6	3.77	15.69	260.2
P1.0 (100)	259.3	4.21	17.56	316.4
P5.0 (500)	280.0	4.59	18.97	362.3



Nr	B-Force cN	Elong. %	Tenacity cN/tex	B-Work cN.cm
Mean	314.1	4.19	21.28	367.7
s	28.19	0.39	1.910	52.96
CV	8.98	**9.42**	8.98	14.40
Q95	0.553	0.01	0.037	1.04
USP07	16	**>95**	21	50
UTRexp*	313.6		20.40	366.4
P0.01 (1)	197.8	2.66	13.40	167.6
P0.1 (10)	222.3	2.95	15.06	203.3
P1.0 (100)	245.3	3.22	16.62	239.4
P5.0 (500)	265.5	3.54	17.98	279.4

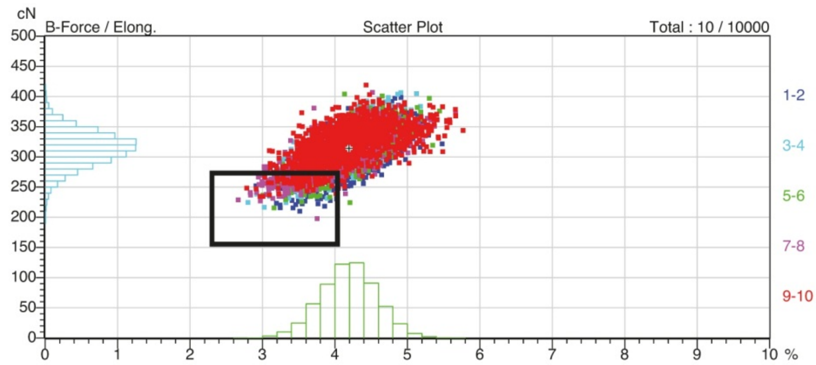


Fig. 21 Comparison of the USTER® TENSOJET results of two yarns 15 tex (Ne 40)

The yarns in Fig. 21 show the same relation as in the previous example. In this case, the yarn is finer and supposed to be used for weaving. The difference in performance is exactly reflected in the USP™ levels. In this specific example, the 34% level in elongation is expected to behave much better than the >95% level, in terms of performance in weaving.

Conclusion

The examples shown above clearly illustrate that yarns with elongation levels of about 25% in Statistics have considerably less risk of breaking compared to those in the area of 95% or more.

It is also shown that USP™ levels can play a decisive role in specifying yarns for different uses – for example whether a yarn is to be used in warp or weft. They can even predict a yarn's performance when different machine types or speeds are used in sizing and warping.

This information is also very important for the yarn producer since yarn elongation is determined, to a great extent, by the processing speeds especially in spinning and winding, significantly affecting the production costs.

6 Interpretation of USTER® *STATISTICS* – the link between the different levels and the yarn price

The link between different USTER® *STATISTICS* levels and yarn price is not easy to make. However, we can draw general guidelines to shed more light on this topic.

For yarn buyers, one of the decisive factors is the yarn price – either ahead of or equal with the yarn quality.

A yarn with evenness at the 5% level of USTER® *STATISTICS* offered at a low (or 'fair') price would indicate that the spinner has used raw material of the right quality and price, and has used a rationalized spinning process to spin it.

A yarn with evenness at the 5% USTER® *STATISTICS* level offered at a high (or 'unrealistic') price indicates that the spinner has used an expensive raw material.

A yarn with evenness at the 75% level of USTER® *STATISTICS* offered at a low price indicates that the spinner has either used raw material of certain (and probably low) quality (regardless of whether it might have expensive or cheap to buy) or has used a spinning process to spin it which is more quantity- and less quality-oriented.

So, there is a link between yarn price and USTER® *STATISTICS* levels, in a general context. This understanding is crucial when making comparisons and decisions for selecting the right yarns to use.

Another way to examine the link between yarn price and USTER® *STATISTICS* levels is to look at the costs involved when processing yarns of different USTER® *STATISTICS* levels. The following paragraphs provide some examples illustrating this.

Example 1 – Costs of the breaks in weaving

When yarn is used in the weft, the peak tenacity depends mainly upon the insertion speed. A tenacity-related weft break occurs when the peak tension overlaps with the weakest spot in the yarn.

The tenacity level where peak tension and yarn weak spot overlap depends on the CV of tenacity. The lower the CV of tenacity, the higher (and better) is the so-called weak spot level which is the absolute minimum tenacity level required. An empirical formula for finding the weak spot level is:

Weak Spot Level = mean tenacity – (4.3 x standard deviation of yarn tenacity)

For example, if a yarn has tenacity of 18 cN/tex and a standard deviation of tenacity of 1.6, then

Weak Spot Level = 18 cN/tex – (4.3 x 1.6) = 11.1 cN/tex.

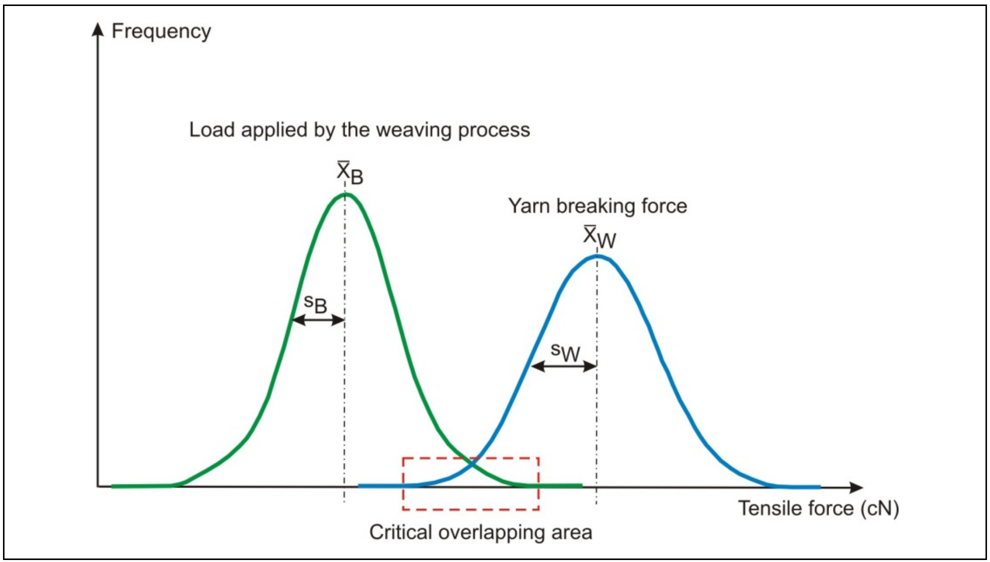


Fig. 22
Relationship between yarn force and weaving machine load on the yarn.

This also means that a yarn with an excellent mean tenacity value but a too-high CV of tenacity will most likely perform worse than a yarn with a lower mean tenacity but a small CV of tenacity.

The example (Table 10) shows the impact on production costs of two yarns of the same count with different tenacities but similar elongation values. The cost comparison case is based on the following article:

Article	Construction Threads per inch	Material Warp	Material Weft	Total ends	Weave
Percal	15.8 x 12.8	100% Cotton 16 tex (Ne 36)	100% Cotton 16 tex (Ne 36)	12916	1/1

Table 10
Weaving article details

The weaving mill consists of 62 double-width air-jet looms, operating at a speed of 600 rpm for a total annual production of approximately 5 million meters of fabric.

The yarn used is a 16 tex (Ne 36) 100% cotton for both warp and weft. As Fig. 23 and Fig. 24 show, both yarns have similar mean tenacity and elongation. Yarn 2 has a wider cloud, indicating that the variation of tenacity and elongation is quite different and worse than that of yarn 1.

Yarn 1 has produced 4 warp stops/100,000 picks and with having 4 weft stops per 100,000 picks, the efficiency achieved is 88.5%. The yarn 2 has produced 5 warp stops per 100,000 picks and having the same weft breaks, the efficiency achieved is 87%. The efficiency loss due to one additional warp break is 1.5%.

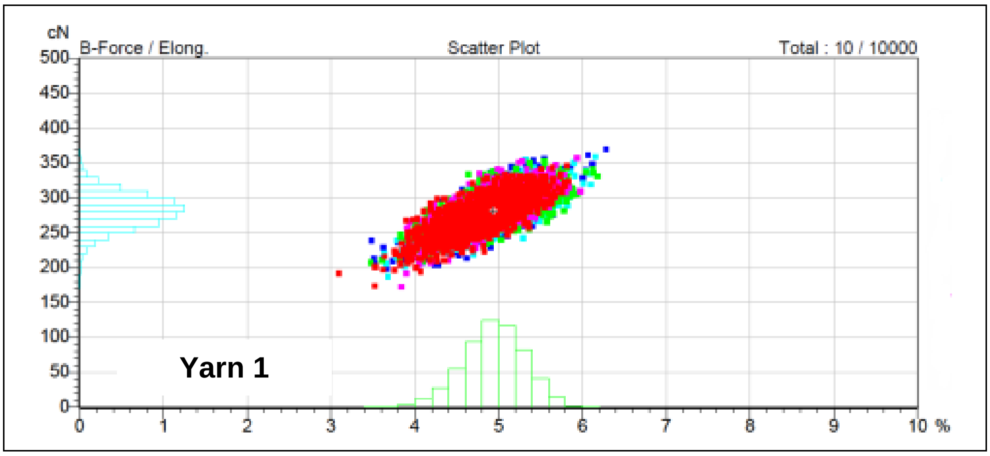


Fig. 23
Scatter plot of the force and elongation of a yarn 1

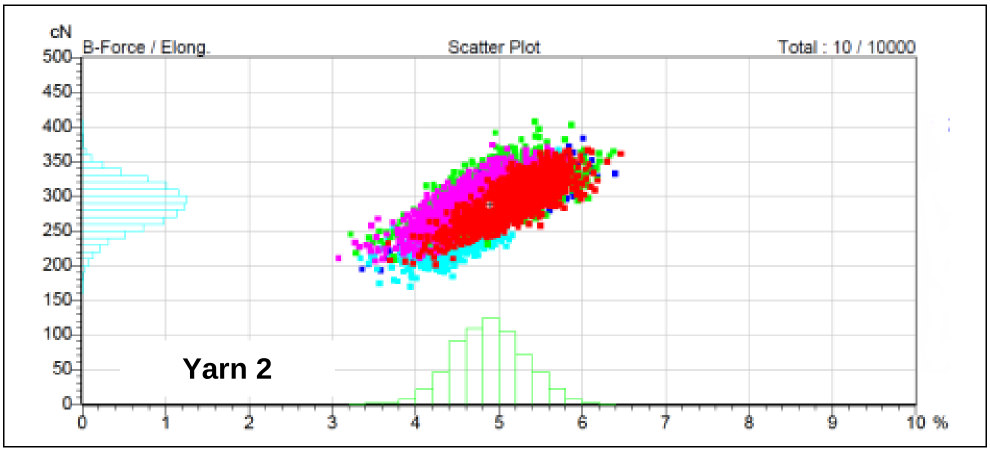


Fig. 24
Scatter plot of the force and elongation of a yarn 2

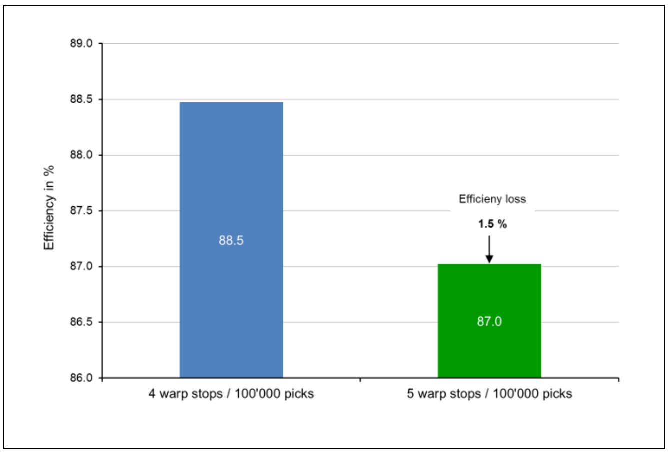


Fig. 25 Impact on the weaving efficiency due to different warp stops

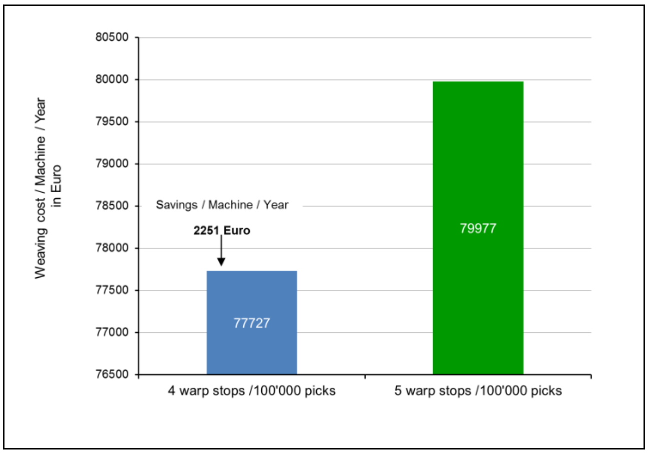


Fig. 26 Impact on the operating costs per machine and year due to different warp stops

Based on all other costs fixed, with only the warp breaks costs variable, the calculated savings due to 1 stop less are 2,251€ per machine per year. (4 stops per 100,000 picks per machine and per year costing 77,727€ compared to 79,977€ that is the cost of 5 stops per 100,000).

Example 2 – Comber noil

In the example used previously for the impact of short fiber content and comber noil, in USTER® *STATISTICS* the difference of short fiber content of the combed sliver is small but the comber noil difference is large (test 2 and test 3 in Table 9). Also, the yarns produced had similar characteristics and the fabrics were very similar in appearance. This would be a hint for the spinner to adapt the noil accordingly.

Adding all the processing parameters into the following cost model, the result was that, for this specific mill, the impact of not taking the right decision was at the level of 32,000 to 49,000 USD per year.

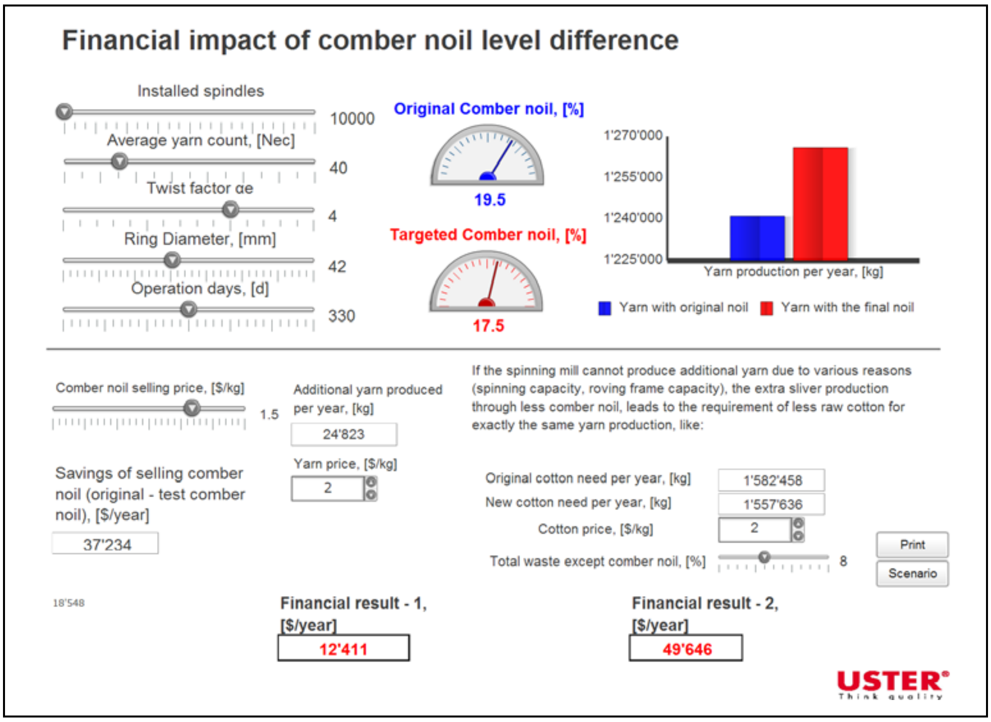


Fig. 27
A model to calculate the financial impact of two different comber noil levels for a given spinning mill setup.

The calculation shows that the part of the spinning mill producing this article (10,000 spindles) can profit by 32,000 USD per year, increasing its output through the reduced comber noil (excluding of course the loss due to less comber noil to be sold).

In some cases and for some spinning mills, their setup means they cannot absorb this extra sliver production, so the profit in those cases arises from savings in cotton raw material while still producing the same amount of yarn as with the initial noil level. In this specific example, the savings that can be made are nearly 50,000 USD per year. In years where cotton prices are high, this is a great saving for the mill.

7 Why USTER® *STATISTICS* are valid only with USTER® instruments

If textile testing instruments are used for benchmarking, it is very important that the accuracy of the instruments is under control. This is required for the determination of the mean as well as for the variation. Otherwise, benchmarks cannot be used because the variations of the test results are too wide.

When manufacturing its testing systems, USTER goes to great lengths to ensure that many of the potential variables which can affect the accuracy and precision of measurements are kept under tight control, including the following:

- Accuracy of the final test, assembly line
- Variation of the sensors and the signal evaluation system
- Variation of the calibration (made in a controlled laboratory)
- Humidity and temperature in the laboratory
- Moisture content of test material at the time of the measurement (adapted to the standard condition of the test laboratory)
- Variation of the quality characteristics within and between the test material
- Traceability of quality characteristics to a master gage

Samples for the USTER® *STATISTICS* are measured on USTER® instruments in our testing laboratories in Uster, Switzerland, and in Suzhou, China. All the quality characteristics – such as evenness, imperfections, hairiness, strength, elongation, count, etc. – decrease if the humidity in the test lab drops below the recommended tolerance band, and increase with higher humidity. Therefore, it is important for accurate measurements to keep the laboratory conditions under control. The conditions in USTER's testing laboratories are permanently checked and the quality characteristics are compared with a master gage.

Since measuring instruments have to provide the same quality values over a long period and from instrument generation to instrument generation, the manufacture of each instrument can be traced back to a master gage, kept securely by USTER for decades. This ensures the same quality characteristics can be guaranteed over a long period, enabling USTER® *STATISTICS* to be compared from the start of these reference figures. In case of doubt, the quality characteristics of customers' laboratory systems can be compared against the master gage.

It has been mentioned already that there is a strong link between USTER® *STATISTICS* levels and quality, as well as costs. This means that someone wanting to use USTER® *STATISTICS* needs to ensure the results being compared with them are within certain tight tolerances; otherwise the comparison to the benchmarks is put at risk.

Uster Technologies undertakes various efforts to keep the variation of the quality characteristics under control. Uster Technologies can also trace back measured values to master gages to keep the mean and the variation of the installed USTER® laboratory systems under control for decades.

Measuring instruments from other suppliers cannot fulfill many of the conditions mentioned here. Therefore, when measurements from these systems are compared with USTER® *STATISTICS*, the variation in the values is so high that the USTER® *STATISTICS* are not longer useful.

In keeping with its long history, Uster Technologies also has the requisite experience in managing variations. Each and every instrument and system that is delivered from an USTER manufacturing plant to the final customer is calibrated and tested within narrow limits. Each sensor that is developed and manufactured by USTER has narrow tolerances. Finally, the evaluation of the raw signals is done in a systematic and reproducible way.

These details may perhaps appear trivial, especially in the 'computer age', but they certainly are not. Other manufacturers of devices for measuring quality characteristics in fibers and yarns simply cannot fulfill these preconditions.

Here is an example of a comparison made between an USTER® *TESTER 5* (USTER in the example) and devices made by three other manufacturers (A, B and C in the example) for measuring mass evenness in yarns. The task was to measure the yarn evenness of a 100% cotton yarn 20 tex (Ne 30).

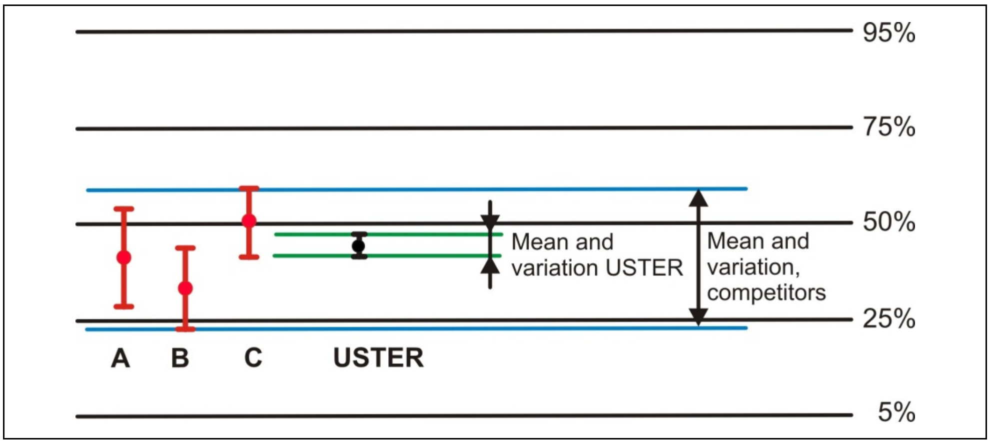


Fig. 28 Measurements of mass evenness (CV_m) of a 100% cotton yarn 20 tex (Ne 30) with different instruments.

As shown, if the other manufacturers also compared their values with the USTER® *STATISTICS*, the values would vary from 20 to 60%. With this level of variability, the use of benchmarks is meaningless. The USTER value only varies from 40 to 45%, a much tighter controlled variation. Under these circumstances benchmarks are valid.

Last but not least, another decisive reason why USTER® *STATISTICS* are valid only with USTER® instruments is because of the unique quality parameters that our instruments are measuring. The instruments that are producing these parameters are:

- USTER® *TENSOJET*
- USTER® *TESTER 5* (OI module, OM module)
- USTER® *CLASSIMAT* 5
- USTER® *ZWEIGLE HL400*
- USTER® *AFIS*
- USTER® *HVI*

8 USTER® *STATISTICS* and `Total Testing´

To be successful in today's challenging textile business environment, companies can no longer rely on just a few basic skills. To achieve growth and sustainable results, they must excel in all areas of their operation. The essential need is to strike the right balance between minimizing costs and consistently achieving the required quality – which demands proper control of yarn quality.

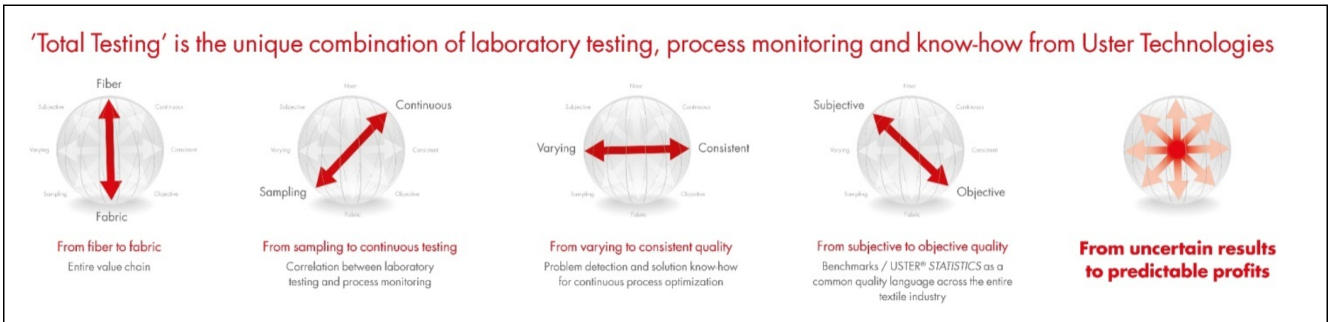


Fig. 29 Total testing approach

USTER has developed a unique approach to this challenge, through the combination of laboratory testing, process monitoring and know-how.

This approach is called Total Testing (Fig. 29) – and it helps textile companies to transform their business from uncertain results to predictable profits. Settings for the manufacturing machines can be made according to USTER® *STATISTICS* values and verified by testing samples in the laboratory on USTER® instruments.

The unique correlation between data from USTER® laboratory systems and USTER® yarn clearers means that 100% of the yarn production is checked. This allows the production to be continuously compared to the required quality limits with any exceptions being instantly identified, ensuring consistency of quality for the total production.

Total Testing and USTER® *STATISTICS* – an essential combination, because standards are a crucial part of USTER's Total Testing approach (Fig. 30).

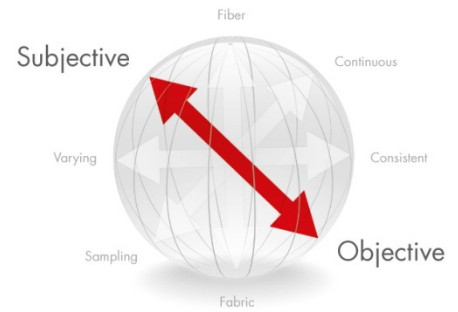


Fig. 30
The combination of USTER® instruments and USTER® STATISTICS provides globally accepted fiber and yarn benchmarks

Among the biggest and most costly problems in textiles are claims for below-par quality. Investigations have shown that quality-related costs in the textile value chain can amount to as much as 6% of a retailer's total revenue (based on retailers' statements during various discussions with them). Yarn producers use USTER® *STATISTICS* to set quality targets, to monitor their consistency, to benchmark performance against competition and to certify the quality of finished articles.

USTER® *STATISTICS* enable users to speak 'the global language of quality' – which does not require explanations or translation and which can be easily understood by all.

9 Some facts about USTER® *STATISTICS 2013*

9.1 How the USTER® *STATISTICS 2013* are generated

Uster Technologies permanently collects samples all over the world and publishes the USTER® *STATISTICS* every five to six years. These samples are tested in the laboratories of Uster Technologies, Switzerland, as well as in Suzhou, China (Chinese samples only), under standard conditions and strict testing guidelines.

Several thousand samples from fiber to yarn have been tested in these two laboratories. Only when the sample size reaches a significant number of fiber, sliver, roving and yarn tests is a new chapter, with all its parameters, published.

After testing, the measured results are transmitted to a database and unique data analysis software calculates the percentile curves. Evaluation of the graphs is conducted by experienced textile technologists at USTER headquarters in Switzerland.

All values for USTER® *STATISTICS* are obtained by using the laboratory instruments of Uster Technologies and are valid exclusively in combination with them. Only laboratory instruments made by Uster Technologies guarantee the accuracy and reproducibility of data, as explained in chapter 7.

The geographical distribution of the origin of all samples measured for the USTER® *STATISTICS* is illustrated in Fig. 31.

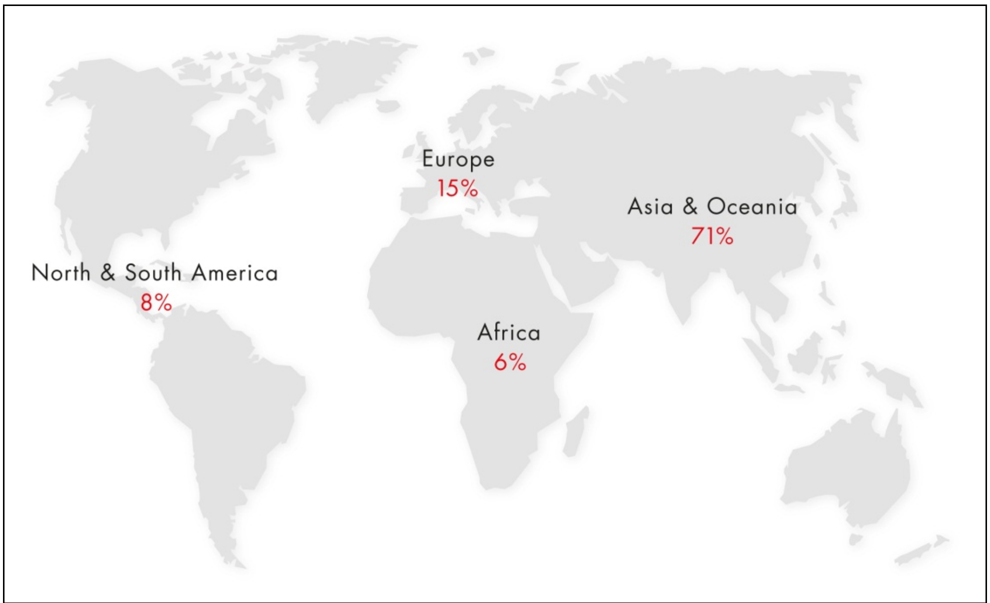


Fig. 31
Geographical distribution of the origin of all samples measured for the USTER® STATISTICS 2013

The majority of samples, 71%, come from Asia. This correlates to the amount of installed ring spindles worldwide. Compared to the previous USTER® *STATISTICS (2007 release)*, the amount of samples from Asia increased by 20%. The figures from Europe, Africa & Middle East and the Americas also represent the amount of installed ring spindles in those areas. So the origin of the samples truly reflects the situation of textile production in the world market.

9.2 Scope of the USTER® *STATISTICS 2013* – what's new

In 1957, Uster Technologies started to publish only a few tables for cotton and wool. USTER has expanded the content to more than 2200 graphs over the past 55 years – always with the ambition to provide USTER® *STATISTICS* for all kinds of material available in the market. Today, more than 30 major yarn styles are presented. Not only has the number of chapters increased over the years, but the number of parameters has risen to include over 60 characteristics for fibers, rovings, slivers and yarns.

The highlights of USTER® *STATISTICS 2013* are the inclusion of data for USTER® *CLASSIMAT 5* and USTER® *ZWEIGLE HL400* and the publication of statistics for plied yarns. While USTER® *CLASSIMAT 5* measures and classifies disturbing yarn defects, foreign fibers and vegetable matter, USTER® *ZWEIGLE HL400* measures and classifies the length of protruding fibers. Both instruments play a vital role in the assessment of fabric appearance.

9.2.1 USTER® *CLASSIMAT 5*

A major requirement for the CLASSIMAT® graphs was to differentiate the yarn counts. So the graphs for USTER® *CLASSIMAT 5* are class-divided in three yarn counts.

The three classes are:

1. Coarse 30.1 to 50 tex (Ne 12 - Ne 20)
2. Medium 15.1 to 30 tex (Ne 20.1 - Ne 40)
3. Fine ≤15 tex (>Ne 40)

As mentioned, it is the goal of Uster Technologies to publish new and innovative quality parameters. So, for the first time, graphs are available for foreign fiber, with separate vegetable matter results.

Next to the traditional classification standards, USTER® *CLASSIMAT 5* introduces measurement of outliers and provides detailed outlier information for all fault categories.

Outliers (Fig. 32) are classified into neps, short thick, long thick and thin places (NSLT), foreign matter including polypropylene, and key quality parameters such as outliers for evenness, imperfections, hairiness and contamination. All these new parameters are published in the new USTER® *STATISTICS 2013.*

For the first time, USTER® *CLASSIMAT 5* shows the amount and characteristics of periodic defects.

Outliers

Type	Abs.	Rel.	USP13	52 week best
NSLT (100%, -65%)	16	8.0	-	1.0
FD (8%, 2cm)	6	3.0	-	0.5
VEG (10%, 2.6cm)	3	1.5	-	0.0
PP (65%)	1	0.5	-	0.5

Quality outliers

Parameter	Range	Affected share	USP13	52 week best
Evenness (CVm) (-16%, +20%)	11.3 - 13.0	-	-	-
Imperfections (Std) (3σ)	61 - 232	5.0 %	-	1.5
Imperfections (Sens) (3σ)	518 - 1,521	2.0 %	-	0.5
Hairiness (H) (-1.0, + 1.0)	4.7 - 6.5	0.3 %	-	0.0

Fig. 32
Summary table of outliers in USTER® CLASSIMAT 5

9.2.2 USTER® *ZWEIGLE HL400*

The hairiness of a yarn has a major impact on virtually every aspect of fabric quality across a wide range of textile end-uses. The appearance, the pilling and durability of the fabric are affected, as well as the productivity and efficiency of further manufacturing operations, by the degree of yarn hairiness (Fig. 33).

The latest USTER® *ZWEIGLE HL400* hairiness tester takes the globally-established ZWEIGLE® S3 hairiness value measurement to the next level. The instrument offers benefits in terms of improved accuracy and it now operates eight times faster than previous instruments, with a test speed of 400 m/min. With an instrument variation lower than 10%, Uster Technologies is now for the first time able to establish USTER® *STATISTICS* using the USTER® *ZWEIGLE HL400*. This was not possible with this measuring principle until now.

Fig. 33
Cotton yarn with high hairiness and pilling in a T-shirt

9.2.3 New yarn styles

For some textile applications, plied yarns are common. We have recognized this need and its importance and published for the first time USTER® *STATISTICS* graphs for plied yarn. The added new yarn styles are:

- Plied yarns made out of 100% cotton, ring-spun, carded as well as combed
- Core yarns made out of cotton and elastomer for bobbins and cones (confirmation of the provisional USTER® *STATISTICS 2007*)
- Air-jet yarns for:
  - 50/50%, 65/35% PES/CO
  - 100% CO
  - 100% PES

9.2.4 New yarn parameters

Since the inception of USTER® *STATISTICS,* the CV_m values have always been published. In order to be able to predict fabric appearance more accurately, as well as highlight the possible improvement that a spinning mill can achieve, we have added the CV_m in longer cut lengths. For USTER® *STATISTICS 2013,* we published the cut length values for 1m, 3m and 10m, to allow comparisons with the best practices worldwide.
The table below shows the new parameters added:

Instrument	Parameter
USTER® *TESTER 5*	CV_m 1m: coefficient of variation of the mass for a cut length of 1m CV_m 3m: coefficient of variation of the mass for a cut length of 3m CV_m 10m: coefficient of variation of the mass for a cut length of 10m CV FS: coefficient of variation of the fine structure
USTER® *ZWEIGLE TWIST TESTER*	Twist per inch
USTER® *ZWEIGLE HL400*	S3 value per 100 m (sum of protruding fibers with a length of 3mm and longer)
USTER® *CLASSIMAT 5*	Classification parameters: – NSLT for the standard classes – NSLT for the extended classes – Foreign matter Dark (FD) including A1+ AA classes – Vegetable matter (VEG) Outliers statistics: – NSLT standard classes – NSLT extended classes – FD, VEG, PP – Sum of affected share of CV, IP, H – Dense areas for foreign matter (FD and VEG)

Table 11

9.2.5 New materials

Next to the new parameters being published, Uster Technologies will extend the range of materials covered, adding chapters for viscose, modal, cotton-viscose, cotton-modal, micro-modal and linen. The list below shows the additional materials:

For roving

- 100% CO, compact yarn, combed
- 100% PES, ring yarn
- 100% CV, ring yarn
- 65/35% PES/CO, ring yarn

For yarns

- Linen yarns made out of chemically treated fibers, i.e. boiled or bleached
  (as introduced in the USTER® *STATISTICS 2007* version 4)
- New blends:
  - 50/50%, 60/40%, 70/30%, CO/CV, ring yarn, combed, bobbins & cones
  - 50/50% PES/CO, ring yarn, combed, bobbins & cones
  - 40/60%, 45/55% PES/CO, ring yarn, combed, bobbins & cones
  - 40/60%, 45/55% PES/CO, ring yarn, carded, bobbins

9.2.6 New chapters

Starting with the USTER® *STATISTICS* edition of 1997, Uster Technologies has been publishing fiber processing data. This includes various quality parameters along the spinning process, from the cotton bale to the roving.

In USTER® *STATISTICS* 2013, Uster Technologies published a new chapter for yarn processing. The graphs there represent the quality change from the bobbin to the cone for specific parameters such as yarn strength, yarn hairiness etc.

Uster Technologies is aware that the winding speed and the winding machine/conditions have a definite influence on that change in quality. USTER's intention is to help the spinner to benchmark that quality change in its own winding process compared to global results and decide if there is scope for improvement or not.

Practically, these graphs will offer a new possibility to compare against best practices worldwide. For example, an increase in yarn hairiness from bobbin to cone not only reveals insights into the structural characteristics of the yarn (twist, friction etc.) but also highlights the contribution of the winding process to the quality level, leading to improvements where necessary.

10 Conclusions

Since 1957, USTER® *STATISTICS* have served the textile industry, offering a worldwide yarn quality reference, so that each spinning mill, machine manufacturer and yarn user can compare their data with global benchmarks.

USTER® *STATISTICS* are widely used by all players in the yarn production and processing field:

For the yarn producers	– Set spinning process Key Performance Indicators – Achieve operational excellence – Specify and communicate quality objectively – Guarantee the quality of yarn being produced and sold
For the yarn users	– Specify the quality needed (quality profile) – Select yarns with the appropriate quality – Optimize the portfolio of the yarn producers – Pay the right price for the right quality
For the machine manufacturers	– Develop spinning machinery achieving both production and quality targets – Develop the right spinning components – Develop appropriate maintenance plans – Link productivity with quality

Table 12
Summary of the role of USTER® STATISTICS for various user groups

There is an unavoidable link between quality and cost, and this also becomes apparent by using USTER® *STATISTICS*. Yarns of different USTER® *STATISTICS* levels result in fabrics of distinctly different quality levels, leading to problems in processing or variations in final value. These differences impact on prices and affect the costs and profitability of the organization.

USTER® *STATISTICS* are the only neutral reference for assessing and classifying the quality of yarn. Their link to yarn prices and indirectly to costs makes them a powerful tool. To avoid mistakes in the interpretation of USTER® *STATISTICS*, users need to compare the quality values from only USTER® instruments.

The new 2013 edition of USTER® *STATISTICS* introduces more yarns, more materials and more quality parameters. A highlight is the introduction of the USTER® *STATISTICS* based on the new USTER® *CLASSIMAT 5,* with its pioneering way of classifying seldom-occurring defects.

We are committed to continuing the tremendous job of collecting, measuring and compiling USTER® *STATISTICS* in the future, with the same effort as we have applied in the past to servicing our customer base and the textile industry in general.

Our motivation is the knowledge that USTER® *STATISTICS* have an irreplaceable value in yarn trading, as well as in promoting the improvement of spinning mills.

Over the past 55 years, USTER® *STATISTICS* have earned legendary status throughout textiles – and their value is more significant than ever in the globalized trading environment today and in the future.

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