USTER® Think quality

USTER® NEWS BULLETIN

Managing a spinning mill with quality in mind

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50

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Sharing extensive and in-depth know-how with customers and supporting them to produce the right quality has always been the main objective of the USTER® *NEWS BULLETIN* – from the first publication in 1961 up to the present. We are committed to continuing this tradition. In doing so, we hope to expand your textile and quality horizons through our publication and provide new impulses to your daily routines.

Uster Technologies is proud to publish the 50th edition of the USTER® *NEWS BULLETIN*. With this anniversary edition, we also embrace a new publishing medium: as well as the printed edition, we now offer the USTER® *NEWS BULLETIN* in an electronic format. Subscribe at www.uster.com/subscriptionunb to receive it regularly.

Several market surveys conducted by Uster Technologies highlight the same major concerns among yarn producers, summarized as 'quality and quality consistency in an extremely volatile environment.' This topic has been covered in the past – notably as 'Quality management of a spinning mill' within UNB 39 in 1993. The significant changes in the textile industry in the past 20 years make it worthwhile to look at today's quality management with a fresh perspective. Now, with USTER® *NEWS BULLETIN No. 50*, we offer our customers the chance to benefit from the very latest know-how, so they can 'manage a spinning mill with quality in mind' as the title states.

Learning from others is important when assessing quality management options. That is why we want to share with you the collective know-how of Uster Technologies, based on insights from spinning mills around the world. This USTER® *NEWS BULLETIN* will provide comprehensive lists of the key focus points which mills need to manage. In most cases, these points influence costs and productivity, as well as quality.

We are convinced that mills should focus on important checkpoints and Key Quality Indicators, as a starting point to managing their mills with quality in mind. Uster Technologies believes that isolated Quality Management is a thing of the past – the trend to follow is 'mill management with quality in mind' – in other words 'Think Quality'.

We invite you to take control of your quality for business success – and improve your quality control with the ultimate aim of turning quality into profitability. Think Quality™ is the best way to achieve predictable profits for long-term business sustainability.

Thomas Nasiou
Head of Textile Technology
Uster Technologies AG

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1 Introduction – trends in industrial production

New challenges in industrial production today
All sectors of industrial production – not only textiles – face new challenges today. New products have to be delivered to the market in extremely short time periods. Market demands continue to increase, with regard to quality consistency, price and delivery times. The effect is to compel the industry to produce higher output from fewer resources, in an efficient and ecological manner, with short throughput times. This USTER® *NEWS BULLETIN* reflects today's situation – highlighting what has changed in the textile industry, as well as noting what has remained the same.

What has changed in the textile industry?
In the past 20 years, the textile industry has undergone remarkable changes. Globalization of the industry is only one element of that. The quality tools in use today are more and more sophisticated – thanks to developments in data handling and processing, as well as in sensor technology. Latest weaving and knitting machines run at higher speeds, placing more demands on yarns, to guarantee high efficiency. Yarn quality levels have increased, even though raw material quality and availability are more variable. The globalization of raw material supply, the volatile price situation, and the fast-changing demands of fashion all force mills to be more flexible and cost-conscious.

Quality management – a demanding, multifunctional task
In this rapidly-changing environment, the role of quality management has also progressed. Quality management today can no longer be viewed as a single function. It has evolved into a multi-functional task, with the complex goal of achieving the right quality at the right cost level, consistently over a long period.

So quality management is now not an isolated process, but an inherent part of all functions in the mill. It is important to recognize the unique drivers (Key Quality Indicators) that influence quality and its consistency, as well as costs, and to find the right balance. Adapting the organization, workflows and personnel to achieve high and consistent quality at lowest cost is essential for the success of any mill in the highly-competitive yarn market.

Future requirements
The production and quality control systems of the future will need to fulfill higher demands: they should be intelligent, flexible, efficient and sustainable. Combining quality systems with information and communication technology will allow future production processes to be better organized and easily improved, thus leading to better product quality.

The rapid analysis of machine and production data is an important element in improving production processes and quality, and this will be a core competence of enterprises in the future.

The enormous volume of data generated must also be filtered, so that the most important information is distilled, allowing fast responses where required. USTER® *EXPERT SYSTEMS*, combined with Key Performance Indicators and Key Quality Indicators are vital tools to support the mill management teams and make this rapid reaction possible.

2 The quality needs of the textile industry today

Concerns of spinning mills
The major concerns of most yarn producers can be summarized as 'how to satisfy customers by keeping the quality consistent and the costs on the profitable level in an extremely volatile environment.' Here, it is important to mention that market demands for yarn quality are not always the same. The requirement can range from 'good enough quality' to 'best or top quality', depending on the final product. This is clear from customer research by Uster Technologies, based on direct discussions, interviews at exhibitions and market surveys.

Sharing know-how to put mills in control
To help spinners take control of their quality challenges, Uster Technologies would like to share know-how collected from textile mills all over the world, with this USTER® *NEWS BULLETIN*. Each spinning mill will have a different approach, so the know-how spans a wide area – covering organization, quality management tools, best practices with workflows, technical and technological guidance.

How to fulfill quality needs
The following key statements are compiled to summarize USTER knowledge and expertise and provide common denominators to define quality:

1. Quality is a mindset that needs to be well established across all mill functions, enabling preventive rather than corrective actions.
2. Quality means fulfilling the product requirements agreed with the end-user.
3. The objective of quality management is to fulfill these requirements consistently, while also considering the long-term cost/profit performance of the spinning mill.

By practical application of these three key statements, mills can fulfill the quality needs of today. How to establish quality as a mindset, supported by organizational changes, is shown in Chapter 2.1. In Chapter 2.2, the progression from quality requirements to quality agreements is described. Achieving quality consistency is a demanding task, which is covered by several chapters: Chapter 2.3 'Quality consistency'; Chapter 3 'Elements for quality management'; and Chapter 4 'Best practices for quality management in the mill'.

2.1 Quality and organizational structure of mills

Quality management of today is no longer a unique function of the quality department. If a proper quality mindset is to be established, it requires a cross-functional approach, initiated by mill management and lived out by each and every person in the mill.

What drives organizational development
Customers, product quality and fast reaction times are the key drivers of modern organizational development. Many successful spinning mills go beyond 'quality control' towards 'quality management' in order to achieve positive, sustainable and significant results. When quality management is a part of the culture of the spinning mill, everybody in the mill keeps customer orientation and mill optimization in mind – and this is also clearly visible in the organizational structure of the mill.

Avoid organizational bottlenecks
A typical organization is shown in **Fig. 1**. The organization chart shows the different departments of the spinning mill and how functions and disciplines relate to each other. In this mill, all departments are headed by the mill management. This degree of overall responsibility tends to overload the mill management and create headaches for them. Quite often with such structures, the mill management is a bottleneck for interaction between departments. Reacting quickly is important to keep quality and production under control, so fast interaction between departments is vital with today's high production rates. Optimized information flow between the departments will help to avoid such organizational bottlenecks.

Adapt organizational structures
To cope effectively with the complexity of mill processes, different organizational solutions are needed to lighten the load on management. More and more spinning mills are evolving an organizational structure in which the leadership is driven by quality, and quality management has a cross-functional role. An example of such an organizational structure is shown in **Fig. 2**.

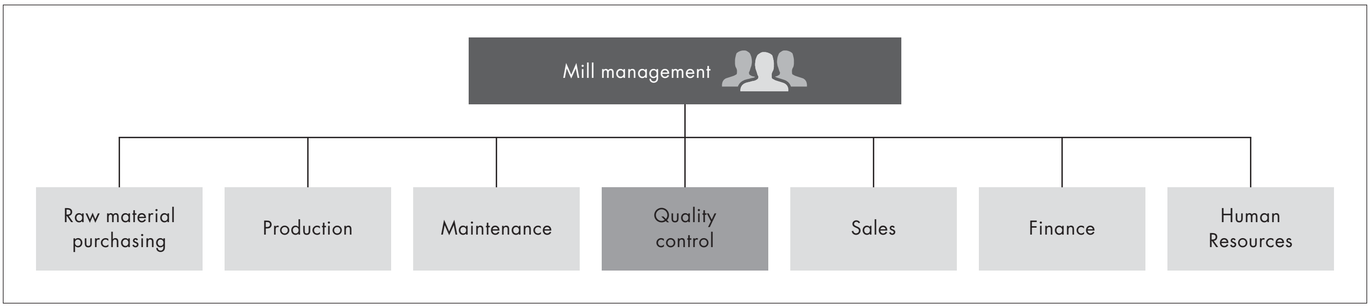


Fig. 1 Typical organization in spinning mills

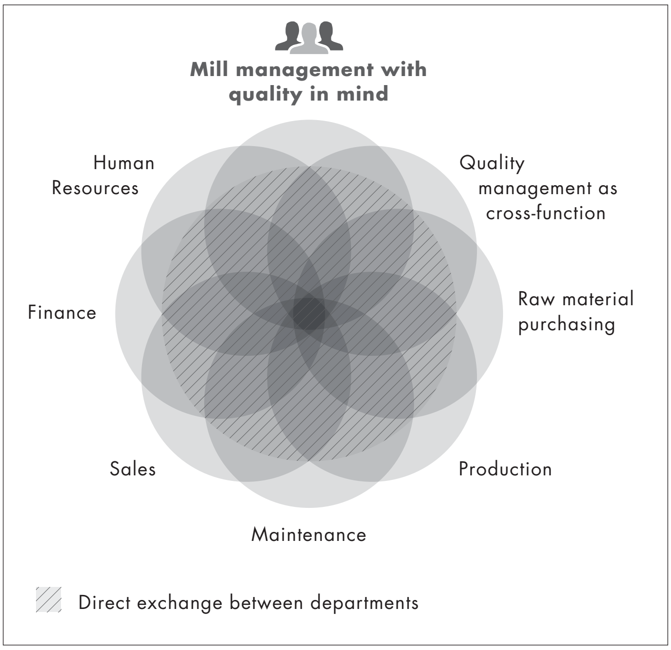


Fig. 2 Modern mill organization with direct exchange between all departments

To increase reaction speeds, some mills have implemented a more 'liquid' form of management, in which the borders between the different departments are flexible. This enables direct interaction between departments, without bottlenecks. Quality management is a cross-function, and the guiding principle of all departments is to achieve the right quality to satisfy the customers, produced cost-efficiently for the mill.

Structured and rapid information flow

Mill management systems provide tools to support the automatic information flow between departments. Quality and production data are stored centrally, but reports are available for multiple users from different departments. Transparent, rapid information – with automated alerts if quality limits are crossed – is the key to fast responses and decisions.

2.2 Quality requirements and quality agreements

Many quality problems and customer complaints in the textile industry are the result of incomplete quality agreements. Quite often spinning mills are forced to take back yarns or grant a large discount, despite the fact that no detailed quality agreement has been fixed.

Why is it difficult to define suitable agreements

One reason for incomplete agreements is that several production steps are involved in producing a textile fabric. The textile supply chain consists of numerous interfaces. Ginning mills, spinning mills, weaving or knitting mills, fabric finishing, garment production and the whole retail business have different demands and requirements and express them in different ways. Successful quality management necessitates intensive communication between all partners, to arrive at suitable quality agreements.

Another cause of inadequate agreements may be that the spinner does not know the intended end-use of the yarn, because it is sold via a trader. This missing knowledge makes it difficult to determine appropriate yarn properties or arrive at proper agreements.

From yarn requirement to yarn agreement

For example, a weaving mill requires a yarn which shows good running behavior on machines, with minimal breaks of warp ends, for a very even fabric appearance with low hairiness. Although these requirements are clear to the weaving mill, they do not know which yarn quality parameters to specify to meet them. The yarn requirements of the weaver must be translated into objective values which spinning mills can use for a yarn agreement. Both parties have to understand and learn to speak the same 'language' in terms of quality definitions and also agree on measurement methods, procedures and conditions. Otherwise any agreements are virtually useless.

USTER® Yarn Profile

USTER® Think quality

Material	100% Cotton
Spinning Technology	ring yarn, combed, weaving, cone
Count (Ne)	48.0
Profile key	R3FUEY
Profile	Quality Level 1A: New Style

Parameter	Unit	Description	USTER® *STATISTICS* Percentile (USP™)	Absolute 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

Fig. 3 Example of a yarn profile for a high-quality woven fabric made from a combed ring yarn

Fig. 3 shows an example of a yarn profile agreed between a weaving mill and a spinning mill for a high-quality woven fabric. The following yarn parameters are important to be listed and defined: yarn count, twist, mass and diameter variation, imperfections (neps, thin and thick places), tenacity, elongation and hairiness. Depending on the end-use of fabric, further parameters can be added, e.g. minimum strength values, remaining CLASSIMAT® defects and foreign fibers.

Yarn profiles and USTER® *STATISTICS*

The values of the yarn profile are related to the USTER® *STATISTICS* Percentile (USP™) range and an absolute value range. Linking the yarn profile to USTER® *STATISTICS* is a great advantage. With USTER® *STATISTICS*, the textile industry knows exactly which quality levels are possible. Yarn profiles show clearly which quality values and quality ranges are important for specific applications. It is effectively the practical application of USTER® *STATISTICS*.

Without the USP™, only a technologically experienced specialist would know if an absolute value was a high or low quality value. With USP™, the yarn user can understand yarn requirements and yarn profiles much better. For example, an USP™ of 5 – 10 % shows that this parameter has to be kept at a high level with low variation. With a value of 25 – 50 %, tolerance to variation can be wider. This level of understanding is difficult to gain from absolute values only.

Incorporated experience in USTER® Yarn Profiles

Based on the broad quality experience which spinners, weavers, knitters and retailers shared with Uster Technologies, model yarn profiles have been developed. **Fig. 4** shows the way for the optimization of yarn profiles in cooperation with the yarn user. If the yarn user is satisfied with the yarn, he can fix the yarn contract according to the values of the yarn profile. The optimization loop for the yarn profile, initialized by feedback from the user, not only improves the yarn quality but also allows the spinner to adjust the raw material or optimize the processes accordingly.

Secure, with 100 % control
To ensure that future yarn quality corresponds to the agreement, both spinning mill and yarn user should control and measure the yarn properties. USTER recommends regular, defined laboratory testing procedures at the spinning mill, combined with 100 % online control by yarn clearers. At the knitting or weaving mill, an incoming test of the delivered yarn material will help to ensure agreement values are maintained. Where the agreement includes that the spinning mill will send printouts of the yarn testing protocols, random testing at the end-user can be reduced to a minimum. This depends on experience and the level of trust between yarn buyer and yarn seller.

In this context, a yarn agreement should not only include yarn values. To control if the agreement is being fulfilled, Uster Technologies recommends that the contract specifies all the testing and laboratory conditions, such as measurement methods, measurement speeds and instruments used to test the yarns.

Benefit of USTER® Yarn Profiles
All partners in the textile chain can benefit from using USTER® Yarn Profiles. There are no more time-consuming discussions if the yarn is good enough or not. Discussions focus on quality measurements, based on real figures.

Weavers and knitters can request a yarn which fits exactly to their fabric end-use. A detailed specification will help them to evaluate which spinning mill is best able to meet their needs. It is important to cross-check the yarn specification by measuring, so that the supplier will more readily accept a claim, should a yarn fail to match the specification.

For the spinning mills, a proper quality agreement allows optimization of raw material use and production of the required yarn quality as cost effectively as possible.

2.3 Quality consistency

'A good spinning mill produces good quality, but the best spinning mill is one which always produces the same (good) quality.' Meeting customers' quality expectations every time requires the spinning mill to produce consistent quality over a long period. This long-term consistence is a precondition for acquiring and keeping loyal customers, a good market reputation and business success.

Meet quality expectations every time
Even with a change of raw material, the customers' quality expectations for the yarn stay the same. Achieving consistent quality over a long period in these changing conditions has a huge impact on spinning mills. They have to implement rigorous process control and optimize processes to stay profitable and produce consistent quality. This is a complex task and needs a great deal of technological and management know-how.

USTER experience shows that many of the expensive claims against yarns are related to quality exceptions, rather than to deviation from the average quality level. This means that quality management of today in general manages to balance the average quality level quite well, but still needs to implement 100 % control to focus on prevention and detection of exceptions.

The next two chapters are devoted to explaining the importance of consistency in mill performance and quality, as well as the tools and techniques needed to achieve it.

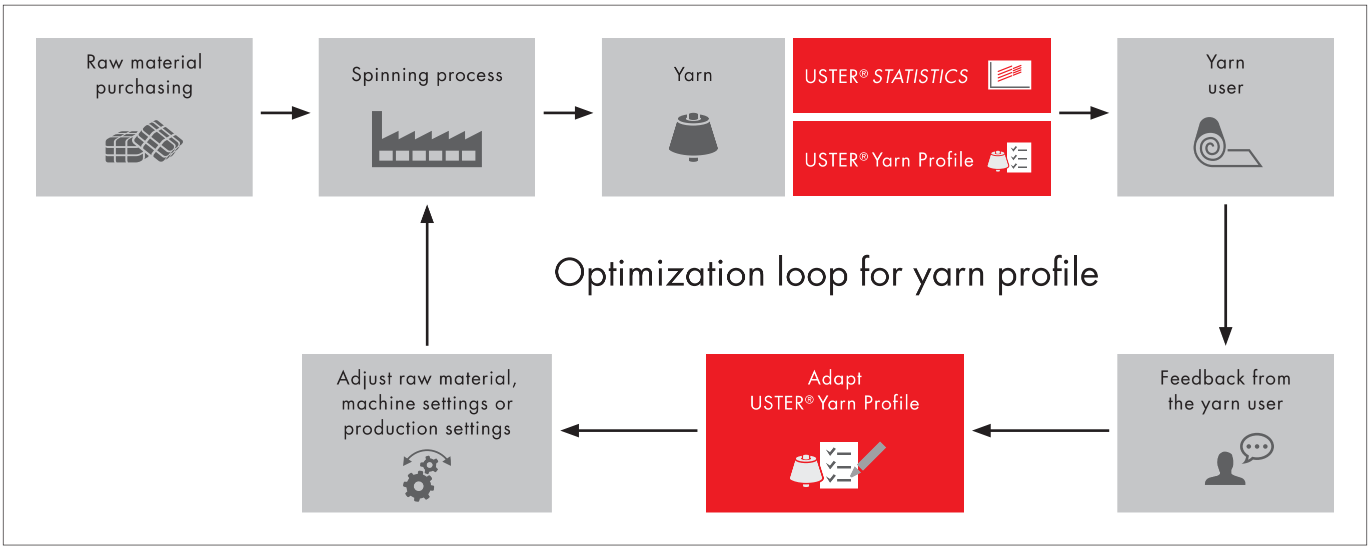


Fig. 4 A way to use yarn profiles

3 Elements for quality management

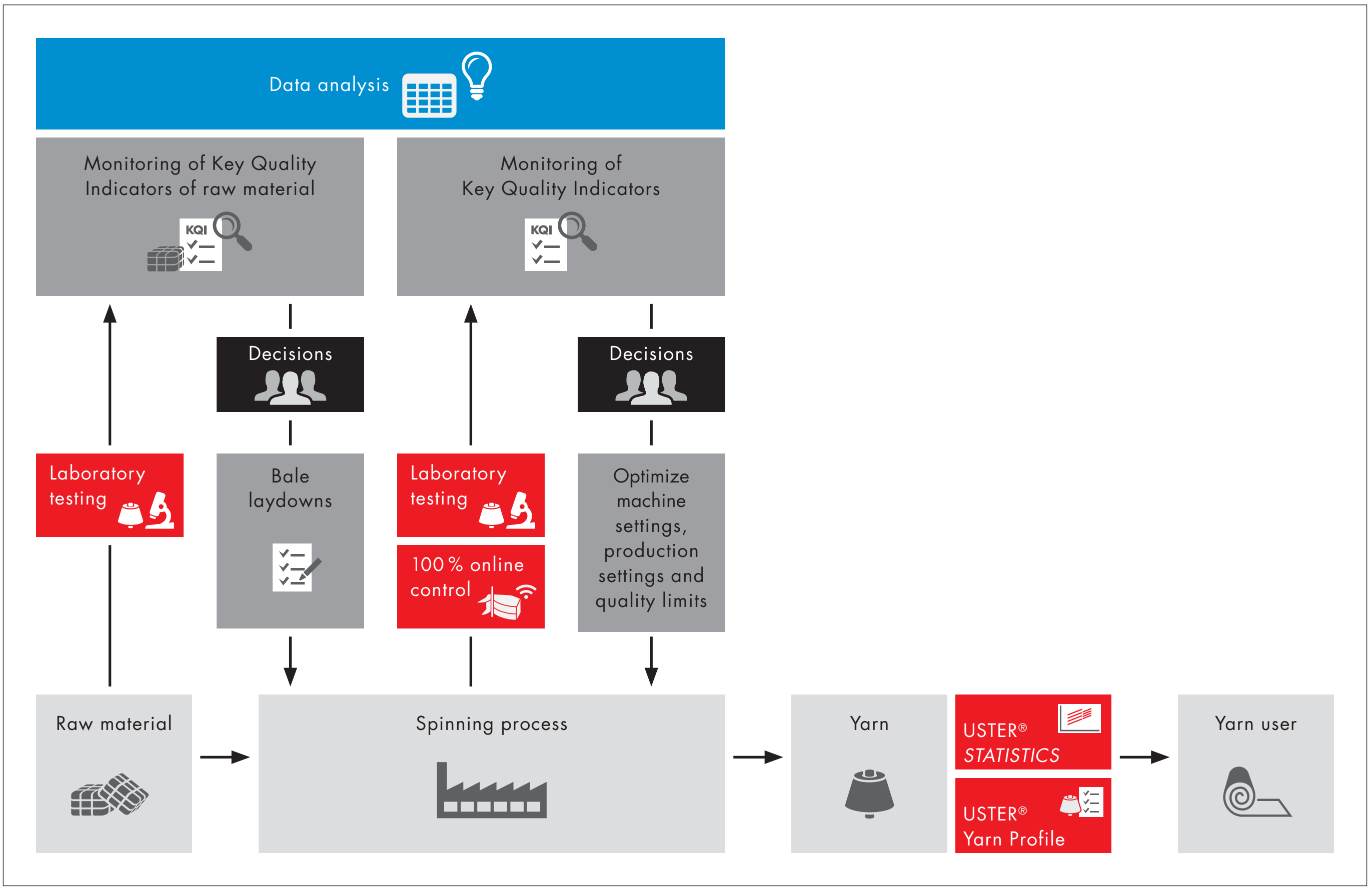


Fig. 5 Elements for quality management in the yarn production process

Quality management, like all processes, needs tools to facilitate the mill management team to achieve their objectives. Uster Technologies recommends the following five elements for successful quality management:

1. Quality-minded and well-trained staff
2. Reliable laboratory tests
3. Online quality control systems
4. Benchmarking and targeting quality with USTER® *STATISTICS*
5. Analysis and interpretation of data and results

When quality-minded staff uses these elements together as a system, it opens the way to sustainable quality management. In the past 20 years, laboratory results, online quality control and data analysis have developed rapidly and taken on a key role in the modern management systems of spinning mills. With these tools, mill managers can make decisions based on accurate and reliable figures – instead of depending on guesswork. The combined use of the five key elements in the yarn production process is shown in **Fig. 5**.

3.1 Quality-minded staff

Working with quality-minded people is an extremely important factor, at the heart of all quality management approaches.

The right spirit is important

Without the right spirit in the mill, any quality management will fail. Experience has shown that one of the most valuable sources of information in the spinning mill is machine operators. If a mill is able to transform 'operators' into 'quality guards' the performance and quality in a mill will reach unprecedented levels. The key to success is to make the staff aware that everyone delivers to product quality; their work is part of the overall quality picture. The main point is to motivate operators so that they feel responsible for 'their working area' and operate it to achieve the best quality.

Train people to involve them
Proper and continuous training of people is one of the most effective ways to involve them. A good practice is to train people not only how to operate the machines, but also how to control them, what to notice, how to report the findings, what is the impact of mistakes and how to fix them. Often there are training plans especially for new employees, but no continuation of the training subsequently. Refresher trainings are necessary to maintain awareness of quality and ensure people are constantly involved. Key Quality Indicators are helpful for such trainings.

Key personnel
A simple approach that many spinning mills follow is to define key processes for their operations, select the most capable staff, develop their know-how, train them and do not change them. Such processes are typically found in blowroom/carding and the winding department. Operators in those departments are key personnel; they can create or avoid problems which are hard to manage afterwards. It is worth having well-trained key personnel and paying a salary based on quality performance. Key Quality Indicators help to identify clear goals for key personnel.

Performance reward programs
Performance reward programs are another method that many spinning mills use as an incentive for operators. However, experience shows that many such programs chiefly reward productivity and not overall performance, since it is difficult to cover quality aspects as well. Spinning mills which have managed to balance and establish programs to include quality metrics as well as productivity have the benefit of the right production at the right quality. These metrics are the Key Quality Indicators.

3.2 Reliable laboratory testing

As textile testing instruments are used for yarn agreements, it is very important that they work as accurately and reliably as possible.

Accuracy and reliability is important
The more accurate and reliable testing instruments are, the more mills can rely on measured values and corresponding yarn quality. A very narrow variation in test results indicates clearly that the measurement results are reproducible.

As an example, the result of a round test from an independent institution is shown in **Fig. 6**. It points out that the CV_m

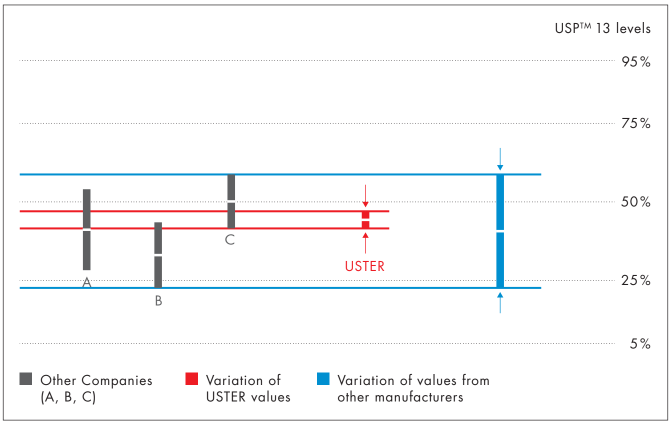


Fig. 6 Measurement variation of different instrument manufacturers

measurements of the USTER® *TESTER 5* have an outstandingly low variation compared to instruments of other manufacturers (Companies A, B, C) – a clear indication that values from USTER® instruments can be trusted.

Invest in trustworthy instruments
Investing in the most accurate laboratory equipment allows a spinning mill to influence the reliability of its testing values. 'Good enough results' do not help to find ways how to optimize settings and costs in a mill, in a sustainable way. The more accurate the laboratory instruments, the more reliable the testing results. For fine-tuning of spinning machine settings, it is important to have the most precise values possible.

For example, Chapter 4.2 gives recommendations for 'Best practice for quality management in cotton sourcing'. It points out that even seemingly small average value differences in micronaire might cause barré effects in fabrics. This shows clearly the relevance of measurement accuracy in achieving good yarn quality results.

Influences on measurement variation
Several factors influence the accuracy of the instrument and the measurement variations (see **Fig. 7**):
- The accuracy of the parts and the assembly line
- The sensor precision and signal evaluation system
- The calibration of the instrument at the manufacturer's site
- The traceability of the quality characteristics to a master gauge, with regard to previous instrument generations

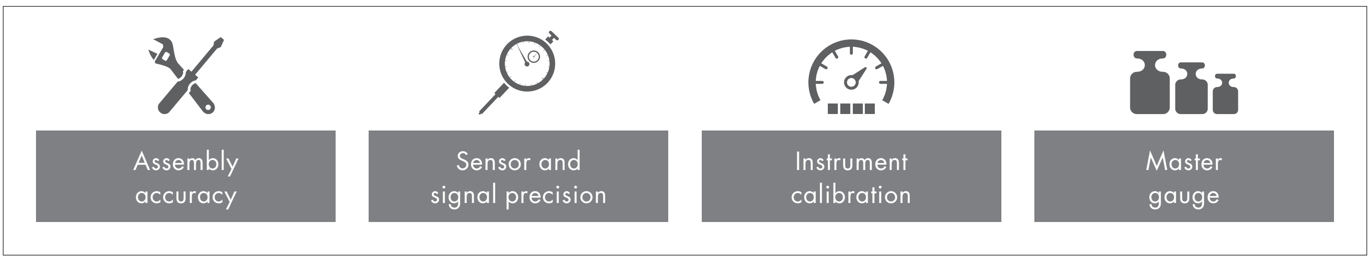
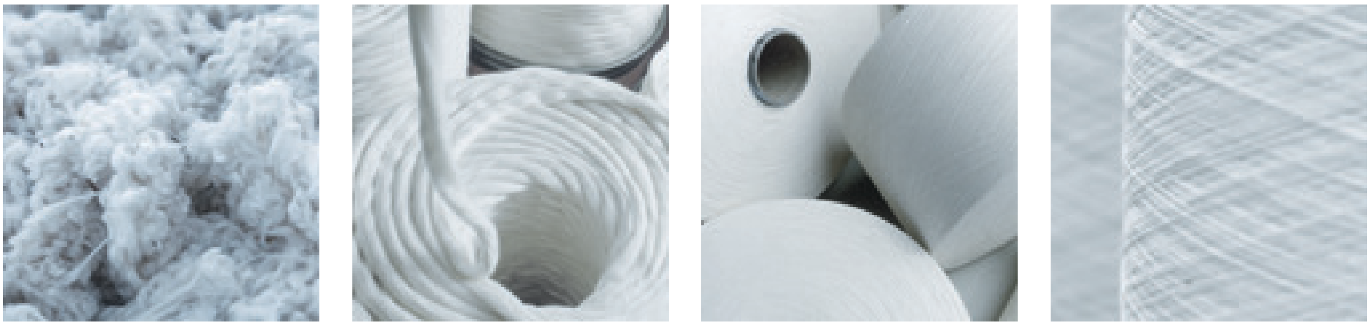


Fig. 7 Influences on measurement variation



Contamination control in blowroom	Sliver control in carding and drawing	Yarn control and contamination control in rotor and air-jet spinning	Yarn control and contamination control in winding
– USTER® *JOSSI VISION SHIELD*	– USTER® *SLIVERGUARD PRO* – USTER® *SLIVER EXPERT SYSTEM*	– USTER® *QUANTUM 2* clearer – USTER® *QUANTUM EXPERT SYSTEM*	– USTER® *QUANTUM 3* clearer – USTER® *QUANTUM EXPERT SYSTEM*
Controls and ejects	Controls and corrects	Controls and cuts out	Controls and cuts out
– Colored contamination – White and transparent plastics – Organic foreign matter – Hair	– Sliver count deviation – Evenness – Spectrogram – Thick places	– Evenness – Yarn faults – Imperfections – Hairiness – CLASSIMAT® faults – Foreign matter – Polypropylene	– YARN BODY™ – Evenness – Yarn faults – Imperfections – Hairiness – CLASSIMAT® faults – Foreign matter – Polypropylene

Fig. 8 USTER® online control systems

Swiss accuracy inside

USTER® instruments are renowned for their use of leading sensor technology with highest accuracy and reliable calibration functions. Each and every development of instruments at Uster Technologies is driven towards constant improvement of instrument accuracy and measurement reliability. Over many years, measurement reliability – based on Swiss accuracy – is an outstanding core advantage of all USTER® testing instruments.

The accuracy of USTER® instruments (assembly, sensor functionality, signal evaluation and calibration) is assured by testing in a controlled laboratory environment. Since measuring instruments have to provide the same quality values over a long period of time, and from instrument generation to instrument generation, the manufacture of each can be traced to a master gauge.

In keeping with its long history, Uster Technologies has the necessary experience in managing variations. Every instrument delivered is calibrated and tested with narrow limits. Each sensor developed and manufactured by USTER has narrow tolerances, so that the evaluation of the measurement signal is done in a systematic and reproducible way. These details are the secret behind the outstanding measurement reliability of USTER® instruments.

3.3 Online quality control systems

A long-held ambition of all spinners and their quality managers is the production of yarns with 'zero defects' or 'minimum deviations'. In fact, in the past 20 years the industry has made remarkable steps in this direction.

Zero defects – no longer a dream

Today, it is possible to monitor and control online a number of key processes in spinning – such as contamination control in the blowroom, sliver quality control and yarn control in spinning and winding (see **Fig. 8**). Online quality control systems constantly measure and evaluate the quality and stop the process whenever deviations and exceptions occur. This means the exceptions are isolated and the final production is 100% free of them. In addition, the exceptions are further analyzed in the laboratory to trace the source of the faults and thus, enable the mill to remedy the problems at source. Uster Technologies offers online control systems for several production steps in the spinning mill.

Contamination control in the blowroom

After the acquisition of Jossi Systems AG, Uster Technologies can now additionally offer a system for fiber cleaning. Efficient fiber contamination control starts in the blowroom. The USTER® *JOSSI VISION SHIELD* scans all fiber tufts, detects all kinds of foreign matter and ejects them, with the help of patented air nozzle technology. The USTER® *JOSSI VISION SHIELD* combines multiple detection principles and is able to eliminate all kinds of synthetic material, including white and transparent polypropylene. The whole production is thus checked before the foreign matter is broken down into numerous small particles at the card. The system uses high-end spectroscopes and different light sources to detect the foreign material. The reduced amount of foreign matter results in a productivity increase in the spinning and winding process.

Sliver control in carding and drawing

In the carding and drawing department, especially at the finisher drawframes, 100 % control of sliver quality is a must. The sliver count is one of the most important parameters which has to remain within certain tight limits. Without sliver control it is impossible to control the yarn count and its variation, which is one of the most important parameters of yarn quality.

USTER® *SLIVERGUARD PRO* is the latest-generation autolevelling system for cards and drawframes. It is a unique quality monitoring tool, measuring sliver quality online. It controls and regulates count deviations, sliver spectrogram and thick places.

Yarn control in rotor spinning, air-jet spinning and winding

Thanks to capacitive, optical and foreign matter sensors, the USTER® yarn clearers (USTER® *QUANTUM 2* and USTER® *QUANTUM 3*) are able to recognize and record the smallest faults and slightest deviations in a yarn. This online control covers 100 % of the production and cuts out disturbing faults. Off-quality yarns cannot pass this 100 % control and only material within accepted quality limits will reach the customers. The USTER® *QUANTUM 2* clearers are used in rotor spinning and air-jet spinning, while the USTER® *QUANTUM 3* clearers are for winding machines.

Expert systems support online control

With the help of expert systems, data from online control systems is collected in an external computer. The reports provided lead directly to practical conclusions and to optimizations, ultimately making the particular process step more productive and profitable. Expert systems from Uster Technologies are available for sliver control and yarn clearer control.

3.4 Combination of laboratory testing and online quality control

Typically, mills set up their quality specifications based either on customer orders or their own experience. In this regard, USTER® *STATISTICS* Percentile values (USP™) are often a key tool. Once the specifications are clear, the spinning mill has to set up bale laydowns and fine-tune machinery settings to deliver yarns within the defined quality limits.

Testing under defined conditions

Laboratory testing is performed in a climate-controlled room, under defined conditions, with an optimal testing speed. It delivers precise and reproducible values, which are mandatory to ensure correct bale laydowns or the best machine settings. After the yarn packages are produced, they need to be tested and certified for yarn quality. This also requires standard test conditions and a controlled testing environment – and therefore must be done with laboratory instruments.

Watch out for exceptions

As soon as production starts, it is essential to ensure that the machines are delivering quality that is within the defined specifications. Exceptions can occur at any time, for a variety of reasons (e.g. a damaged part). When there is a problem, production must be stopped immediately and the operators alerted. Here, time really does mean money, since a fast reaction reduces the amount of off-quality yarn produced. This is the main role of online instruments: since they are mounted on production machines, they can monitor quality for 100 % of the production.

Correlating values support fast reaction

In order for this quality approach to work properly, online and off-line instruments ideally need to use a common language, with the same quality parameters and quality levels. Because the values from USTER® online and off-line control systems correlate with each other, the mill can analyze the data and processes and react much more quickly with corrective actions (see **Fig. 9**).

In conclusion, both online and off-line quality control are an absolute necessity. Without laboratory testing, there would be major quality risks from badly set-up raw material mixes, or inaccurate machine settings – with the potential for disputes between trade partners.

Without online control instruments, there is a risk of massive off-quality production, resulting in damaging claims. Both scenarios are unacceptable in today's market environment of high pressures on price, quality as well as production speeds.

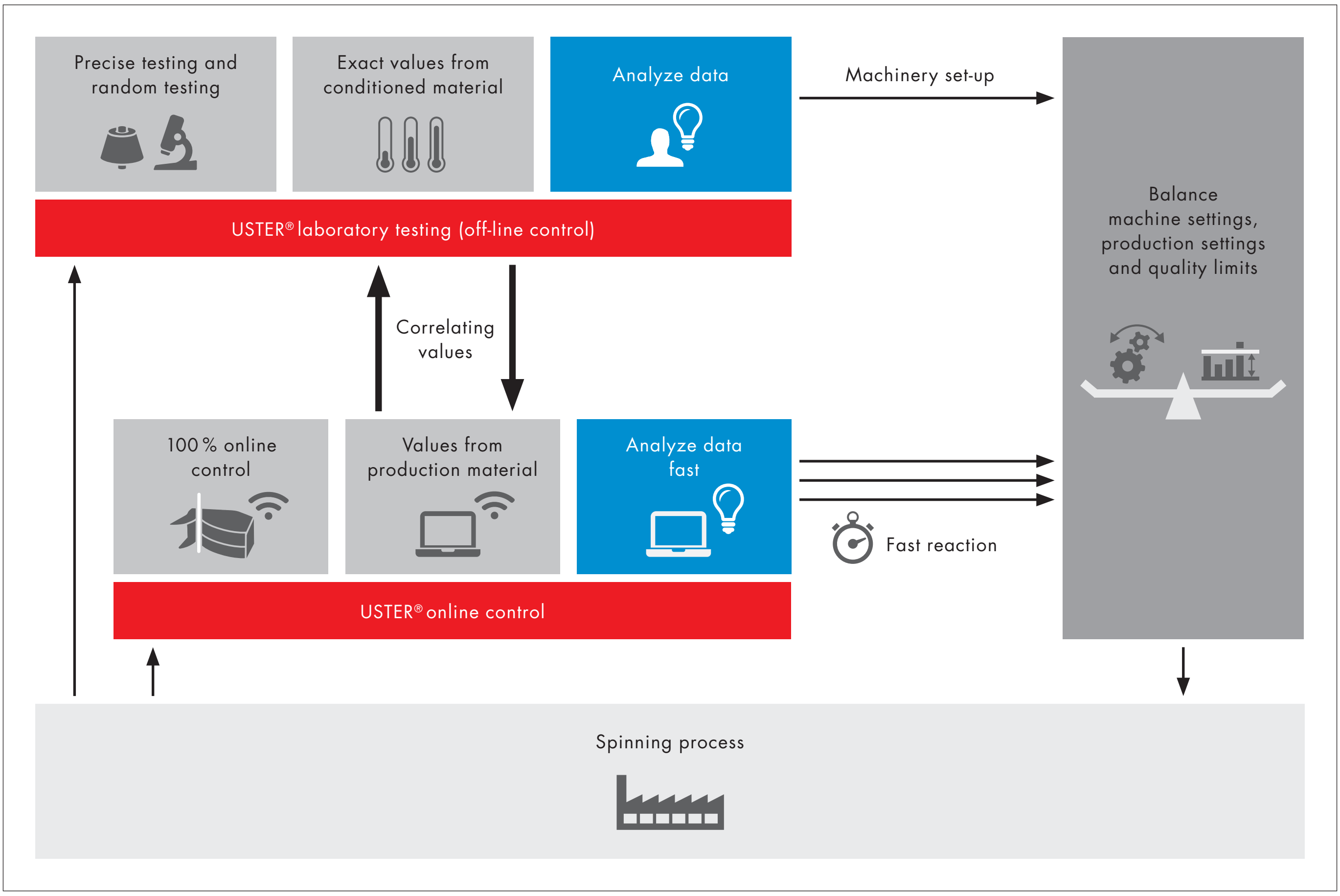


Fig. 9 Role of USTER® online control and USTER® laboratory testing (off-line control)

3.5 USTER® *STATISTICS* – standards for the industry

The textile industry has benefited from USTER® *STATISTICS* since 1957. These globally established yarn quality reference values serve yarn producers, traders, yarn users and machine manufacturers. They can compare their measured results with practical benchmarks collated via results from textile mills worldwide. Thus, USTER® *STATISTICS* are used to guide spinning mills towards operational excellence, improving the quality of the spinning process and the products being made.

Increased number of users

Uster Technologies has noted that the number of spinning mills using USTER® *STATISTICS* as an internal quality benchmarking tool has increased over the years. We grant complimentary access to USTER® *STATISTICS 2013* to our customers. It is available as an interactive online version. USTER® *STATISTICS* on CD, with similar content, can be ordered easily via internet as well.

Scanning the QR codes in **Fig. 10** with a smartphone app will automatically link to these internet sites.

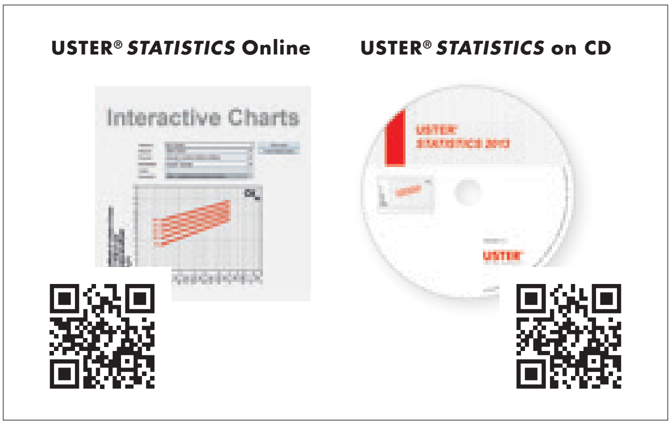


Fig. 10 The latest USTER® *STATISTICS* published in 2013 – scan the respective QR code for the online version or to order the CD

Spinners can set targets with USTER® *STATISTICS*

USTER® *STATISTICS* help spinning mills to define Key Quality Indicators for their spinning process and measure them objectively with the help of USTER® instruments. Spinning mills can compare their values to those of other mills with the help of USTER® *STATISTICS* and set targets for the quality they want to achieve.

Benefits for yarn producers

Yarn quality generally has improved significantly in the past 60 years, because of the use of better quality control tools and systems – helped by the availability of appropriate testing methods, accepted benchmarks and reliable improvement practices. USTER® *STATISTICS* have been a vital element in this development because they can also be used to guide the spinning mill to achieve operational excellence.

Another benefit for the spinning mill is an improvement 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*.

3.6 Data analysis

With the development of testing instruments and online control systems over the past 20 years, spinning mills now face a new situation: the problem is not the availability of data to measure and control quality – but the enormous amount of data which is being provided. The expression 'Big Data' is used to describe the trend for the uncountable mass of data available and needing a systematic analysis. Traditionally, the assessment of quality data – the 'what it means to me' – was in the hands of experienced technologists and textile engineers. With the expansion and shift of the industry around the globe, knowledgeable experts have become scarcer and therefore support systems are needed to analyze the quality data provided. Additionally, the amount of data provided today is immense, with new data coming in constantly to make data assessment extremely challenging.

Combine data sources for success

One key to processing the vast amount of quality data successfully is to combine various sources, using both off-line and online data. The second step is to interpret it in such a way that leads to conclusions and actions to improve the actual quality and performance of the spinning mill.

Many successful spinning mills understood early the need to rely on data. They adapted their organizations accordingly and based their decisions on gathered data. In such organizations, specific people are assigned to check, analyze and control data combinations.

Focus on key parameters for analysis

Another tactic, implemented by several spinning mills, is to recognize key parameters for each process step. They focus only on the key parameters and check the results in laboratory testing and online control. In other words, these mills train people to filter data and to distinguish between more relevant and less relevant information.

Of course, all these tactics require effort, know-how and patience. There might be the situation that the knowledge built up in the spinning mill exists only in the heads of a few key people and has not been recorded systematically. Today, the high rate of personnel movement makes the risk of knowledge loss for the spinning mill quite high.

4 Best practices for quality management in the mill

The following best practice recommendations are structured according to the steps of the spinning process and show the most important Key Performance Indicators and Key Quality Indicators. The focus is on the cotton spinning process and the production of ring-spun yarn, since this combination allows to describe and share as much of the best practices as possible.

4.1 Best practice in mill management

Uster Technologies believes that the trend to follow is 'mill management with quality in mind' because it is hard to distinguish between quality management and mill management. We share with this USTER® *NEWS BULLETIN* a compendium of best practices to follow.

Important key indicators at a glance

An overview at **Fig. 11** shows the best practices for the whole spinning mill with the most important Key Performance Indicators and Key Quality Indicators. Every mill is different and special. Uster Technologies has tried to consolidate the common denominators influencing mill performance. The list might not be complete and not all points apply to all spinning mills, but it certainly reflects the most important indicators for most spinning mills.

The list consists of a mixture of indicators, for productivity as well as quality.

At the end of the day, almost all indicators refer to quality. For example, the total cost of the laydown or the amount of stops of the machinery or the setting of the production rate of the machines, these all are not only production or cost indicators. Since they influence the quality level and its consistency, Uster Technologies defines them as being also among the quality indicators.

Key Performance Indicators and Key Quality Indicators in spinning mills

Productivity
- Efficiency per production step (for each department)
- Efficiency comparison per shift
- Machine availability
- End breaks per 1 000 spindle-hours at ring spinning machines
- Yarn joints per 100 km at winder
- Clearer cuts per shift
- Amount of rewinding per week
- Throughput time from bale to yarn

Production yield
- Grams of yarn per spindle (per day, shift, month or year)
- Kg of yarn (per day, shift, month or year)
- Waste in % per process step
- General fiber yield in % (ratio of input to output) based on kg of fiber material to kg of yarn
- Tonnage of yarn produced (per month or per year)
- Amount of 2nd quality (in kg or in % of total production)
- Moisture amount of final yarn

Maintenance
- Total maintenance time per month
- Maintenance hours per kg of yarn produced per year
- Main reasons for maintenance
- Average time of stops in the spinning preparation per week
- Reasons for efficiency losses
- Cost for maintenance (personnel and maintenance material)

Operators
- Kg of yarn per operator
- Operators per 1 000 spindles
- Cost for operators

Warehouse and stock
- Duration of raw material on stock (buffer) in weeks
- Cost of raw material stock
- Cost of yarn stored in the warehouse

Pricing and cost
- Average production cost
  - Raw material cost
  - Waste cost
  - Energy cost
  - Labor cost
  - Auxiliary material cost
  - Interest rates
  - Depreciation
- Sales price and margins
- Cost-price balance per article

Energy and cost
- kWh per kg of yarn
- Total energy consumption per year
- Energy cost

Analysis
- Reasons for efficiency losses
- Reasons for quality deviations
- Optimizing potential for productivity, quality and cost saving
- Ratio of solved or remaining issues
- Trend of productivity
- Trend of quality
- Trend of waste amount

Testing
- Off-line testing in laboratory to control and balance machine settings, production settings and quality
- Recording and monitoring of quality parameters e.g. evenness, imperfections, strength, elongation, hairiness, count, count CV, twist etc.
- Remaining outliers
- Online testing in the mill for 100 % control and fast reaction (USTER® *JOSSI VISION SHIELD*, USTER® *SLIVERGUARD*, USTER® *QUANTUM*)
- Splicer strength compared to yarn strength
- Detection of contamination in blowroom and yarn clearing
- USTER® *STATISTICS* level per quality parameter and article
- Number of laboratory tests per process step
- Utilization of laboratory instruments

Claims
- Amount of customer claims
- Weight of returned yarns in kg
- Speed of handling of complaints
- Cost for customer claims

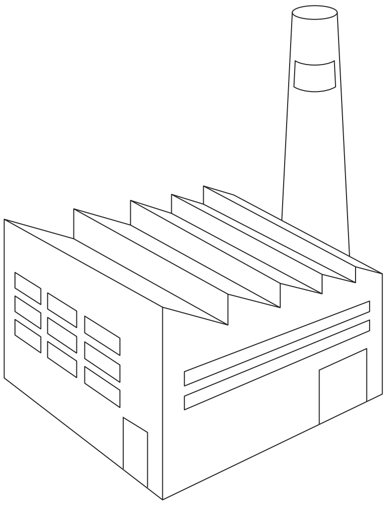


Fig. 11 Key Performance Indicators and Key Quality Indicators in spinning mills

4.2 Best practices for quality management in cotton sourcing and mixing

Raw material management is very important for the success of a spinning mill, because it absorbs most of the cash resources of the spinning mill. In most countries, cotton raw material accounts for more than 60 % of total yarn production costs, regardless of the origin of the cotton.

Raw material management pays off

This forces spinning mills all over the world to consider the same optimization challenges: how to buy the right cotton, how to process it without losing too much fiber and how to exploit the spinning limits of the available cotton.

Raw material management is quite demanding, because cotton fibers have an inherent natural variation in quality. The focus of the following chapter is on important Key Quality Indicators for sourcing cotton fibers.

It is important to implement a system which ensures that the spinning mill gets exactly the fibers it has ordered and paid for – and nothing less. **Fig. 12** contains a list of important Key Quality Indicators related to raw material management, which includes cotton sourcing.

The letters marked in red refer to the process steps or machines and are indicated in the drawing, if possible. The grey marked figures refer to the quality tests, and show, which testing routines are necessary to control the feature or setting. With the suggested routine tests, a clear overview is given regarding which tests are necessary after a change of raw material or article change, or maintenance. For high production machinery, older machines and high quality level, a higher test frequency is recommended. The recommended test plans are also depending upon the size of the mill and the operating scheme of the laboratory. These recommendations can be used as a guideline and each mill has to adapt the testing intensity to its needs and quality goals.

To highlight the importance of some Key Quality Indicators, further information and explanations are given below.

The influence of ginning

The quality variation of cotton within bales and lots is influenced to a great extent by the quality management of the ginning mill. With the widespread introduction of USTER® *HVI* cotton classification systems, a quality improvement in delivered material can be recognized, because the ginner is not only aware on output tonnage, but also about the higher cotton quality and the higher price they can achieve for it.

There are a few very important aspects of cotton ginning which affect cotton quality and are only under the control of the ginners. To optimize the value chain, it is an advantage for the spinning mill to know – and if it is possible to visit – the ginning mill they source the cotton from.

This allows them to communicate their requirements to the ginning mill, in case the cotton does not meet the spinner's requirements. This way spinning mills and gins around the world are able to build up partnership relations.

Bale uniformity is essential

How can a ginning mill guarantee that all 150 or 220 kg of cotton fibers inside a cotton bale are of similar quality? The degree of quality uniformity in the bale depends a lot on the practices that the ginning mill follows before and during ginning.

Some ginning mills have developed smart, systematic ways to tackle this problem. They group the seed cotton before ginning: according to quality parameters such as seed variety, micronaire, moisture, length, etc. This simple, but time-consuming classification allows the ginner to process seed cotton lots with the least possible quality variation and thus to produce bales of uniform quality. At the same time, with this classification technique, the ginner is able to adapt the best ginning set-up to process the different seed cotton qualities by altering for example the drying of the seed cotton, the production rate, the number of the lint-cleaner passages and the final moisture in the bale.

Quality data per bale

Consistent, long-term yarn quality and cost performance is the goal of spinning and the expectation of the yarn users. It starts:

– by testing the fiber quality with the USTER® *HVI* instrument
– classifying the cotton into respective quality groups
– and implementing a bale laydown according to the rules in **Fig. 13**, which are based on USTER experience.

Depending upon the availability of the USTER® *HVI*, the quantity of bales tested in a mill can vary from 100 % to 20 %. Many spinning mills test only a small amount of bales from each lot, say 20 %, and then assign the quality characteristics of the measured samples to the whole lot. This is an easy practice and very 'practical' but not always correct.

A few leading spinning mills take an extra step. They check the variation of quality within the samples tested from the lot:

– If this variation is within certain limits, they assign the average quality from the samples to the whole lot.
– If the variation exceeds the limits, they increase the number of tests from the lot to cross-check how homogenous the cotton quality is.
– If the variation is great, they split the lot into two or more quality groups.

This is an excellent practice to follow.

Quality management of raw material

Key Quality Indicators and checkpoints

A Gin

- Cotton variety
- Growth area
- Ginning method
- Know ginning mills and their practices

B Raw material sourcing

- Contract with detailed quality specification
- Training of cotton buyers in the mill
- Cost per supplier
- Cost per lot

C Bale storage

- Proper storage conditions
- Warehouse inventory system (First in- First out/First in-Last out/ Last-in-First out or others)
- Cotton stock duration
- Warehouse storage cost

D Bale quality and size

- Moisture content of cotton
- Bale dimensions
- Bale packing material
- Bale weight

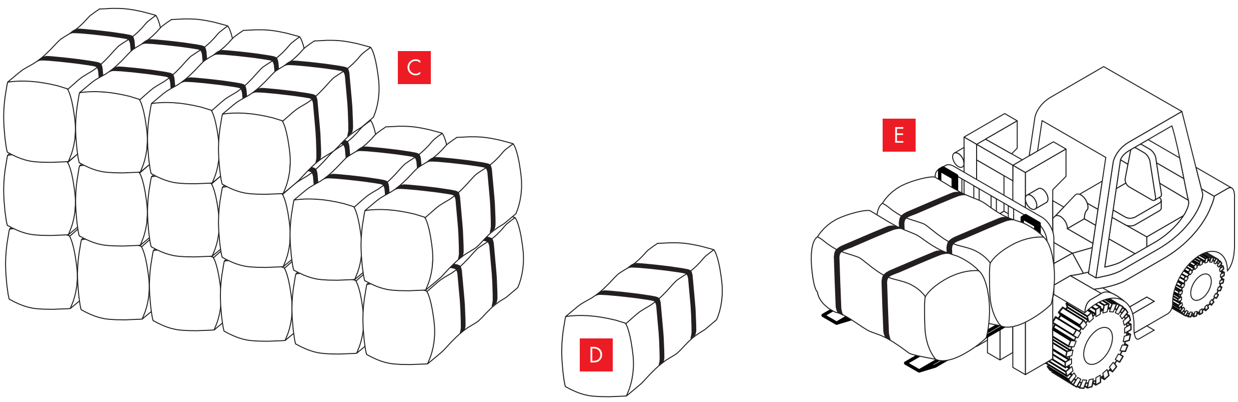
E Handling

- Bale laydown according to quality rules (mixing recommendations)
- Transportation of bales
- Ambient conditions

F Fiber quality

- Measuring fiber quality with USTER® *HVI 1000* and USTER® *AFIS PRO 2* 1 2 3 4 5 6 7 8 9 10
- Bale classification according to quality in the mill

Grey figures = Test parameters to control the Key Quality Indicators, see table 'Important quality tests' below



Important quality tests for fibers in the bales

Test parameters	Instruments	Test frequency*
1 Fiber fineness (micronaire)	USTER® *HVI 1000*	100 % – 20 % of all bales used per lot is the recommended quantity for testing.
2 Neps	USTER® *AFIS PRO 2*	
3 Maturity	USTER® *HVI 1000*	
4 Fiber length (upper half mean length)	USTER® *HVI 1000*	
5 Short fiber index	USTER® *HVI 1000*	
6 Strength	USTER® *HVI 1000*	
7 Elongation	USTER® *HVI 1000*	
8 Color (reflectance, yellowness, grade)	USTER® *HVI 1000*	
9 Trash (count, area, grade, amount)	USTER® *HVI 1000*	
10 UV reflectance	USTER® *HVI 1000*	

* The test frequency is influenced by the quality requirements of the mill and the variation within lots. Uster Technologies recommends to test at least 20% of the bales per lot.

Fig. 12 Quality management of raw material

Cotton classing on the rise

Today, with the adoption of cotton fiber classing programs in many countries, a large proportion of cotton bales produced are provided with USTER® *HVI* quality data for the spinner to use. Some countries do not yet follow this practice, but the level of classed cotton is steadily increasing.

Contracts with fiber quality parameters

Traditionally, only micronaire, strength, staple length, color and trash is fixed in cotton trading contracts. Both associations, the International Textile Machinery Federation (ITMF) and the International Cotton Association (ICA), recommend that cotton trading contracts should include all possible cotton quality values, as well as the measurement system to be used.

With USTER® *HVI* today, 14 different parameters can be measured for automatic cotton quality classification. Contracts which include all USTER® *HVI* quality data allow fewer possibilities for mistakes or misunderstandings.

Including all or most of the fiber quality parameters into a contract is not only for commercial reasons. These quality parameters help the mill to arrange the laydown optimally.

To estimate the fiber yield, mills can use parameters such as short fiber content, length uniformity and trash content. With low short fiber content, fewer fibers are wasted and the costs of the spinning mill are reduced. This really matters with today’s raw material prices.

For example, neps are one of the most important parameters for cotton fiber quality, and are also used to judge ginning, carding and combing quality and even fabric. The amount of neps influences the quality of the final yarn. The nep level in the bale is an important starting point to understand how the blowroom and subsequent processes have to be set to remove neps and ensure that the level is reduced and stabilized throughout the remaining processes.

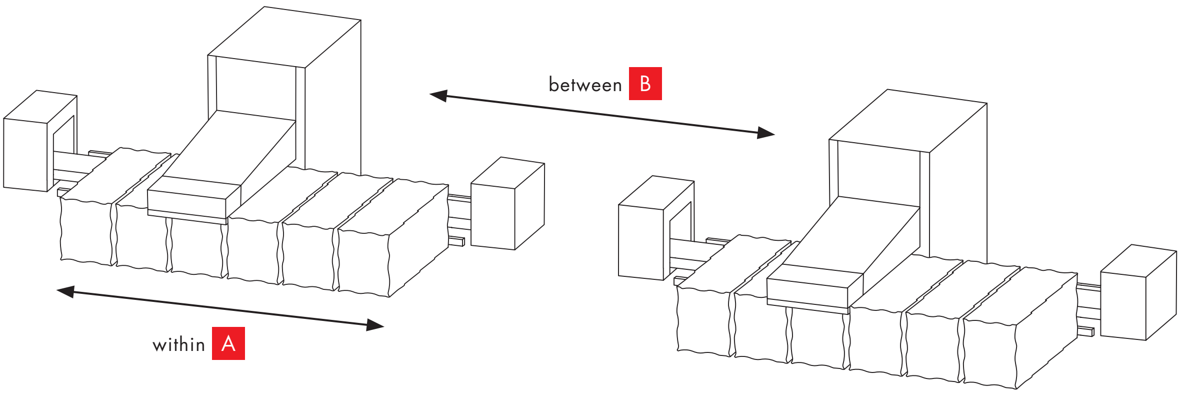
Another example is the trash content which influences the cleaning intensity in the blowroom and processing in the whole spinning mill and is therefore an important quality value.

Another important example is the color grading and UV reflection which can influence the subsequent dyeability of the yarns and fabrics.

Quality recommendations for laydowns at the bale opener

Mixing recommendations

Recommendations based on USTER® *HVI 1000* test parameters	Effect in spinning mill if values are not kept	Effect in fabric if values are not kept
For fiber fineness (micronaire) – Average micronaire between B bale laydowns ≤ 0.1 – CV % Variation of micronaire within A bale laydown ≤ 8 %–10 % – Do not place groups of bales with the same micronaire value side by side	→ Variation in comber noil extraction → Variation of the number of fibers per cross section → Mass variation of the yarn → Nep formation → Yarn tenacity variation	→ Barré (stripes) in fabric → Uneven look of the fabric → End breaks during knitting or weaving
For fiber length (UHML in mm) and fiber length uniformity (UI in %) – Average fiber length between B laydowns ≤ 0.5 mm – Variation of length within A laydown max. 2 mm – Average fiber length uniformity between B laydowns ≤ 0.5 %, max. 1 %	→ Difficulties in defining the draft zone settings → Variation of comber noil level → Yarn strength level with high variations → End breaks during spinning	→ End breaks during knitting or weaving → Uneven look of fabric
For fiber color reflectance (Rd in %) – CV % Variation of reflectance between B and within A laydowns ≤ 5 %	→ Yarn lots with different yellowness and dyestuff absorption	→ Barré (stripes) in fabric → Variation in dyestuff absorption
For fiber color (yellowness +b) – Average of yellowness +b between B laydowns ≤ 0.2 – CV % Variation of yellowness +b within A laydowns ≤ 8 %	→ Yarn lots with different yellowness and dyestuff absorption	→ Barré (stripes) in fabric → Variation in dyestuff absorption
For impurities – Lowest possible trash content – Bigger trash particles are easier to extract – Variation of trash in the laydown as low as possible – Remove trashy bales	→ High waste level in the blowroom → Sliver with high or uneven trash content → High comber noil → High number of clearer cuts (vegetable contamination)	→ Bleaching needed to remove vegetable contamination



A Recommendations valid within laydown

These rules are valid in the same laydown.

B Recommendations valid between laydown

These rules are valid from laydown to laydown, used after each other.

Fig. 13 Quality recommendations for laydowns at the bale opener

4.3 Best practice for quality management in the blowroom

The journey of the fiber through the spinning process starts in the blowroom and ends in the yarn. How the fiber is treated in the blowroom has an enormous influence on the final yarn quality. If fibers are damaged in the blowroom, it is impossible, or very costly, to remedy it. In a carded spinning process, mills do not have the chance to remove damaged fiber after carding, which negatively impacts manufacturing cost and quality. In a combed spinning process, which is more critical, the damaged fibers are combed out during the combing process as waste, which also negatively impacts on manufacturing cost even more, while influencing the quality.

In **Fig. 14** all important Key Quality Indicators and important quality tests for the blowroom can be found. Some points deserve further comment to highlight their importance.

Mixing recommendations for laydowns

A precondition for consistent, long-term yarn quality is an optimal mixing of fibers at bale opening. In the optimal laydown of cotton bales, the most important factor is to keep the variation of fiber quality as low as possible and as constant as possible in the long term. The following recommendations are based on quality experience over the years. It is important to be aware that some recommendations are for parameters within the same bale laydown, whereas other recommendations are given for parameters between laydowns, e.g. laydowns from one day to the next.

The fiber fineness (micronaire) is perhaps the most important parameter to be kept within given limits. It influences the spinability of cotton fibers as well as the quality of the resulting yarn. The target is to use bales within a constant, and as low as possible, micronaire range and have a low micronaire variation between the laydowns. The shift of micronaire values between laydowns is often the reason for numerous and expensive claims, such as barré in fabrics or yarn tenacity variation. Spinners who are aware of the key role of this parameter for a correct laydown will avoid the risk of costly claims.

Beside fiber fineness, other quality parameters are important and have to be considered for the bale laydown. The recommendations for five different parameters are listed in **Fig. 13**, as well as the effects occurring in the spinning mill or in the fabric, in case the limits are not kept between and within laydowns. Not all five parameters are equally important: depending on the final textile product they may have to be adapted to the required level of the individual spinning mill.

Relation between trash, neps and short fiber content

It is crucially important to manage the trio of trash reduction, short fiber content increase and nep increase in the blowroom. Cotton is principally opened into tufts in the blowroom and passes through different opening and cleaning stages, for the removal of impurities. The nature of this cleaning process is not as gentle to the fibers as it ideally would be, so the reduction of impurities is accompanied by an increase of neps and short fiber content.

Many spinning mills pay highest attention to this fact and adapt their testing routines to measure the performance of their blowroom with USTER® *AFIS* regularly, and after maintenance of blowroom machinery, or after a cotton recipe change in the laydown (see **Fig. 14**, important quality tests). The reason for these tests is to check that no fiber damage occurs and the machinery is fine-tuned to produce the appropriate amount of waste with the optimum opening and cleaning effect.

When the short fiber content through fiber damage is increasing or the nep level rises to an unacceptable limit, there are two ways to handle it:
- by adapting card production speed and card settings to treat the fibers more gently
- or by combing out the broken fibers in the later combing process.

Both methods are not economical and cannot make up fully the damage done to the fibers. Mills are wise to invest in testing and optimizing the blowroom performance instead of dealing with problems later in the spinning process.

Reducing neps is one of the three most frequent challenges for spinning mills – according to USTER's experience. Instead of trying to reduce the neps in spinning, it is an advantage to avoid creating them at the start of the process.

Cleaning

The following advice is quite simple, but very effective and important. In 'the old days' the mill management considered cleanliness as very important in every area of the operation.
1. Use clean material and clean out contamination
2. Have a clean surrounding in the whole mill
3. Keep the processing machines clean

Why is cleanliness, especially in the blowroom, one of the most critical and important parameters for the performance of the spinning mill? The reason is simple, best shown with an example, as follows. It needs 1000 kg of cotton fibers per hour to feed 25 000 spindles in a modern ring spinning mill, producing an average count of Ne 20. The 1000 kg of fibers are prepared for the process in a relatively small place – the blowroom. Any contamination entering the blowroom is then spread to all spindles.

Quality management in the blowroom

Key Quality Indicators and checkpoints

A Bale opening
- Conditioning of bales
- Cleanliness
- Number of bales in laydown
- Rules for recycling material
- Stop-go ratio (fiber supply management)

B Blending and mixing
- Fiber quality of input and output 1 2 3 4 5
- Blending and mixing consistency
- Stop-go ratio (fiber supply management)

C Cleaning and dedusting
- Fiber quality of input and output 2 3 4 5
- Dust and trash extraction 6
- Waste amount 7
- Lint, short fibers and trash amount and spinable fiber in waste

D Fiber transport
- Transport ducts 2
- Dust removal to air filters 6
- Metal detection 8
- Spark detection 9

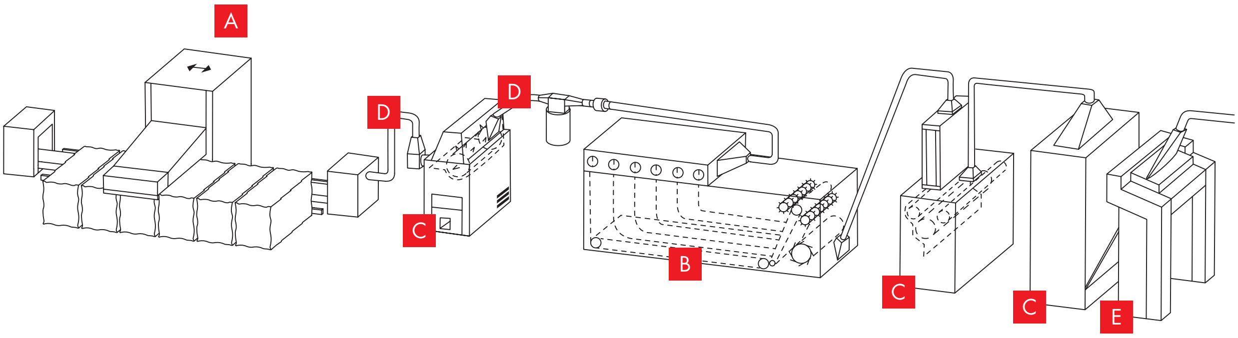
E Contamination control
- Ejected contamination 7 10 11
- Clean environment

F Fiber treatment
- Neps, short fiber content and trash balance through the opening and cleaning stages in the blowroom 2 5 6

G Production
- Production rate in kg (throughput)
- Number of operators
- Ambient conditions

H Maintenance
- Maintenance plan
- Condition of opening and cleaning components of machines
- Condition of transport ducts and fans

Grey figures = Test parameters to control the Key Quality Indicators, see table 'Important quality tests' below



Important quality tests as routine test* & after recipe change & maintenance

Test parameters	Instruments	Test frequency I*	Test frequency II*
1 Fiber fineness	USTER® *AFIS PRO 2*	every 2nd week	monthly
2 Neps	USTER® *AFIS PRO 2*	every 2nd week	monthly
3 Seed coat neps	USTER® *AFIS PRO 2*	every 2nd week	monthly
4 Fiber length	USTER® *AFIS PRO 2*	every 2nd week	monthly
5 Short fiber content	USTER® *AFIS PRO 2*	every 2nd week	monthly
6 Trash and dust content	USTER® *AFIS PRO 2*	every 2nd week	monthly
7 Waste amount	Balance	every 2nd week	monthly
8 Metal ejections	USTER® *JOSSI METAL SHIELD*	online	
9 Spark ejections	USTER® *JOSSI SPARK SHIELD*	online	
10 Foreign fibers	USTER® *JOSSI VISION SHIELD*	online	
11 Synthetic fibers (PP)	USTER® *JOSSI MAGIC EYE*	online	

* The test frequency is influenced by production speed, machinery age and the quality level to be achieved.
For high production machinery, older machines and high quality level, Uster Technologies recommends test frequency I.

Fig. 14 Quality management in the blowroom

It is important to ensure blowroom operators understand this context. Often, for instance, it might be common practice for cleaning to use compressed air to blow trash away in this area, instead of vacuum devices, which are a much better option as they not only clean trash away but also prevent contamination.

Contamination control with USTER® *JOSSI VISION SHIELD*

To meet rising quality demands, spinners have to eliminate contamination from cotton. Early-stage cleaning in the blowroom is an advantage, before the foreign matter is broken into small particles by the carding process. The USTER® *JOSSI VISION SHIELD* is therefore installed directly after the fine-cleaner in the blowroom.

Some foreign materials are not visible in raw fabrics, but they do not absorb color in the dyeing process and thus stand out as extremely disturbing in finished fabrics. White and transparent synthetic fibers and optically brightened material can cause these defects. They are often not easily detected by human eye or standard cameras. Impurities with a very low contrast to the color of the cotton also cannot be easily detected. But the combination of special spectroscopes with different light sources allows the USTER® *JOSSI VISION SHIELD* to detect these low-contrast impurities. Optically brightened material is exposed with additional UV light to allow better detection.

With the USTER® *JOSSI MAGIC EYE*, the detection of white and transparent plastics is further improved. An additional powerful light source, called Corona Spot, ensures that all plastic contaminants (such as polypropylene and polyester from bale packaging) can be identified and removed.

With every ejection of contaminants, some good fiber material is also lost. The USTER® *JOSSI VISION SHIELD* minimizes this by the use of sophisticated air jet nozzles that are carefully directed to take out the contaminants. The ejection is steered according to the size of the contamination to ensure a minimum loss of good fibers.

Total Contamination Control

The combination of the USTER® *JOSSI VISION SHIELD* and the USTER® *QUANTUM 3* yarn clearers offers the highest level of foreign matter detection. The spinning mill can direct the elimination of foreign matter in two separate production areas, to achieve the required quality at highest productivity rates. This concept is called 'Total Contamination Control'. A clear economic advantage of controlling contamination in the blowroom is that less foreign matter reaches the spinning and winding processes. It means that a yarn with the lowest possible contamination level is produced and can run at high productivity rates in winding.

4.4 Best practice for quality management in carding

Experts often state that 'the card is the heart of the spinning mill', so a gentle fiber treatment in carding leads to good quality results. **Fig. 15** shows the important Key Quality Indicators and the important quality tests for carding.

Neps and short fiber content in carding

Maintaining the fiber length during carding is important for good quality results. By comparing the USTER® *AFIS* results from input fibers (from the card mat of the chute feed) and output fibers (card sliver), the mill can easily judge how gently the card treats the fibers. Implementing a weekly routine test and controlling neps and short fiber content with the AFIS® fiber process control system has helped many mills to improve their carding quality.

As a rule of thumb, the amount of short fibers in the carded sliver (2) should never exceed the short fiber content of the material in the chute feed (1), as shown in **Fig. 16**. If this happens, it is an indication that the carding is very aggressive and most probably the distance between flats and cylinder is set too close or component speeds or speed ratios have to be changed.

Using this simple measurement to set the cards, in addition to the neps reduction anticipated, a straightforward quality improvement can be achieved. Experience has shown that this is underestimated by spinning mills. Some spinning mills have given priority to decreasing the amount of neps during carding, without taking account of the fact that fibers can be damaged and break, thus increasing the short fiber content.

If a spinning mill wants to decrease the nep level in carding, it should not be done by increasing the short fiber content at the same time. Those short fibers will need to be removed later during combing, increasing costs and reducing mill efficiency in general and if not, they will influence the yarn quality negatively. The best practice is to avoid neps increasing (e.g. above +100 %) in the blowroom, rather than trying to reduce them aggressively in carding. It is important to keep in mind that increasing the short fibers during spinning leads to many quality problems, such as higher unevenness, higher hairiness, lower tenacity, higher variation of tenacity and higher end breaks during spinning.

Quality management in carding

Key Quality Indicators and checkpoints

A Feed chute

- Neps, trash and short fiber content in chute 6 7 8 9 10 11
- Mix consistency in chute
- Constant feeding amount

B Licker-in

- Waste/trash amount 12
- Amount of short fibers and spinable fibers in waste
- Wire type and point density
- Exchange of licker-in

C Flats

- Grinding 6 7 8 11
- Waste at flats 12
- Cleanliness of flats
- Wire type and point density
- Exchange of flats
- Flat speed and distance setting 6 7 8 11

D Main cylinder/Doffer

- Grinding 6 7 8 11
- Type of clothing
- Wire point density
- Exchange of clothing
- Cylinder speed and distance setting 6 7 8 11
- Doffer speed and distance setting 6 7 8 11

E Sliver quality

- Neps, trash and short fiber content 6 7 8 9 10 11 to calculate removal efficiency from chute to sliver
- Other sliver quality parameters 1 2 3 4 5

F Cans/Workflow

- Spring load of can bottom
- Card/can marking with numbers or colors
- Card grouping according to nep level 6
- Clean surrounding

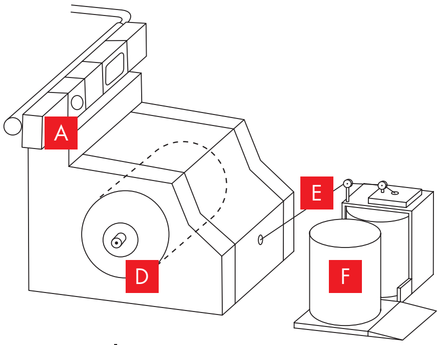
G Production

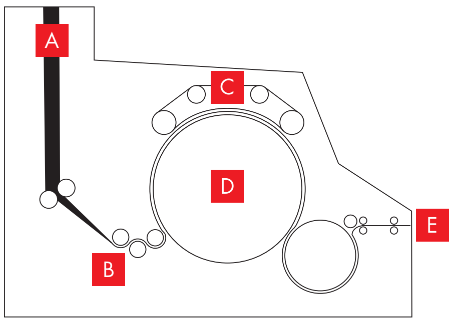
- Production rate 2 3 6 7 8 11 12
- Speed and efficiency
- Stop reasons and stop rates per kg produced
- No change of operators if possible
- Number of operators
- Ambient conditions

H Maintenance

- Maintenance plan
- Distance settings of flats, main cylinder, licker-in, doffing 6 7 8 11
- Settings in pre- and post-carding zone 6 7 8 11
- Suction efficiency for removal of waste

Grey figures = Test parameters to control the Key Quality Indicators, see table 'Important quality tests' below





Important quality tests as routine test* & after recipe change & maintenance & grinding

Test parameters	Instruments	Test frequency I*	Test frequency II*
1 Sliver count	USTER® *AUTOSORTER 5*	daily	weekly
2 Sliver evenness	USTER® *TESTER 5*	weekly**	monthly
3 Sliver mass diagram	USTER® *TESTER 5*	weekly**	monthly
4 Sliver spectrogram	USTER® *TESTER 5*	weekly**	monthly
5 Sliver thick places	USTER® *TESTER 5*	weekly**	monthly
6 Neps	USTER® *AFIS PRO 2*	weekly**	every 2nd week
7 Fiber length	USTER® *AFIS PRO 2*	weekly**	every 2nd week
8 Short fiber content	USTER® *AFIS PRO 2*	weekly**	every 2nd week
9 Immature fiber content	USTER® *AFIS PRO 2*	weekly**	every 2nd week
10 Maturity ratio	USTER® *AFIS PRO 2*	weekly**	every 2nd week
11 Trash content	USTER® *AFIS PRO 2*	weekly**	every 2nd week
12 Waste amount	Balance	weekly**	every 2nd week

* The test frequency is influenced by production speed, machinery age and the quality level to be achieved.
For high production machinery, older machines and high quality level, Uster Technologies recommends test frequency I.
** If 20 % of the cards are tested daily, all cards are tested within one week.

Fig. 15 Quality management in carding

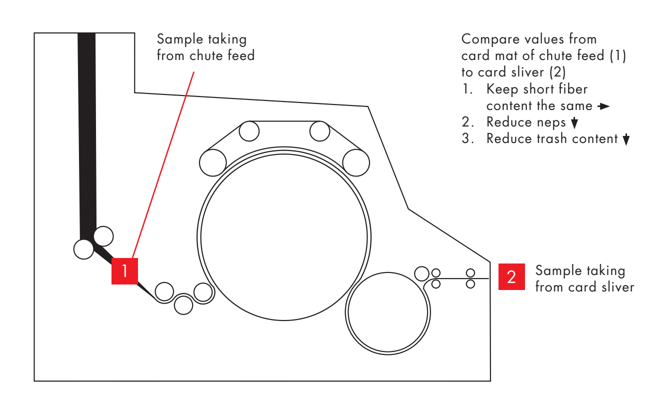


Fig. 16 USTER® *AFIS PRO 2* measurements in carding to control short fiber content and nep amount

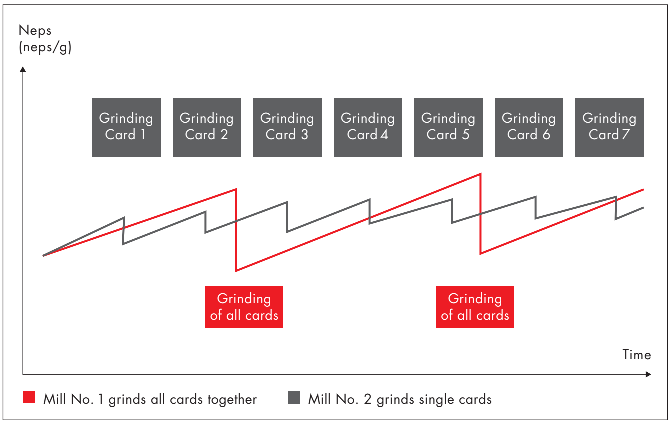


Fig. 17 Influence of different grinding schedules on long-term nep consistency

Card clothing

Of all card components, the clothing has the biggest influence on quality and productivity. That is why the maintenance of card clothing is extremely important. A key parameter in carding is the reduction of neps from the chute feed (1) compared to the card sliver (2), as shown in **Fig. 16**. Over time, this efficiency deteriorates because the teeth of the card clothing and card flats become less sharp. To maintain efficiency at the highest possible level, spinning mills monitor the nep levels of cards on a weekly basis. Based on these results, they decide to maintain the flats (primarily) and the cylinder wire by grinding them.

There are different approaches for a card maintenance schedule. For example, mill No. 1 in **Fig. 17** is doing maintenance on all cards at the same time. The advantage is that all cards have the same nep level, but grinding will greatly reduce instantly the overall nep level and lead to a marked and sudden change in yarn quality. It is important to manage these quality differences affecting the end product.

Mill No. 2 has chosen to have cards with different nep levels, in this case dividing its cards into three groups. The maintenance of all the cards in a group takes place once the nep levels of these cards overstep the predefined limits. For long-term quality consistency, the maintenance approach of mill No. 2 is better and leads also to a constant workload for the maintenance personnel in carding.

4.5 Best practice for quality management in combing

Combing is used to improve the evenness, strength and cleanliness of yarns and is a value-adding process step in cotton spinning. Due to the elimination of short fibers and impurities, combing is a very expensive process step. Additional machinery has to be used for the combing process: the material has to be prepared in the form of laps with a sliver lap machine. The Key Quality Indicators and important quality tests for combing preparation can be found in **Fig. 18**.

Combing preparation

The comber is fed by laps, which are formed in combing preparation from several – typically 24 – slivers. Among the most important parameters in combing preparation are

- the linear density of the laps or batt weight (ktex or g/m)
- the fineness of the fibers (micronaire) inside the lap
- how easy and gentle is the separation of the layers of the lap

The effectiveness of the combing process depends on the number of fibers at the combing zone and is directly related to the uniformity of cotton fineness. Depending on the comber model and staple length, the ideal amount of fibers for the lap is different and the linear density of the lap (ktex or g/m) has to be adapted accordingly.

Quality management in combing preparation

Key Quality Indicators and checkpoints

A Infeed sliver

- Check of infeed slivers 1 2
- Blending of cans
- Number of cans

B Lap formation

- Weight of lap
- Linear density of lap 3
- Separation of layers and lap hairiness
- Lap forming pressure and lap strength

C Lap quality

- Fiber fineness in lap
- Fiber length in lap 4 5
- Neps 6

D Handling

- Manual lap transport
- Semiautomated or fully automated lap transport

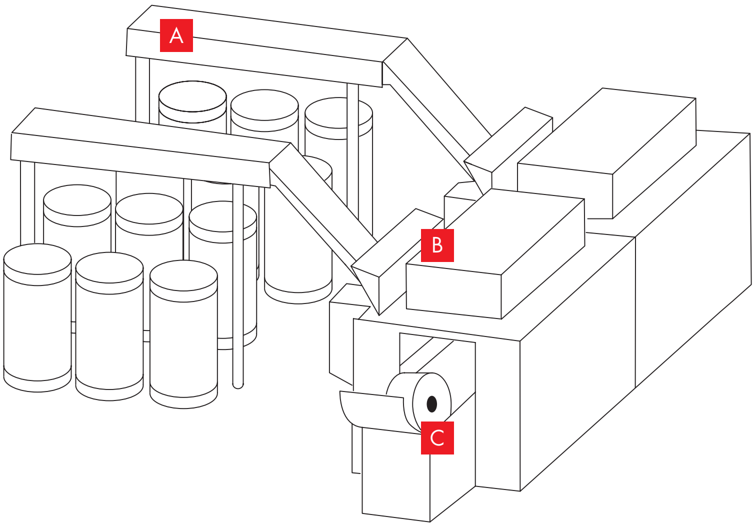
E Production

- Production rate
- Speed and efficiency
- Number of operators
- Ambient conditions

F Maintenance

- Maintenance plan
- Control of lap forming unit
- Sliver guiding elements

Grey figures = Test parameters to control the Key Quality Indicators, see table 'Important quality tests' below



Important quality tests
as routine test* & after cotton recipe change & maintenance

Test parameters	Instruments	Test frequency I*	Test frequency II*
1 Fiber fineness of infeed sliver	USTER® *AFIS PRO 2*	weekly	every 2nd week
2 Fiber length of infeed sliver	USTER® *AFIS PRO 2*	weekly	every 2nd week
3 Lap linear density – count	USTER® *AUTOSORTER 5*	weekly	every 2nd week
4 Fiber length of lap	USTER® *AFIS PRO 2*	weekly	every 2nd week
5 Short fiber content of lap	USTER® *AFIS PRO 2*	weekly	every 2nd week
6 Neps in lap	USTER® *AFIS PRO 2*	weekly	every 2nd week

* The test frequency is influenced by production speed, machinery age and the quality level to be achieved.
For high production machinery, older machines and high quality level, Uster Technologies recommends test frequency I.

Fig. 18 Quality management in combing preparation

Combing

For the combing process the important quality tests and Key Quality Indicators are listed in **Fig. 20**. The combing process is quite complex.

To achieve good results, a number of technological issues have to be controlled: lap feed distance, lap tension, combing direction, etc. The determination of the optimal comber noil level is the start point for all settings.

Comber noil level

Checking the comber noil level is an ongoing task in a spinning mill. As shown in **Fig. 20**, after a material/lot change (recipe change) a comber noil check is highly recommended, as well as routine testing. Checking the lap, the combed sliver and the comber noil should be a regular routine in the mill. The testing intensity has to be adapted to production speed, machinery age and the quality level to be achieved. By testing the amount and the quality of noil extraction regularly, the mill can make sure that short fibers are extracted without wasting good fibers and that trash and neps are combed out as well.

Combing with a noil percentage below 12 % is referred to as upgrading, since this type of combing enables cotton to be moved up one or two classes, with the additional advantage of elimination of short fibers. Normally-combed yarns have a noil percentage between 12 % and 18 %, highly-combed yarns 18 % to 22 %. Combing with a noil percentage above 22 % is rare and is generally used only where superfine yarns are to be spun, according to Werner Klein in The Manual of Textile Technology, Volume 3, 1987.

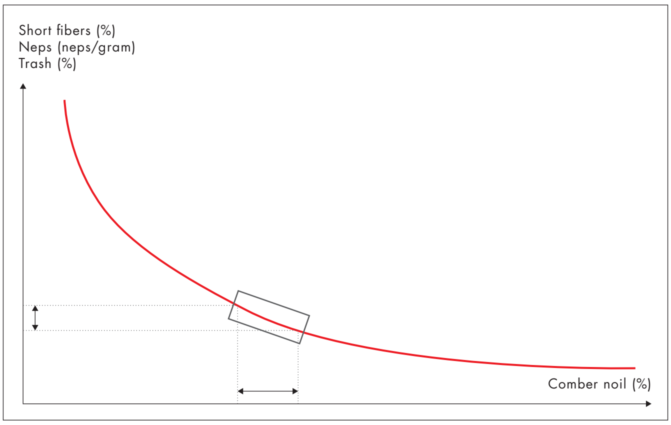


Fig. 19 Combing optimization in terms of cost and quality

Increasing the comber noil rate over a certain level does not necessarily improve yarn quality or ends-down rate, as the efficiency of the comber to remove neps, short fiber, and trash begins to level out, as demonstrated in **Fig. 19**. In some cases, the increase of noil leads to deterioration in quality. The optimum percentage of noil amount has to be determined in each mill for each different article – by controlling the final yarn quality and the performance in spinning.

There are many parameters influencing the comber noil level and its consistency. These include: machine type; machine generation; machine settings (detachment setting, feed length, feed system, top comb, waste removal system); settings between combers (all machines the same); lap weight (and fiber fineness); length uniformity and micronaire consistency between laydowns; consistency of material blending after carding; and the type and the condition of the combing elements (top comb, circular comb, brushes). For these reasons, it is necessary to ensure that comber noil levels are set to the optimum at all times.

Quality management in combing

Key Quality Indicators and checkpoints

A Top comb

- Settings 1 2 3 4 5 6 7
- Type and needle density
- Penetration depth of the top comb
- Cleanliness and condition

B Circular comb

- Settings 1 2 3 4 5 6 7 10 11
- Wire type and point density (number of sections, comb surface)
- Brushes

C Settings

- Detachment setting 1 2 3 4 5 6 7
- Grinding of detachment rollers 1 2 3 4 5 6 7
- Drafting settings 6 7 8 9
- Combing direction
- Setting for piecing

D Noil

- Amount of long and short fibers in sliver and noil 2 3 10 11
- Noil balance between top comb and circular comb
- Suction and removal of noil
- Noil variation between combers

E Cans

- Spring load of can bottom
- Can filling
- Marking of cans

F Laps

- Lap weight and density
- Lap tension
- Lap feeding distance 1 2 3 4 5 6 7
- Lap piecing

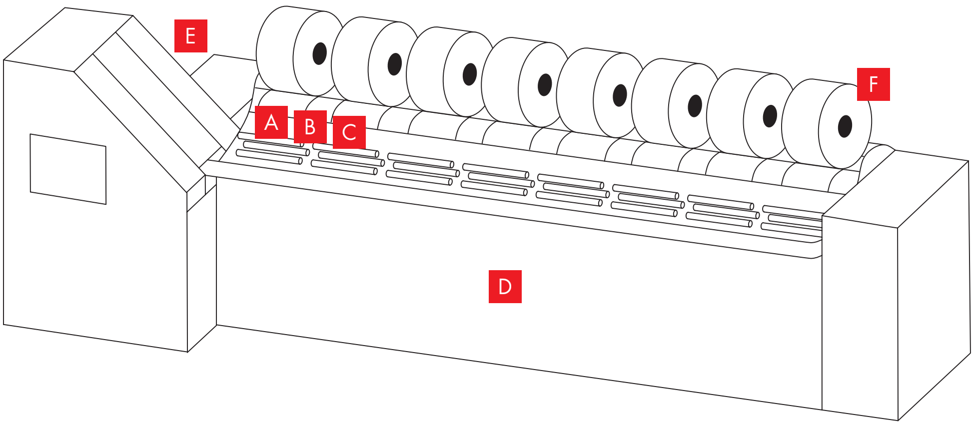
G Production

- Production rate
- Speed and efficiency 1 2 3 4 5 6 7
- Number of operators
- Ambient conditions

H Maintenance

- Maintenance plan
- Cleaning schedule
- Regular change of circular combs
- Grinding schedule of detachment and drafting rollers

Grey figures = Test parameters to control the Key Quality Indicators, see table 'Important quality tests' below



Important quality tests as routine test* & after recipe change & maintenance

Test parameters	Instruments	Test frequency I*	Test frequency II*
1 Comber noil amount	Balance	weekly	every 2nd week
2 Fiber length of sliver	USTER® *AFIS PRO 2*	weekly	every 2nd week
3 Short fiber content of sliver	USTER® *AFIS PRO 2*	weekly	every 2nd week
4 Neps in sliver	USTER® *AFIS PRO 2*	weekly	every 2nd week
5 Trash content in sliver	USTER® *AFIS PRO 2*	weekly	every 2nd week
6 Sliver count	USTER® *AUTOSORTER 5*	weekly	every 2nd week
7 Sliver evenness	USTER® *TESTER 5*	weekly	every 2nd week
8 Sliver mass diagram	USTER® *TESTER 5*	weekly	every 2nd week
9 Sliver spectrogram	USTER® *TESTER 5*	weekly	every 2nd week
10 Fiber length in comber noil	USTER® *AFIS PRO 2*	weekly	every 2nd week
11 Short fiber content in comber noil	USTER® *AFIS PRO 2*	weekly	every 2nd week

* The test frequency is influenced by production speed, machinery age and the quality level to be achieved.
For high production machinery, older machines and high quality level, Uster Technologies recommends test frequency I.

Fig. 20 Quality management in combing

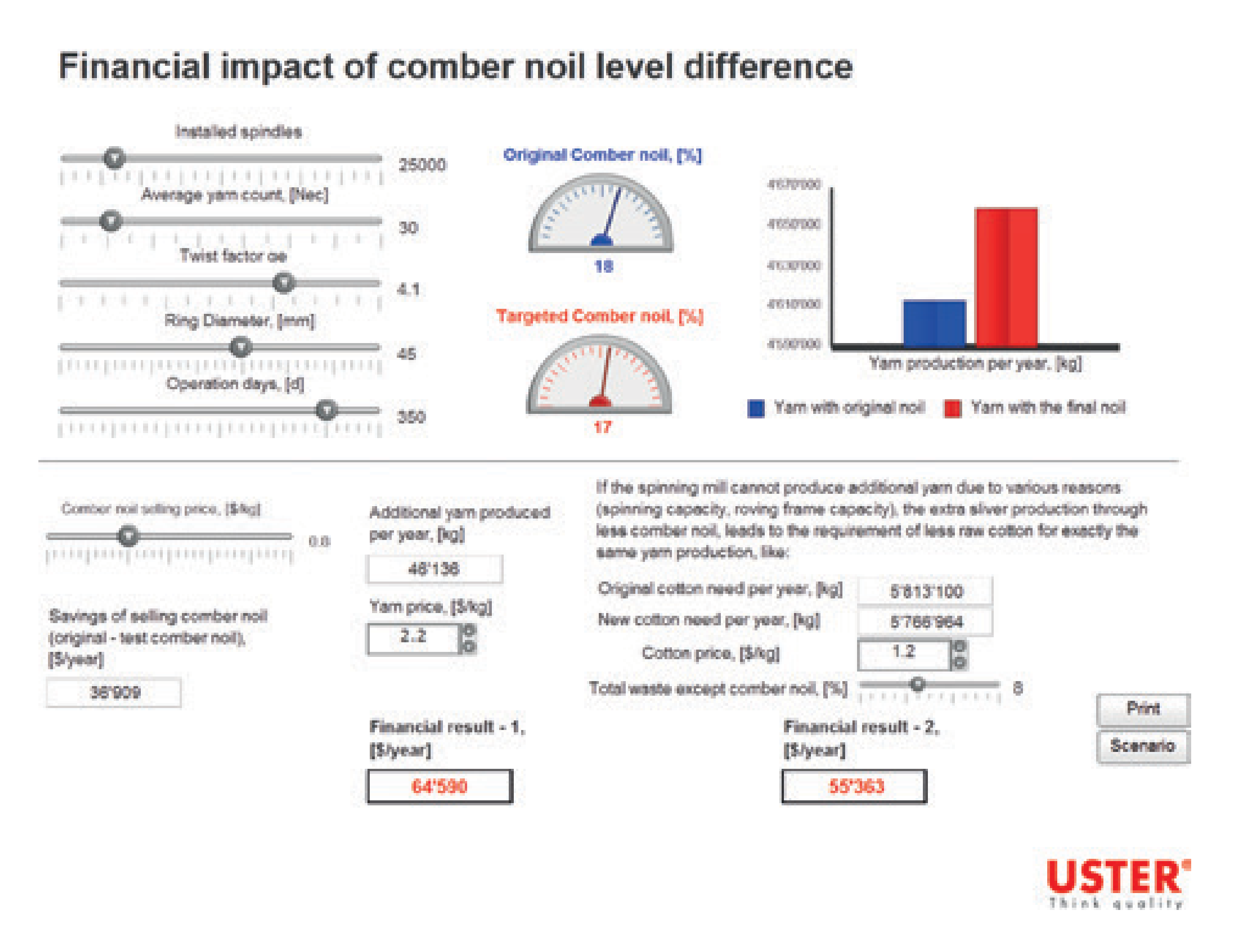


Fig. 21 Financial impact of comber noil level difference (comber noil reduction from 18 % to 17 %)

Cost savings in combing

By combing out fibers, waste is generated – which increases the manufacturing cost of combed yarns. So, when deciding on the optimal noil level, the cost factor also has to be considered. The financial impact of the comber noil level can be shown with an example calculation. **Fig. 21** shows the financial impact of saving 1 % comber noil per year in a spinning mill with 25 000 ring spindles. Per year, the mill can increase yarn production by 46 136 kg and yarn profit by 64 590 USD, provided that the mill has additional production capacity to utilize the saved fiber material.

If the mill in this example cannot produce more yarn, because of the restricted production capacity, the calculation is different. With the reduction of the comber noil from 18 % to 17 %, the same mill can produce the same amount of yarn and consume less cotton bales. The mill saves 46 136 kg cotton, which leads to cost savings of 55 363 USD per year.

Spinning mills are well aware of the impact of combing on quality and profitability and they generally implement strict testing routines to set the comber noil always at the optimum level, relying on USTER® *AFIS PRO 2* to test it.

4.6 Best practice for quality management in drawing

Drawing has a big influence on quality of the final yarn, because it is the last point in spinning to actually control and affect the quality. One of the main tasks of the drawframe is to improve the short-term and medium-term mass variation and linear density, with regard to evenness of slivers.

The last drawframe passage (finisher drawframe) should be equipped with an autolevelling function to equalize sliver unevenness. This 100 % control of the sliver is also a form of online control and is very important for processing security. Important Key Quality Indicators and important quality tests for drawing can be found in **Fig. 22**.

Quality management in drawing at finisher drawframe

Key Quality Indicators and checkpoints

A Input sliver
- Fiber length 8
- Short fiber content 9
- Fiber fineness 6
- Neps 7
- Blending of cans from combing or breaker drawframe
- Doubling

B Output slivers
- Count check and long-term count check 1
- CV_m, $CV_{m\,1m}$ mass diagram, spectrogram 2 3 4
- Thick places in sliver 5
- Short fiber content 9
- Neps 7
- Fiber cohesion in sliver

C Drafting settings
- Testing routine to evaluate predraft and maindraft 1 2 3 4 and distances of drafting rollers 6 7 8 9
- Pressure of rollers and pressure bar 9
- Roller quality/hardness
- Autoleveler performance 1 2 3 4 5

D Handling
- Piecing of slivers 5
- Marking of cans
- Release of cans after group check
- Transport rules for cans

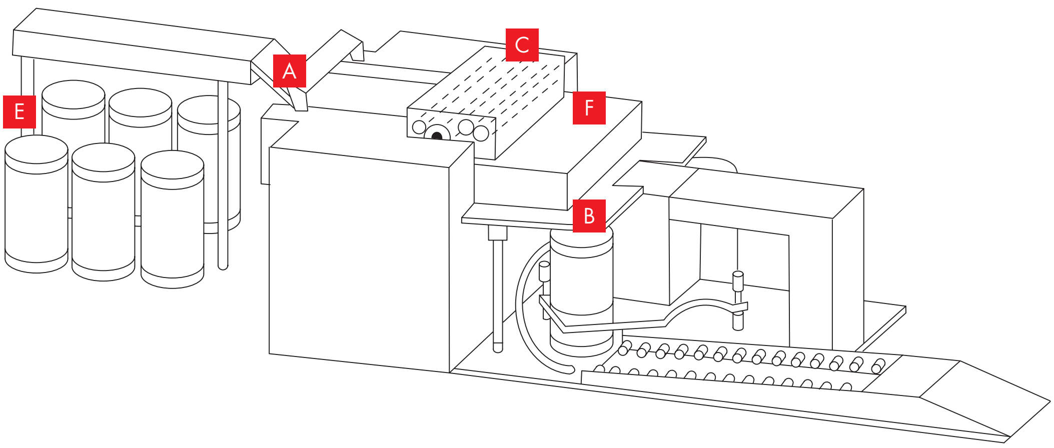
E Cans/Creel
- Draft in creel 1 2 3 4
- Guiding elements of creel
- Filling of cans
- Damaged cans
- Spring load of cans

F Coiling/Cleaning
- Coiler speed
- Sliver tension at coiler
- Suction of drafting zone
- Cleaning frequency
- Waste in filters 8 9 10
- Handling of waste

G Production
- Production rate
- Speed and efficiency
- Start-stop optimization 3
- Number of operators
- Ambient conditions

H Maintenance
- Maintenance plan
- Cleaning and grinding schedule of rollers
- Minimum diameter of rollers
- Sliver lapping on rollers

Grey figures = Test parameters to control the Key Quality Indicators, see table 'Important quality tests' below



Important quality tests
as routine test* & after recipe change & roller setting & roller grinding

Test parameters	Instruments	Test frequency I*	Test frequency II*
1 Sliver count	USTER® *AUTOSORTER 5*	every shift	every day
2 Sliver evenness	USTER® *TESTER 5*	daily	2 – 3 times/week
3 Sliver mass diagram	USTER® *TESTER 5*	daily	2 – 3 times/week
4 Sliver spectrogram	USTER® *TESTER 5*	daily	2 – 3 times/week
5 Sliver thick places	USTER® *TESTER 5*	daily	2 – 3 times/week
6 Fiber fineness	USTER® *AFIS PRO 2*	weekly	every 2nd week
7 Neps	USTER® *AFIS PRO 2*	weekly	every 2nd week
8 Fiber length	USTER® *AFIS PRO 2*	weekly	every 2nd week
9 Short fiber content	USTER® *AFIS PRO 2*	weekly	every 2nd week
10 Trash content	USTER® *AFIS PRO 2*	weekly	every 2nd week

* The test frequency is influenced by production speed, machinery age and the quality level to be achieved.
For high production machinery, older machines and high quality level, Uster Technologies recommends test frequency I.

Fig. 22 Quality management in drawing at finisher drawframe

Setting of the drafting zone

The drafting zone is the core of the drawframe and its setting has a decisive influence on quality. For correct setting of the drafting zone and the distances between the drafting rollers, it is important to know the fiber length distribution in the sliver. Guidelines for these settings differ according to the drawframe type and manufacturer.

The drafting roller settings should never lead to broken fibers. So the short fiber content of output sliver should not exceed the short fiber content of the incoming slivers.

The roller distances of the predrafting zone and of the main drafting zone are set according to the fiber length of the long fibers, measured by USTER® *AFIS*. For slivers with very fine fibers (fine micronaire), some spinning mills increase the break draft and enlarge the roller distances for the break draft to achieve better quality results.

After setting the drafting zones, a cross-check of the mass diagram and the mass spectrogram with USTER® *TESTER 5* is recommended, to be sure that the roller settings are correct and the draft ratios set properly.

Autolevelling drawframes

The performance of the autoleveller mechanism has a great influence on sliver quality. The task of the autoleveller is to control the variation of the sliver count and consequently the variation of the yarn count.

The autolevelling drawframe improves the efficiency of subsequent processes in the mill. The efficiency of roving frames and spinning machines is increased by reducing the ends-down rate. Subsequently, there are also fewer ends-down in weaving preparation, weaving or knitting.

The autolevelling systems work on short-length mass deviations, but also on medium-term mass deviations in the sliver, resulting in a reduced number of long thin places and long thick places in the yarn. Avoiding these long thin and thick places will result in a better, more even fabric appearance.

4.7 Best practice for quality management in roving

Roving bobbins, which are required by the ring spinning process, are very delicate and need careful handling to achieve consistent quality in ring spinning.

It is important to determine the correct twist level for rovings, because this influences the drafting behavior of the roving in ring spinning. If the twist is too low, it will lead to false drafts with long thin places. If the twist is too high, thin and thick places will occur, due to uneven and 'hard' draft. To set up the right twist level for rovings, some spinning mills use USTER® *TENSORAPID 4* measurements. The standard test method for fiber cohesion in sliver and top (static tests) is described by the test standard ASTM D 2612-99 (2011) and can be used in a similar way for rovings.

Fig. 23 shows the Key Quality Indicators and important quality tests for quality management in roving.

Quality management in roving

Key Quality Indicators and checkpoints

A Cans

– Correct can and sliver material
– No false draft from inner and outer can 1
– No crossed ends with correct can position

B Drafting

– Total draft, predraft and main draft
– Drafting distance check 4 5
– Material and quality of drafting rollers

C Settings

– Pressure on rollers 1 2 3 4 5
– Roving tension 1 2 3
– Roving twist

D Roving bobbin

– Control roving count from inner and outer rows 1
– Build-up of roving bobbin
– Diameter of roving bobbin
– Weight of roving bobbins
– Doffing handling
– Storage and transport of roving bobbins

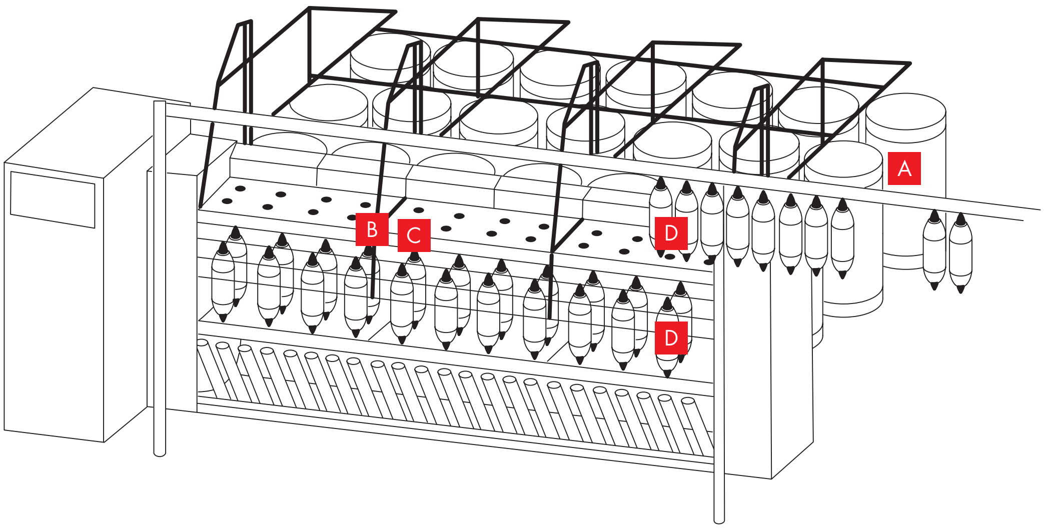
E Production

– Production rate
– Speed and efficiency
– Doffing efficiency
– Roving break level
– Number of operators
– Ambient conditions

F Maintenance

– Maintenance plan
– Suction tubes
– Grinding schedule of rollers
– Damage to sliver guiding parts 5 6
– Travelling cleaner setting

Grey figures = Test parameters to control the Key Quality Indicators, see table 'Important quality tests' below



Important quality tests as routine test* & after cotton recipe change & article change

Test parameters	Instruments	Test frequency I*	Test frequency II*
1 Roving count	USTER® *AUTOSORTER 5*	weekly	every 2nd week
2 Roving mass variation CV_m	USTER® *TESTER 5*	every 2nd month each position	every 4th month each position
3 Roving spectrogram	USTER® *TESTER 5*	every 2nd month each position	every 4th month each position
4 Fiber length in roving	USTER® *AFIS PRO 2*	every 2nd week	monthly
5 Short fiber content in roving	USTER® *AFIS PRO 2*	every 2nd week	monthly
6 Neps in roving	USTER® *AFIS PRO 2*	every 2nd week	monthly

* The test frequency is influenced by production speed, machinery age and the quality level to be achieved. For high production machinery, older machines and high quality level, Uster Technologies recommends test frequency I.

Fig. 23 Quality management in roving

4.8 Best practice for quality management in ring spinning

Ring spinning is the most expensive process step in the conventional ring yarn production process. In a typical mill, about 60 % of the conversion costs from fiber to yarn are attributable to ring spinning, taking into account labor, investments and energy costs. Ring spinning machines determine the productivity of the spinning mill and they are some of the bottlenecks in the performance of the whole mill. The important Key Performance Indicators and quality tests are listed in **Fig. 24**.

Production speed and end-break ratio

When producing a ring spun yarn, the mill has always to balance yarn quality versus running conditions. Some mills tend to work with the lowest-possible twist level, to increase production, but then yarn strength will be reduced.

It is not advisable to increase spinning speed without taking care of the maximum traveler speed in m/sec and the end-break ratio. When starting up the ring spinning machine after doffing, the target should be less than 10 end-breaks per 1 000 spindles for a standard yarn. During the running phase, a level of 10 – 25 end-breaks per 1 000 spindles/hour is a good and acceptable ratio.

If this value increases – for example to above 40 end-breaks per 1 000 spindles/hour – the total break duration also increases. Too long a break duration means the higher production speed will not produce the financial benefit to the anticipated extent. The break duration is also closely related to the number of machines per operator. Too many end-breaks will also affect winding performance, by adding cuts to replace the piecings.

Spinning elements

Using the right traveler and ring type, as well as the right materials and dimensions, has a major impact on yarn quality and productivity. This helps to achieve proper spindle speed levels, with good quality. Spinning room conditions, cotton quality and production parameters are all important considerations when selecting the correct traveler and ring types and sizes.

The aprons and surfaces of the top rollers need attention in two different directions – type selection and maintenance. The right material, the dimensions and hardness degree (shore value) of these elements will impact the running behavior. Regular maintenance, with an exchange and/or grinding schedule, will help to control and reduce quality deviations. The goal of each mill is to find the right combination and maintain the conditions in an efficient and reliable way.

Another important aspect for many spinning mills is the selection of the correct ring diameter. On one hand, it is always a target to achieve the highest possible spindle speed, which is facilitated by smaller ring diameters. But when processing coarser counts, this has the opposite effect: the number of splices in winding caused by more bobbin changes will at least partially negate the advantage of the higher spindle speeds, in addition to the yarn quality deterioration inherent in the extra splices.

Machine and spinning conditions

A key to quality in ring spinning is definitely the cleanliness of the spinning machine. The fact that the yarn is simply running is no guarantee of good quality. A high level of fluff accumulation, as well as fiber deposits in the region of the drafting zone, correlates to a high number of yarn faults. A blocked roving trumpet can cause count deviations without initiating a yarn break. In many cases, the operators are trained to concentrate on fixing the end-breaks and do not control what is happening in the creel or in the drafting zone.

Nowadays, high productivity in ring spinning can be only ensured if the climatic conditions are controlled in a proper way. The target is not only achieved by 20 – 40 air changes to reduce the fiber fly and fluff generation, it also depends on the suction channels below the machines and proper air conditioning.

In older buildings, this is often challenging and the air conditioning might not fulfill all requirements in the best way. For new installations, as well as extensions in new buildings, these requirements are easier to control and optimize from the beginning.

For air conditioning during spinning, an absolute water content in a range of 10 – 14 grams of water per kg of dry air is common for the ring spinning department, also depending on the fiber type to be used. A drier environment will help in processing sticky cotton, but will generate more fiber fly. In contrast, more humidity will increase the risk of lapping.

4.9 Best practice for quality management in winding

The winding process after ring spinning is the last chance to control the quality of the production, to ensure its homogeneity and consistency.

The yarn clearers on the winding machines allow 100 % control of the quality of the yarn, by cutting out the disturbing faults and by blocking the exception bobbins. All exceptions are tested on the USTER® *TESTER 5* to trace the root cause of the fault.

Quality management in ring spinning

Key Quality Indicators and checkpoints

A Roving

- Roving quality
- Natural wax of cotton
- Change of rovings without material waste
- Roving hanger movement
- Roving traverse
- Position of roving creel guide bar

B Drafting

- Total draft, break draft, main draft, drafting roller distance and settings 1 3 4 5 6
- Top roller quality (type, hardness) and diameter 1 3 4 5 6
- Pressure on rollers 1 3 4 5 6
- Type of clips resp. color 1 3 4 5 6
- Apron types (material, dimensions) and condition 1 3 4 5 6

C Ring and traveler

- Traveler speed 1 2 9 10 11 12
- Traveler type selection (weight, profile, material)
- Routine for traveler change 9 10
- Ring type (diameter, surface finish, profile)
- Ring eccentricity check 3 9 10
- Routine for ring replacement 9 10

D Spindle and tubes

- Slip spindles 2 3 7 8 9 10 11 12
- Centering and condition of thread guiding element 9 10
- Centering and condition of anti-balloon ring 9 10
- Condition of separators 9 10
- Vibrating spindles 3 9 10
- Bobbin diameter
- Spindle condition
- Tube condition
- Dimension, type and condition of spindle tape

E Energy and air

- Condition and type of suction pipes
- Underpressure level at suction pipe and compacting device (for compact yarns)
- Air suction in the spinning room
- Air changes

F Cleaning

- Cleaning schedule
- Cleaning of cleaner roller at draft zone
- Checking vacuum tube suction
- Setting and efficiency of traveler cleaner
- Suction of fiber fly from environment
- Cleaning of compacting device (for compact yarns)

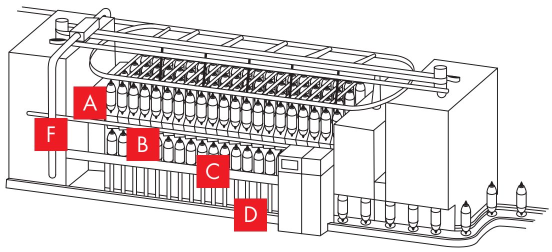
G Production

- Speed and efficiency
- Start-up end break level
- End break level 2 3 4 5 6 9 10 11 12
- Spindles with high end-breaks 2 3 4 5 6 9 10 11 12
- Number of operators
- Ambient conditions

H Maintenance

- Maintenance plan
- Amount of roller lappings
- Condition check of spinning elements
- Schedule for grinding top rollers
- Change schedule for apron and spindle type

Grey figures = Test parameters to control the Key Quality Indicators, see table 'Important quality tests' below



Important quality tests as routine test* & after article change & after maintenance

Test parameters	Instruments	Test frequency I*	Test frequency II*
1 Yarn count	USTER® *TESTER 5*/USTER® *AUTOSORTER 5*	2–3 times/week 8–10 bobbins	weekly 8–10 bobbins
2 Twist	USTER® *ZWEIGLE TWIST TESTER 5*	2–3 times/week 8–10 bobbins	weekly 8–10 bobbins
3 Evenness	USTER® *TESTER 5*	2–3 times/week 8–10 bobbins	weekly 8–10 bobbins
4 Thin places	USTER® *TESTER 5*	2–3 times/week 8–10 bobbins	weekly 8–10 bobbins
5 Thick places	USTER® *TESTER 5*	2–3 times/week 8–10 bobbins	weekly 8–10 bobbins
6 Neps	USTER® *TESTER 5*	2–3 times/week 8–10 bobbins	weekly 8–10 bobbins
7 Yarn diameter	USTER® *TESTER 5* OM Module	2–3 times/week 8–10 bobbins	weekly 8–10 bobbins
8 Yarn shape	USTER® *TESTER 5* OM Module	2–3 times/week 8–10 bobbins	weekly 8–10 bobbins
9 Hairiness	USTER® *TESTER 5* OH Module	2–3 times/week 8–10 bobbins	weekly 8–10 bobbins
10 Hairiness	USTER® *ZWEIGLE HL400*	2–3 times/week 8–10 bobbins	weekly 8–10 bobbins
11 Yarn strength	USTER® *TENSORAPID 4*/USTER® *TENSOJET 4*	weekly 8–10 bobbins	weekly 8–10 bobbins
12 Yarn elongation	USTER® *TENSORAPID 4*/USTER® *TENSOJET 4*	weekly 8–10 bobbins	weekly 8–10 bobbins

* The test frequency is influenced by production speed, machinery age and the quality level to be achieved.
For high production machinery, older machines and high quality level, Uster Technologies recommends test frequency I.
Some mills even carry out daily tests and increase the amount of bobbins to be tested.
Additionally some mills carry out studies on the number and causes of end-breaks as a quality check.

Fig. 24 Quality management in ring spinning

The role of laboratory testing in this stage is very important. The USTER® *TESTER 5* with the USTER® *TENSORAPID 4*/ USTER® *TENSOJET 4* and USTER® *CLASSIMAT 5* are responsible for the determination of the final quality of the yarn and ultimately for the prediction of the fabric appearance as well as its running performance.

In **Fig. 25**, the Key Quality Indicators for winding are listed, followed by the most important quality tests.

Smart clearing in winding

Continuous development in the area of sensor technologies is a main focus of Uster Technologies. Thanks to this, the USTER® yarn clearer and data systems of the latest generation are able to recognize and record the smallest faults and slightest deviations. But cutting out all faults would decrease the productivity of the winding machine.

To avoid this, the USTER® *QUANTUM 3* yarn clearer is equipped with an intelligent control, which has the ability to distinguish between disturbing and non-disturbing defects and cut out only what is necessary. Thanks to decentralized data processing at the clearer, the huge amount of quality data can be handled in very quickly, enabling the USTER® *QUANTUM 3* clearers to use all inbuilt smart rules at highest speeds. The USTER® *QUANTUM EXPERT 3* data system collates the quality data from each winding position and brings it into a condensed format for quick reading, analysis and fast reactions.

Amount of splices and splice quality

The functionality of the latest clearer generation has increased, which is why modern clearers detect many more defects than previously. This leads to a higher number of cuts – to eliminate foreign fibers or polypropylene, for instance – and hence generate more splices. Because of the increased number of splices, the quality of the splice is an important focus point. Additionally, the demands on splice strength are increased – especially for weaving – due to higher processing speeds and hence higher stresses on the yarns. Spinning mills today put all their efforts in making stronger and more even splices, to guarantee good running behavior of the yarns in downstream processing.

Another way to improve downstream processing is to avoid unnecessary cuts, to reduce the number of splices. With the development of the USTER® *QUANTUM 3* yarn clearer, three solutions have been introduced to reduce the need for splicing. With its higher processing capacity, the yarn clearer becomes more intelligent, better able to identify and sort disturbing defects to avoid unnecessary cuts.

One unique feature of USTER® *QUANTUM 3* is the distinction between vegetable matter and foreign fibers by the yarn clearer. Vegetable matter is treated with a bleaching process in finishing to eliminate it. The USTER® *QUANTUM 3* clearer function identifies these particles and their size, allowing a defined range of them to pass without being cut – thus avoiding many unnecessary cuts.

Another improvement is the very rapid transfer of yarn clearing settings to the splice channel settings. This allows control of the splice quality within very strict limits – and the splice quality is linked to the yarn quality. Bad splices – those which are too thick, too thin or have loose ends – are eliminated with the help of this function. This control of the splice quality is appreciated by weaving and knitting mills producing high-quality fabric where an even appearance is desired.

The third and biggest improvement is the smart and simple setting of the clearing limits. The challenge is not merely to design a clearing curve, as in the past, but to make sure that the clearing curve is correct and optimized to the yarn. For the USTER® *QUANTUM 3* yarn clearer, a Smart Clearing Technology™ for yarn clearer settings has been developed. By scanning a certain amount of yarn, the clearer identifies automatically the so-called YARN BODY™ for mass/ diameter defects and the Dense Area for contamination detected in the yarn. Thanks to the optical display of the YARN BODY™ and the Dense Area it is extremely easy to see which faults do not belong to the yarn. Thus clearing curves can be set easily in seconds, so that unnecessary cuts are reduced and winding efficiency and quality are improved.

Total Contamination Control in winding

Foreign matter in the fabric is one of the most disturbing defects and often only detected at the end of the value chain. The USTER® *QUANTUM 3* has powerful foreign matter sensors with multicolored light sources, which can detect all colored defects in the yarn. Even short and low-intensity foreign matter defects can be eliminated by the yarn clearer. An additional polypropylene sensor allows the detection of short and fine white polypropylene fibers in the yarn material.

The highest level of foreign matter detection is achieved by using a combination of the USTER® *JOSSI VISION SHIELD* and the USTER® *QUANTUM 3* yarn clearer. By steering the elimination of foreign matter in two production areas, in the blowroom and the winding department, mills have the chance to reach the required quality level with fewer cuts for foreign matter at the winding machines.

Another benefit of Total Contamination Control is that the clearing limits for contamination can be set very close at the yarn clearer. This allows the mill to produce a yarn with much lower contamination using the same raw material. Spinning mills using Total Contamination Control can satisfy highest quality demands and have the chance to increase their market success.

Quality management in winding

Key Quality Indicators and checkpoints

A Bobbins

- Amount of bobbins with rest material
- Amount of blocked bobbins
- Quality of spinning tubes
- Quality of bobbins build-up
- Remove all bobbins before article change to avoid mix up

B Splicing

- Type of splicer
- Splicing settings
- Splice size
- Splice strength tests 7
- Splice appearance

C Clearer settings

- Clearer limits determination 8 9 10
- Clearer efficiency control 8 9 10
- Control of number and category of cuts
- Control of foreign fiber cuts 9 10

D Settings

- Winding tension
- Wax selection and wax pick-up
- Anti-patterning setting
- Bobbin unwinding
- Winding speed 6

E Packages

- Packages without reserve
- Packages with winding defects
- Rewound packages
- Uniformity of package density
- Uniformity of length across packages of the same article
- Yarn quality 1 2 3 4 5 6 7 8 9 10

F Energy, air and waste

- Energy consumption
- Air consumption
- Weight of yarn waste

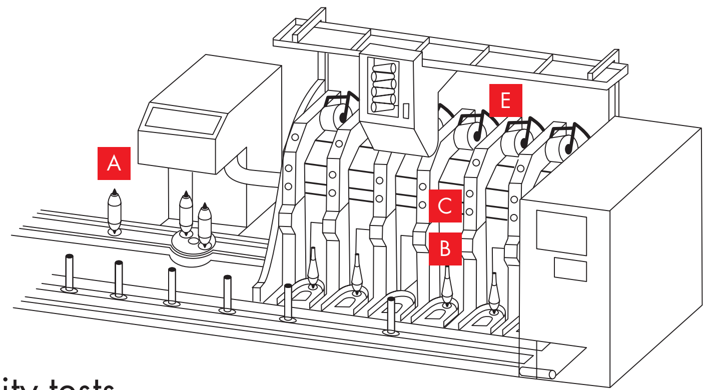
G Production

- Speed and efficiency 2 3 4 5 6
- Consistency of winding speed
- Total alarms per 100 km
- Amount of red lights
- Number of operators
- Ambient conditions

H Maintenance

- Maintenance plan
- Cleaning schedule
- Tension discs
- Travelling cleaner settings

Grey figures = Test parameters to control the Key Quality Indicators, see table 'Important quality tests' below



Important quality tests
as routine test & after article change & after maintenance

Test parameters	Instruments	Online check	Test frequency I* per article	Test frequency II* per article
1 Yarn count	USTER® *TESTER 5*	USTER® *QUANTUM 3*	2 times/week 6–10 pkg.	weekly 6–10 pkg.
2 Evenness	USTER® *TESTER 5*	USTER® *QUANTUM 3*	2 times/week 6–10 pkg.	weekly 6–10 pkg.
3 Thin and thick places	USTER® *TESTER 5*	USTER® *QUANTUM 3*	2 times/week 6–10 pkg.	weekly 6–10 pkg.
4 Neps	USTER® *TESTER 5*	USTER® *QUANTUM 3*	2 times/week 6–10 pkg.	weekly 6–10 pkg.
5 Hairiness	USTER® *TESTER 5/ZWEIGLE HL400*	USTER® *QUANTUM 3*	2 times/week 6–10 pkg.	weekly 6–10 pkg.
6 Yarn strength/elongation	USTER® *TENSORAPID 4/TENSOJET 4*		2 times/week 6–10 pkg.	weekly 6–10 pkg.
7 Splicer strength**	USTER® *TENSORAPID 4*		2 times/week 6–10 pkg.	weekly 6–10 pkg.
8 Seldom faults	USTER® *CLASSIMAT 5*	USTER® *QUANTUM 3*	weekly 6 packages***	weekly 6 packages***
9 Foreign fibers	USTER® *CLASSIMAT 5*, FF module	USTER® *QUANTUM 3*	weekly 6 packages***	weekly 6 packages***
10 Polypropylene fibers	USTER® *CLASSIMAT 5*, PP module	USTER® *QUANTUM 3*	weekly 6 packages***	weekly 6 packages***

*The test frequency is influenced by production speed, machinery age and the quality level to be achieved.
For high production machinery, older machines and high quality level, Uster Technologies recommends test frequency I.
**Splicer strength has to be tested after maintenance and article change in addition to the periodical checks.
***The minimum test length for USTER® *CLASSIMAT 5* is 200 km. The number of packages has to be adapted accordingly.

Fig. 25 Quality management in winding

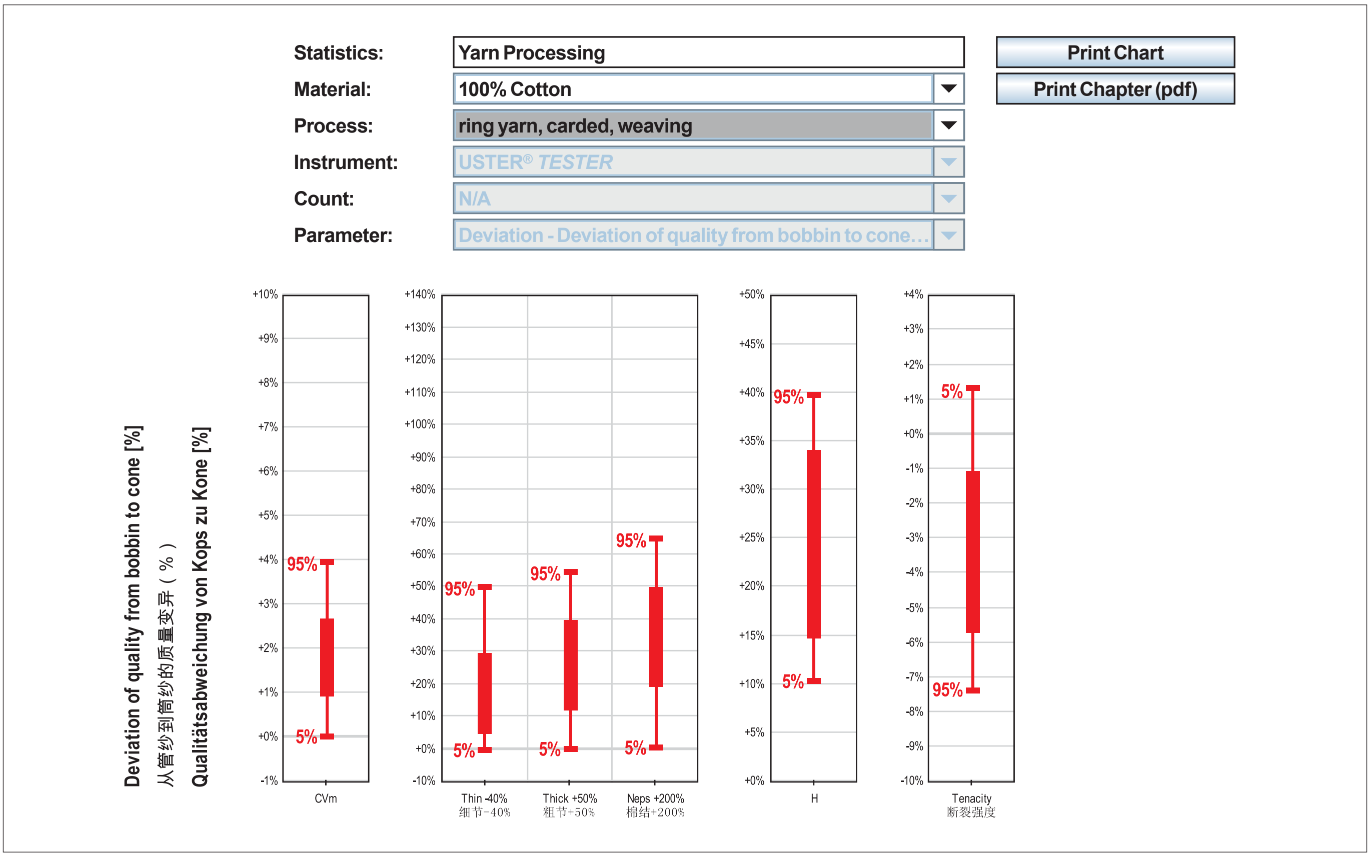


Fig. 26 USTER® *STATISTICS 2013* interactive chart showing the deviation of quality from bobbin to cone for 100 % cotton yarns, carded, for weaving

Winding speed, winding tension and yarn path

The setting of winding speed and winding tension is very important. Both parameters are related to the productivity of the winding machines but at the same time are responsible for the deterioration on the yarn quality during the winding process, together with the influence from the yarn path. Today, spinning mills have several options to optimize those settings thanks to the efforts of winding machine manufacturers. In USTER® *STATISTICS 2013*, a new chapter for yarn processing has been published. This shows the change of certain quality parameters from bobbins to packages, such as yarn strength, yarn hairiness etc. **Fig. 26** shows an example with 100 % carded cotton yarn, used for woven fabrics.

This chapter of USTER® *STATISTICS* enables a spinning mill to compare the quality change in its winding process with global results and to decide if there is scope for improvement or not. Practically, these graphs offer a possibility to compare against best practices worldwide.

For example, the 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.

The friction which is applied during the winding process at touching points on the yarn can initiate a fiber movement – leading to higher imperfection values (thin and thick places, neps). The hairiness increase is mainly caused by friction of protruding fibers, which is influenced by winding speed.

The main reason for the elongation decrease is the tension applied during winding process on the yarn. In the USTER® *NEWS BULLETIN No. 49* the crucial role of yarn elongation to the weaving performance is explained in detail.

USTER experience in this area shows that with the latest generation of winding machines the quality differences from bobbin to packages remarkably decreased – based on the improved yarn guidance with less friction and fewer touching points.

Training

The complexity of settings on winding machines and splicing devices is high. At the winder and yarn clearer, it is a necessity to have good and well-trained people in quality control, as well as maintenance personnel and operators. Many successful spinning mills try to avoid changing their winding room operators, investing in continuous training for them.

Winding machine operators can often earn incentives, with a performance-based salary. A key to this is the way the spinning mill defines performance. Most relate performance to the volume of yarn produced over a shift. But a few have methods which include quality aspects, as well as output, making the operators responsible not only for producing yarn – but producing the right yarn.

5 Conclusions

With this USTER® *NEWS BULLETIN*, the aim was to share best practices, point to Key Performance Indicators and highlight testing routines which successful spinning mills are already following to manage their operations.

When compiling the Key Quality Indicators and Key Performance Indicators for a spinning mill, it became clear that it is not easy to distinguish between indicators which are influence only quality or productivity or performance.

It is important to realize that quality management is not a single function in the mill. It has to become a mindset for nearly all functions. Instead of quality management, today we suggest the goal should be to manage the spinning mill with quality in mind.

The example of a 100 % cotton, combed, conventional (ring spun yarn) – and collective know-how from the USTER experts was assembled and shown with the help of this example mill. By setting up lists per department with the most important Key Quality Indicators, and linking these indicators with the most important quality tests, Uster Technologies wants to encourage mills to keep the important points in mind and focus on them.

Within the past 20 years, more and more tools have been developed to ease the operation of a spinning mill. These tools help mill managers to take better decisions, by providing process and quality data and becoming smart and intelligent at the same time thanks to integrated expert know-how.

Uster Technologies is sure that the future in textile manufacturing will see smart expert systems which will not only measure quality but also automatically identify quality shortfalls, alerting the user and suggesting actions to be taken. Such smart systems will use all available data, presenting it in a comprehensive and user-friendly way to facilitate analysis, draw conclusions and show the way to solve problems or optimize processes. This way, the mill management will become more effective and more efficient.

6 Bibliography and links

USTER® *NEWS BULLETIN No. 49*
USTER® *STATISTICS – The common quality language for the textile industry*
November 2014, order via info@uster.com

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CD ROM with USTER® *STATISTICS 2013* order via
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