Analysis of yarns by a sophisticated classifying system
THE YARN CLASSIFICATION SYSTEM

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1 Introduction

Today, the selection of the right yarn for the right product is crucial for economic reasons. A continuous incoming inspection guarantees a constant satisfactory quality of the end product. In this respect yarn clearing and classifying systems are playing a very important role. At the beginning of electronic yarn clearing the setting of the clearing curve has been quite difficult and has required specialists. In 1968 Uster Technologies launched an electronic system by the name of USTER® CLASSIMAT which was a revolution in yarn clearing at that time. The purpose of the system was the analysis of seldom-occurring or disturbing thick places and the setting of an optimum clearing curve on the winding machine to eliminate the really disturbing yarn faults and to simultaneously keep the efficiency of the winding machine as high as possible. For this purpose the yarn was classified into four length and in four thick place classes.

This analyzing system was not only used by spinners. The yarn buyers (traders, weavers, knitters, garment makers, etc.) also detected this system as a tool to separate yarns into first grade, second grade, etc., or to establish minimum conditions for the acceptance of yarns.

As already mentioned, the first classifying system was introduced in the market in 1968. Therefore, the year 2008 marks the 40th anniversary of this analyzing tool. Fig. 1 also shows that the system was permanently improved in the past 40 years.

Fig. 1 Improvements of the USTER® CLASSIMAT system
Today with the USTER® CLASSIMAT QUANTUM generation, the cleared and uncleared yarn can be checked; the classification of thick and thin places, neps and foreign fibers in the yarn can be fulfilled. This system also helps the user in determining the optimal limits for yarn clearing, in analyzing new material, and supports with experience values which can be used for benchmarking and evaluation.

In this article, we will try explain the most important features of the USTER® CLASSIMAT QUANTUM and its possible usage in improving the quality of yarns.

2 Classification of seldom-occurring thick and thin places

Classifications are used in spinning mills either as on-line monitoring system as a feature of the clearing system on automatic winding machines or as an analyzing instrument on manual winding machines in textile laboratories and they have played a very important role to analyze seldom-occurring yarn faults.

Fig. 2 shows the classification matrix of this analyzing system with a few examples of seldom-occurring yarn faults for the thick place classes A1 to D4 which are assigned by the system to the respective classes.

Fig. 2 Classes of the USTER® CLASSIMAT QUANTUM system
It is obvious that the appearance of seldom-occurring faults in a grey fabric depends on various items:

- The cross-section of the fault compared to the mean value
- The length of the fault
- The count of the yarn
- The yarn density in the fabric
- The type of fabric (weaving or knitting)

With USTER® CLASSIMAT QUANTUM, there is also a possibility of defining new customized classes called “Tailored classes”. The system can classify and present the events in the tailored classes for thick places, thin places and foreign fibers.

### 3 Origin of seldom-occurring yarn faults

A basic rule in quality management is a preventive maintenance rather than corrections afterwards. Unfortunately, this is not yet possible with the technology of today. Textile specialists in spinning mills who have to conquer disturbing yarn fault have to find the origin of such yarn faults.

Table 1 shows a selection of sources which produced seldom-occurring faults in the respective categories. It is a collection of reasons over many years why such events happened.

<table>
<thead>
<tr>
<th>Classes</th>
<th>Possible reason of faults</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (Thick place)</td>
<td>A0  Extended class, mainly used for ply yarn</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A1  Bad condition of carding, blow room, trash in yarn</td>
<td>(Short thick places)</td>
</tr>
<tr>
<td></td>
<td>A2  Bad condition of carding, blow room, trash in yarn</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A3  Neps, fluff, foreign matters, dirty drafting zone</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A4  Ring front zone dirty, fly waste in trumpet</td>
<td>(Unacceptable faults)</td>
</tr>
<tr>
<td>B (Thick place)</td>
<td>B0  Extended class, mainly used for ply yarn</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B1  Fibers damage in process, spindle without aprons</td>
<td>(Short thick places)</td>
</tr>
<tr>
<td></td>
<td>B2  Fibers damage in process, spindle without aprons</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B3  Fluff in travelers, unsuitable travelers, bad piecing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B4  Slub from ring spinning department</td>
<td>(Unacceptable faults)</td>
</tr>
<tr>
<td>C (Thick place)</td>
<td>C0  Extended class, mainly used for ply yarn</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C1  Bad piecing in cans, silver entanglements</td>
<td>(Short thick places)</td>
</tr>
<tr>
<td></td>
<td>C2  Bad piecing in cans, silver entanglements</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C3  Piecing, ring spinning</td>
<td>(Unacceptable faults)</td>
</tr>
<tr>
<td></td>
<td>C4  Floating fibers, fly, slub</td>
<td>(Unacceptable faults)</td>
</tr>
<tr>
<td>D (Thick place)</td>
<td>D0  Extended class, mainly used for ply yarn</td>
<td></td>
</tr>
<tr>
<td></td>
<td>D1  Floating fibers</td>
<td></td>
</tr>
</tbody>
</table>
### Classes

<table>
<thead>
<tr>
<th>Classes</th>
<th>Possible reason of faults</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>D2</td>
<td>Gauge problem of roving frame, spacer problem</td>
<td>(Unacceptable faults)</td>
</tr>
<tr>
<td>D3</td>
<td>Fluff in ring spinning department</td>
<td>(Unacceptable faults)</td>
</tr>
<tr>
<td>D4</td>
<td>Fluff in ring spinning department</td>
<td>(Unacceptable faults)</td>
</tr>
<tr>
<td>E (Thick place)</td>
<td>Double yarn</td>
<td>(Spinners double)</td>
</tr>
<tr>
<td>F (Thick place)</td>
<td>Bad piecing in ring yarns, roving &amp; back process</td>
<td>(Long thick places)</td>
</tr>
<tr>
<td>G (Thick place)</td>
<td>Bad piecing in ring, roving &amp; back process etc.</td>
<td>(Long thick places)</td>
</tr>
<tr>
<td>H (Thin place)</td>
<td>Mostly eccentric bobbins on roving &amp; ring frames, eccentric spindles</td>
<td>(Thin places)</td>
</tr>
<tr>
<td>H1</td>
<td>Poor handling of material during processes</td>
<td>(Thin places)</td>
</tr>
<tr>
<td>I (Thin place)</td>
<td>This type of faults is produced by separation of parts of sliver or roving prior to spinning</td>
<td>(Long thin places)</td>
</tr>
<tr>
<td>I1</td>
<td>This type of faults is produced by separation of parts of sliver or roving prior to spinning</td>
<td>(Long thin places)</td>
</tr>
</tbody>
</table>

Table 1 Classimat defects / Classification and sources of origin

### 4 Description of the data output of the classifying system

#### 4.1 The scatter plot

The scatter plot is a very important feature of USTER® CLASSIMAT QUANTUM which helps the user in analyzing the exact place of each event in the classification matrix and indicates the yarn faults of both the standard classes and the extended classes as points in the classification matrix. The exact length and cross-section increase of the individual yarn faults can easily be determined with the horizontal and vertical scales.

In order to show the usage of the scatter plots, two yarns of two mills were given (Ne 30, 100% cotton, carded) as an example. 100 km of these two yarns were measured with USTER® CLASSIMAT QUANTUM and the nep, short thick, long thick and thin places (NSLT) were counted and classified. In Fig. 3, we can see the scatter plot of a yarn produced in a mill with a good quality management having less number of faults. These faults are shown according to the CLASSIMAT Classes (NSLT) as green colored points. In Fig. 4 the scatter plot of a low quality yarn is shown having a high number of faults. When we compare these two yarns, for example in the B1 class, the first yarn (left) had only 9 short thick places; Fig. 4 shows, as a contrast, a yarn with 488 short thick places in the same class. The faults in the B1 class can be the result of a wrong raw material, fiber damages in spinning or other processing problems. The difference between these two yarns is enormous, and by the help of the scatter plot the user can analyze and choose the yarn having better quality easily.
The yarn of Fig. 4 also has much more faults in the thin place area (part below the zero line of the scatter plot).

4.2 Detection of foreign fibers

Foreign fibers are one of the major problems in spinning mills. The global ITMF survey on cotton contamination in 2007 showed that in the perception of spinners from around the world contamination remains a serious problem. During the past 18 years the degree of contaminated cotton bales was increasing steadily from 14% to 22%. Organic matters are still the main contaminants, followed by fabrics of cotton and plastic film, strings of jute and plastic [1]. These fibers can be of different origin, character, structure, or color other than the original fibers of the yarn (for example synthetic fibers in a cotton yarn). There are distinct benefits to early detection and removal of unwanted fibrous material since later processing stages open up and spread out these “foreign fibers.” This can result in the contamination of many yarn packages [2]. Schenek named that due to the fact that fabrics containing foreign fibers can not be dyed homogeneously, these fibers can cause a lot of quality problems especially after finishing [3]. Lord mentioned that these foreign fibers and materials adversely affect processing and produce error and also affect the properties such as dye uptake, fiber reflectance and the appearance of the final product [4].

Fig. 5 shows the risk of a spinning mill which has the foreign fiber challenge not under control.
In this example, the calculation is based on a bale of 500 lbs (227 kg) and the price for the bale was USD 600. The yarns made of this bale were sold for USD 1'320 and the raw fabric price was USD 3'840. Finally, the finished fabric was sold for USD 7'320.

Because the foreign fibers were only detected after bleaching, the finishing plant did not send the complaint to the cotton producer or cotton trader, but to the spinner. Therefore, the finishing plant had a damage of USD 7'320 per bale which had to be paid by the spinner, but the spinner only earned USD 720 for the processing of the entire bale.

4.3 Classification matrix for foreign fibers

In addition to the standard classification, this system also allows the user to measure foreign fibers and vegetables in a yarn and classify these faults in 27 foreign fiber classes.

With the vegetable filter, it is possible to differentiate between organic and synthetic foreign fibers. Based on the fact that vegetables mostly do not have a disturbing effect on the appearance of fabrics, because they can be bleached and can absorb the same dyestuff, these particles are allowed to remain in the yarn for many fabrics and, as a result, it saves a considerable number of cuts on the winding machine and reduces the formation of splices.

The USTER® CLASSIMAT QUANTUM uses the basic matrix for foreign fiber classification of the USTER® QUANTUM, but the classes B1, B2, C1, D1 and E1 have been further divided. Because the most frequent foreign fibers occur mainly in the classes B1, B2 and C1, these classes and the class D1 are further divided (Fig. 7).
Since the basic matrix is retained, this means, for example:

- B11 + B12 + B13 + B14 = B1 or
- B21 + B22 = B2

Fig. 6 and Fig. 7 show the structure of the classification matrix for foreign fibers, which represents the appearance (in %) and length (in cm). The appearance corresponds to the visibility of a fault. No classification data is available for the A1 class, because there is too high accumulation of foreign fibers. The foreign fiber matrix is divided into 21 (Fig. 6) or 27 (Fig. 7) foreign fiber classes depending on a coarse or fine setting.

4.4 Scatter plot of foreign fibers

With the scatter plot (Fig. 8 and Fig. 9), the distribution of foreign fibers in the yarn can be seen at one glance. Furthermore, vegetables are distinguished from actual foreign fibers by the vegetable filter and displayed separately (olive-green).

In Fig. 8 and Fig. 9, we can see the foreign fiber scatter plots of the same yarns mentioned above (In Fig. 3 and Fig. 4, Ne 30, 100% cotton, carded). In Fig 8, the scatter plot shows a yarn with a low amount of foreign fibers. These faults are shown as green colored points and vegetables are shown in olive-green. In Fig. 9, the scatter plot shows a yarn with a high number of foreign fibers. When we compare these two yarns, for example in the Class B1, the yarn in Fig. 8 has only 103 foreign fibers and 24 vegetables; Fig. 9 shows, as a contrast, a yarn with 673 foreign fibers and 238 vegetables in the B1 class. Again the user can analyze and choose the yarn having a lower number of foreign fibers by using the scatter plot.
The difference between the two yarns, what foreign fibers are concerned, is enormous, and also has considerable consequences on the appearance of the fabric. The comparison also shows that the yarn in Fig. 9 has much more remaining vegetables (olive-green dots).

Both yarns were processed on a winding machine with no foreign fiber clearing. However, in order to avoid a considerable drop of the efficiency of the winding machine it is only allowed to remove the most significant foreign fibers in the yarn of Fig. 9.

5 Benchmarking for USTER® CLASSIMAT classification

In 1975, Uster Technologies introduced the USTER® STATISTICS for the USTER® CLASSIMAT for the first time. Uster Technologies has carried out many tests with yarns coming from all over the world and the results were published in 2003 as the first USTER® STATISTICS for foreign fibers and in 2007, the new USTER® STATISTICS 2007 were introduced to the market.

Fig. 10
Cotton 100%, carded, Ne 10 to Ne 40, ring-spun, for knitted fabrics
In Fig. 10 the red symbol (on the right hand side) explains the significance of statistical values and indicates the range from 5 to 95%. A foreign fiber content on the 95% level means that 95% of all spinning mills worldwide are below this figure. A value on the 5% level, however, indicates that only 5% of all spinning mills worldwide could achieve this quality level.

Fig. 10 shows for example that the spinning mills with the lowermost number of foreign fibers only have 15 events in the B21 class whereas the mills with the highest level have 600 and more foreign fibers in the same category.

6 Conclusion

It is well known that the yarn quality is very important for the quality of the end product. Weak places, for example, mainly affect the productivity (machine stops caused by end breaks) whereas coarse yarn faults in woven or knitted fabrics result in costly rejects. Today, the selection of the right yarn for the right product is crucial for economic reasons. A continuous incoming inspection guarantees a constant satisfactory quality of the end product. In this respect classifying systems are playing a very important role. For example many of the foreign fiber problems are only detected after finishing, and the spinner is finally made responsible for the damage. For this reason, the sooner they are detected, the lower the costs and the better the quality. The costs and claims due to foreign fibers can be prevented by setting up a quality management system to eliminate or minimize the number of foreign fibers in yarns.

Within the scope of a modern quality assurance program it is now possible that test reports, which serve as a quality guarantee for the observance of supplier agreements or certificates, are requested with every yarn delivery. As a result of 40 years of continuous experience in yarn clearing and classification, the USTER® CLASSIMAT QUANTUM can be used not only as a tool in order to examine the yarns to be purchased for remaining disturbing thick places, thin places and foreign fibers but also as a sophisticated classifying system which can help the user to determine and set his own yarn quality standards.
7 Literature


2. Oxhenam W., “Preparing for Change, Yarn preparation faces questions as to what the future holds” http://www.textileworld.com/Articles/2000/April/Features/Preparing_For_Change.html


