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SGS

MICROSCOPE ANALYSIS OF ANIMAL FIBRE BLENDS

TRAINING OF OPERATIVES

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SUMMARY

The SGS animal fibre testing laboratory in Bradford, UK, has been involved in the measurement of animal fibre blends for over 20 years and has been working with and approved by the Cashmere and Camel Hair Manufacturers Institute (CCMI) for over 10 years.

Traditionally Operative training has been carried out by a peer to peer method, which has proved successful in the past.

However SGS now operates 3 laboratories based in Europe and China, and has up to 15 operatives measuring and/or training at any one time. Under these circumstances the traditional methods are more difficult and expensive to operate.

A strategic decision has been taken to co-ordinate the training and operation of these laboratories by use of a centralised facility based in the UK.
The main objective is to ensure consistent results throughout the SGS operation by the standardisation of operational and training methods, and the provision of traceable training and reference material in the form of both physical and electronic means.

This paper outlines the approach used.

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1. INTRODUCTION

Measurement of the composition of cashmere and other animal fibre blends is a difficult and subjective procedure. It relies on the identification of individual fibres, primarily from the scale characteristics, but also from pigmentation and other visual characteristics plus the objective measurements of features such as diameter, scale density and scale thickness.

There is also a problem with substitution with lower value fibres such as wool and yak. This substitution can take places at all points along the processing chain from the raw cashmere to the final yarn spinning process.

There exist two current "commercial" methods – Optical Microscope Method and Scanning Electron Microscope (SEM) Method.

Optical Microscope Method

The **Optical** method relies on an operator identifying magnified fibres from their scale structure and other features. Methodology is outlined in a number of sources, including ASTM-629, AATCC-20A, Wildman and Bray, which include some photographs and descriptions of the main identifying features of different fibre types. When differentiating between cashmere and wool fibres there are areas of overlap of characteristics and correct training of operatives is crucial to maintaining reasonable accuracy and consistency of results.

HOWEVER, the method remains primarily subjective and is further complicated by the increasing introduction of modified wool fibres, other animal fibres of similar characteristics (Yak, cashgora, other goat fibres, etc.) and the different sources of cashmere (e.g. Iranian cashmere compared to Mongolian cashmere).

Further difficulties in identification arise from treatment of the fibres, which can hide the surface characteristics. This is particularly prevalent with finished garments/fabrics that have undergone extensive chemical and physical processing, and in some cases make it impossible to identify individual fibres.

The basic operation of Optical methods is limited by the resolution of the microscopes (best resolution of about 0.3 microns) and the small depth of field (1 to 2 microns) which means that surface characteristics are not in focus. Also the Optical microscope views the transmitted light, so interference with scale shadows from both sides of the fibre occurs. The big advantage is that the internal structure (pigments) of the fibres can be seen.

Scanning Electron Microscope (SEM) Method.

The scanning electron microscope uses secondary electrons to "view" the surface characteristics of a fibre. Unlike Optical microscopes the fibre interior is not viewed, indeed the surface is usually coated with a thin layer of gold to assist speedy display of the scanned surface.

The major advantage of the SEM is it very high resolution (down to 2 nanometres) and the relatively large depth of field. This enables the complete surface of a fibre to be seen in high detail (usually limited by the resolution of the digital display) thus enabling a better discrimination of the surface characteristics. However no internal information (i.e. pigmentation) is available as with Optical Microscopes.

This enables clear measurement of topographical features of the fibre such as scale height and density (ratio of scale length to fibre diameter) which can also be useful in objective discrimination of fibres.

The measurement of composition by SEM has been standardised as IWTO-58, which uses the scale height to differentiate between Wool and Speciality fibres (cashmere, mohair, Llama/alpaca, camel etc.). Wool is defined as animal fibres with a scale height (thickness) greater than 0.55microns. The identification of the "speciality" fibres is then determined from other topographical properties such as scale shape, density, micron etc. In this sense the procedure relies on clear separation on scale height of wool from the others. Identification of the others is then on subjective assessment of surface characteristics. For this training of operatives is still essential.

Figure 1 below shows examples of the images obtained from Optical and SEM microscopes.

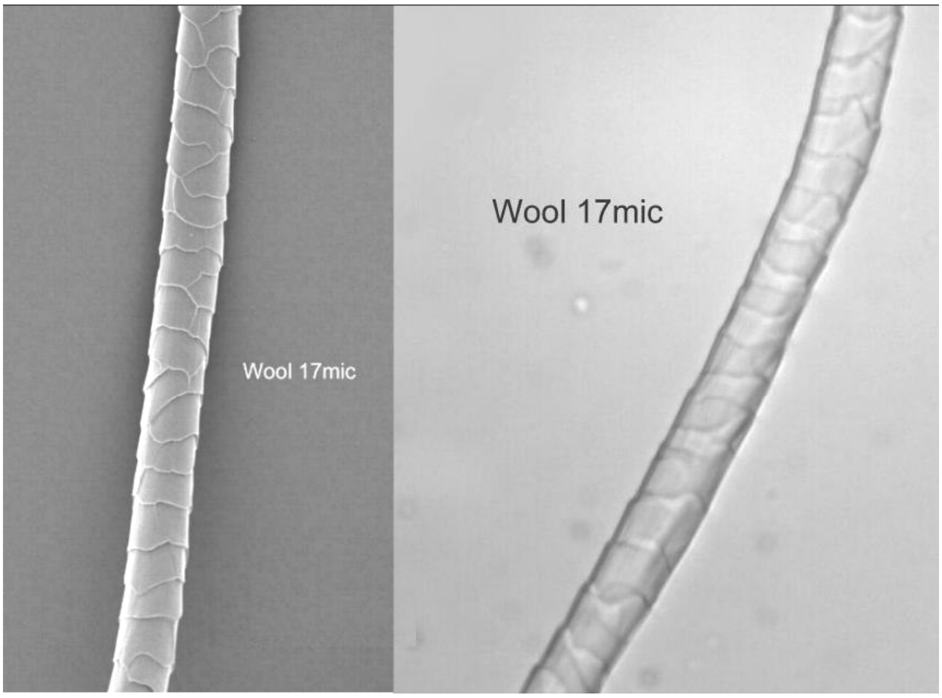

FIGURE 1: COMPARISON OF OPTICAL AND SEM IMAGES OF A WOOL FIBRE

2. CRITICAL AREAS FOR MEASUREMENT OF COMPOSITION

There are a number of critical areas that need to be addressed to ensure consistency. One of the major concerns of clients is the differences that are observed between laboratories. Some of these are unavoidable due to the nature of the testing - subjective assessment of the morphology of magnified fibres - but others are undoubtedly caused by poor or inconsistent training of operatives. Such problems can occur with both optical and SEM techniques.

These critical areas can be divided into Technical Procedures and Fibre Identification.

2.1 Technical Procedures

Technical procedures includes both sampling techniques and measurement techniques.

Sampling is an important area, which is often neglected, and refers to the selection of a representative, unbiased sample. This covers such things as **Global Sampling** (core sampling, yarn packages, fabric) and **Subsampling Procedures**. Consistent procedures and equipment will greatly reduce errors from this source.

Where possible SGS uses standard published procedures, and staff are trained in their application. Extra procedures are written for clarification or where a suitable procedure does not exist.

Measurement Procedures

Another important area relates to the test methods and procedures used for measurement. Aspects covered include Slide/Snippet Preparation, selection of fibre snippets to ensure that a length biased sample is obtained, and defining how Micron is measured and composition calculated.

Again SGS used published test procedures wherever possible, or bases its written procedures on the best practice as indicated from the published methods.

2.2 Fibre Identification

Probably the most important and difficult aspect is to ensure that operatives are properly trained to identify the fibres correctly. This applies to both Optical and SEM microscopy. It is probably true to say that consistency only comes with experience.

3. OPERATIVE TRAINING

3.1 Background

Training at SGS, and I suspect elsewhere, has been carried out using peer to peer training methods, where an experienced operator is placed with a new operative and is shown how to carry out the procedures and how to identify the different fibres. This requires long sessions with the microscope gaining experience, and ties up a qualified operative for long periods.

Experience shows that a new operative can take between 3 to 6 months to train and that, in some instances, the operative never becomes skilled enough in fibre identification to carry out commercial tests.

In the case of SGS where 3 separate laboratories are in operation, and up to 15 operatives can be active at any time, this can become a big problem, especially as there are large distances between the laboratories and the requirement to train new staff when trained personnel leave.

For this reason SGS made a strategic decision to co-ordinate the activities of these laboratories through a centralised facility based in the UK. The main objective of this project is to ensure consistent results throughout the SGS operation by the standardisation of operational and training methods, and the provision of traceable training and reference material in both physical and electronic forms.

3.2 Training

SGS is developing standardised training of Operatives in 3 basic areas: Technical Procedures, Fibre Identification, and Monitoring of Performance.

3.2.1 Training in Technical Procedures.

This relates to the technical procedures as discussed in section 2.1 and preliminary training in the standardised procedures is carried out in the normal manner of study, demonstration and practice. In all cases training of staff is relatively straight forward as it involves following written procedures which are clear and objective.

Once completed this enables operatives to select and prepare samples and specimens, and to operate the microscopes (Optical or SEM) in the required manner. Staff can always refer to the written procedures if necessary.

2: Fibre identification

Training operatives to identify different animal fibres requires that operatives are exposed under standard conditions to images of **known** fibres and instructed by an experienced operative on the basis for distinguishing the different fibre types. For this purpose most laboratories have a collection of "**known**" fibre samples which form the basis for training and comparison purposes.

Traceable Animal Library
With the objective of having a sound basis for standardise training, SGS has undertaken the collection of fibres direct from **known** animals. In this way a completely **traceable** fibre collection is being formed, where we can **certify** exactly from which animal the fibres originate.

A detailed procedure has been designed for collection of these fibres to ensure that an appropriate range of animals from a herd or flock are collected, and the details of the animal recorded and certified by an SGS employee or Agent. To date approximately 60 animal samples, predominately cashmere from the different areas of China, have been collected. Figure 2 shows the type of information collected on each animal sampled.

This is an ongoing program using SGS Offices to obtain samples from all relevant countries and animal types.

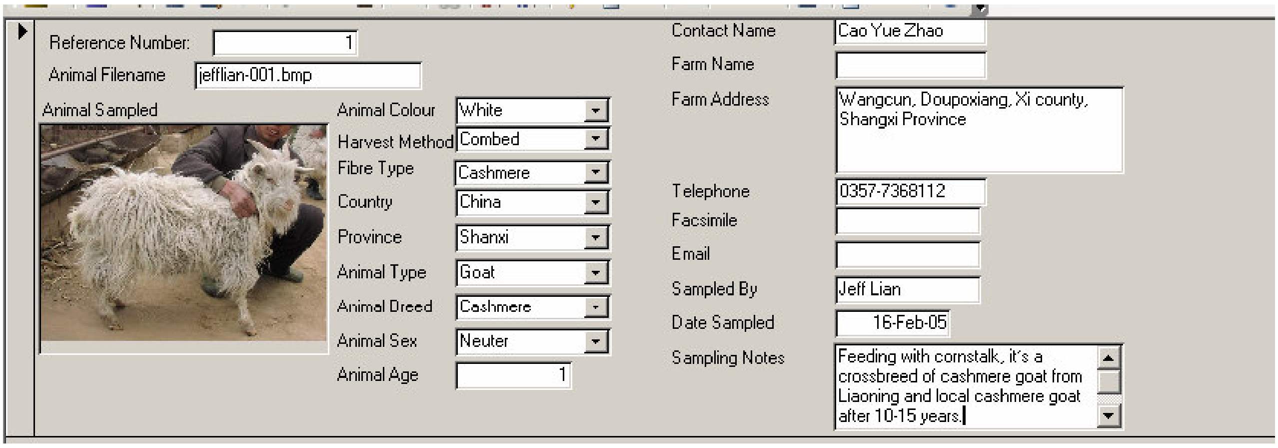

FIGURE 2: DETAILS OF ANIMALS FROM WHICH SAMPLES ARE COLLECTED.

Traceable Fibre Library
From each known source, SGS intends to build up a Traceable Fibre Library of both SEM and Optical Images, which will then be used for both reference and training purposes.

It is intended that each fibre image will be measured for the following properties:

- ✓ Mean Fibre Diameter (and perhaps Variation within fibre snippet)
- ✓ Scale Ratio (measured as Scale Length to Diameter)
- ✓ Scale Height (Thickness - SEM images only)
- ✓ Scale Angle

And the following descriptors also noted:

- ✓ Fibre treatment (e.g. greasy, scoured, carbonised, bleached etc.)
- ✓ Fibre Damage (e.g. split, abraded, fibrillated etc.)
- ✓ Fibre Pigmentation (Optical only, relative levels of pigmentation)
- ✓ Colour Depth (for dyed fibres, optical only)
- ✓ Medullation (relative levels of medullation)
- ✓ Scale Shape (basic description such as coronal, smooth edged etc)
- ✓ Scale Flaking (relative level of flaking)
- ✓ Damage (relative level of damage)

This information is stored in a database (Figure 3) along with the fibre image to facilitate its use for both training of operatives and reference purposes.

Over a period, representative images of a full range of fibres/sources will be collected.

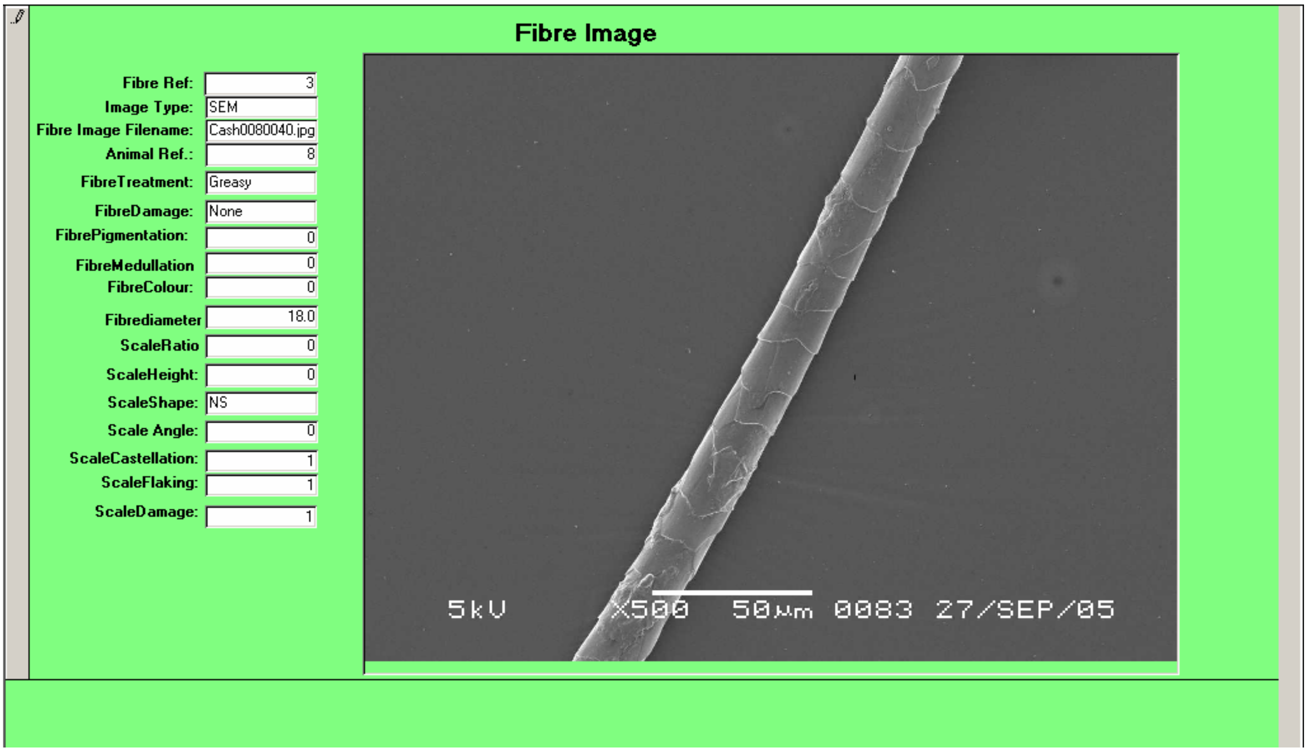

FIGURE 3: DATABASE OF FIBRE IMAGES

Operative Training - Fibre Identification

The Fibre database is intended to be used for the training of operatives as follows.

First, using specially selected images, the main features of the different fibres are shown and explained to the new Operatives. For this purpose SEM photos are used to provide the best images and these are correlated with Optical Images. In this way Operatives can better interpret the surface characteristics as viewed using an optical microscope.

For example Figure 4 below shows a comparison between a cashmere fibre and a wool fibre of the same diameter as taken by a SEM microscope and Figure 5 below shows a similar image comparing cashmere to wool using an Optical microscope.

While the identification of the fibres is still very obvious, the differences between the two images enable better interpretation of the optical image by comparison with the distinct surface image of the SEM microscope.

The effects of low depth of field, and the mixture of surface and internal features caused by the transmitted light of the Optical Image, are clearly shown.

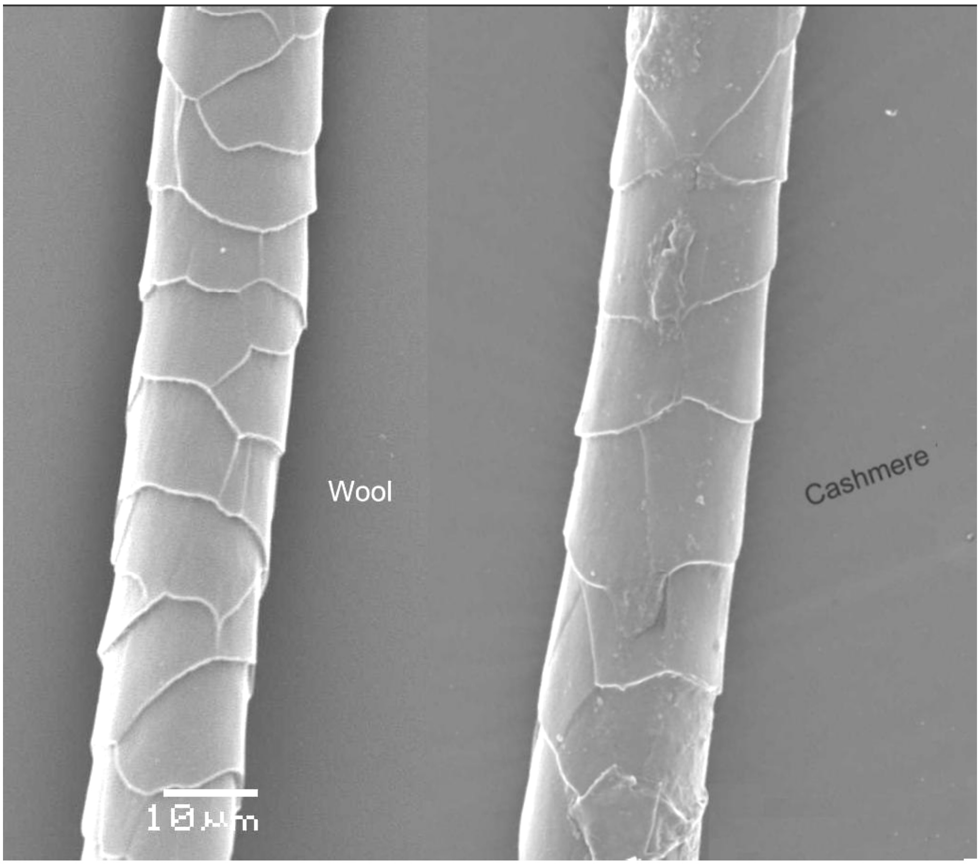

FIGURE 4: TYPICAL CASHMERE AND WOOL FIBRE - SEM IMAGE

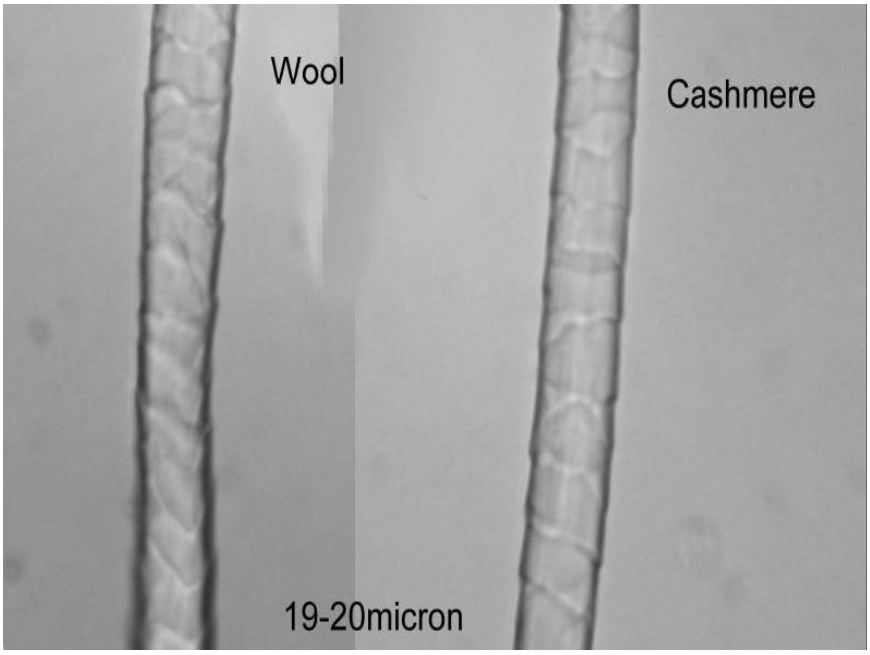

FIGURE 5: CASHMERE AND WOOL FIBRE - OPTICAL IMAGE

By selection of appropriate images the observer can quickly be introduced to the fundamentals of Fibre Identification. Even more importantly this can be done over a wide range of fibres, for example, cashmere fibres can be compared to wool fibres of the same diameter over a range of diameters so that Operatives can understand the effect that diameter has on the scale structure/ fibre image.

Figure 6 below shows a comparison for fine fibres, and Figure 7 for relatively coarse fibres.

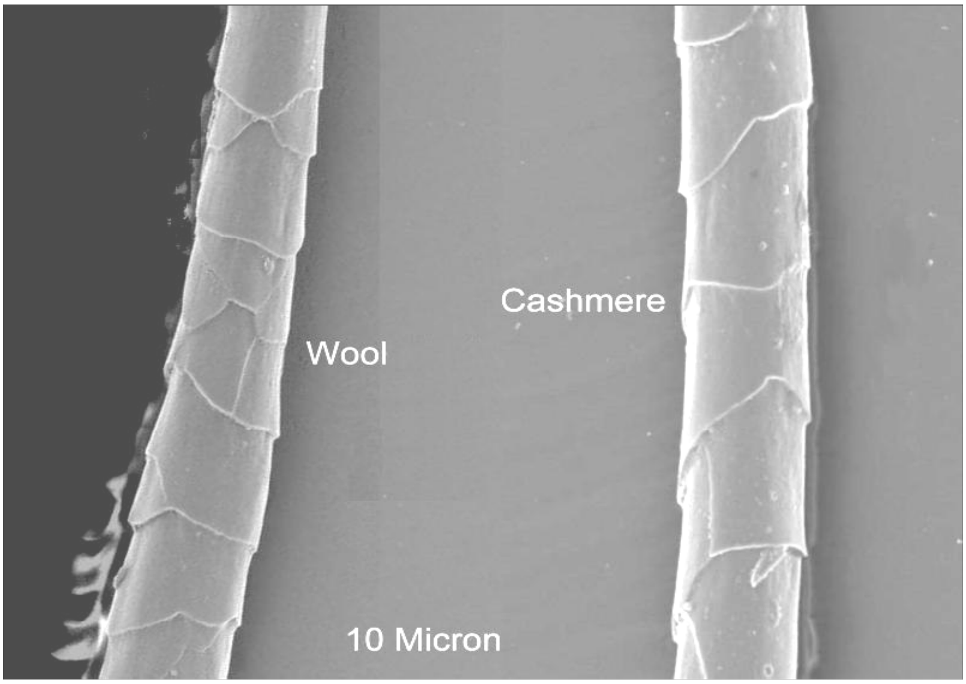

FIGURE 6: SEM IMAGE OF 10 MICRON CASHMERE AND WOOL FIBRES.

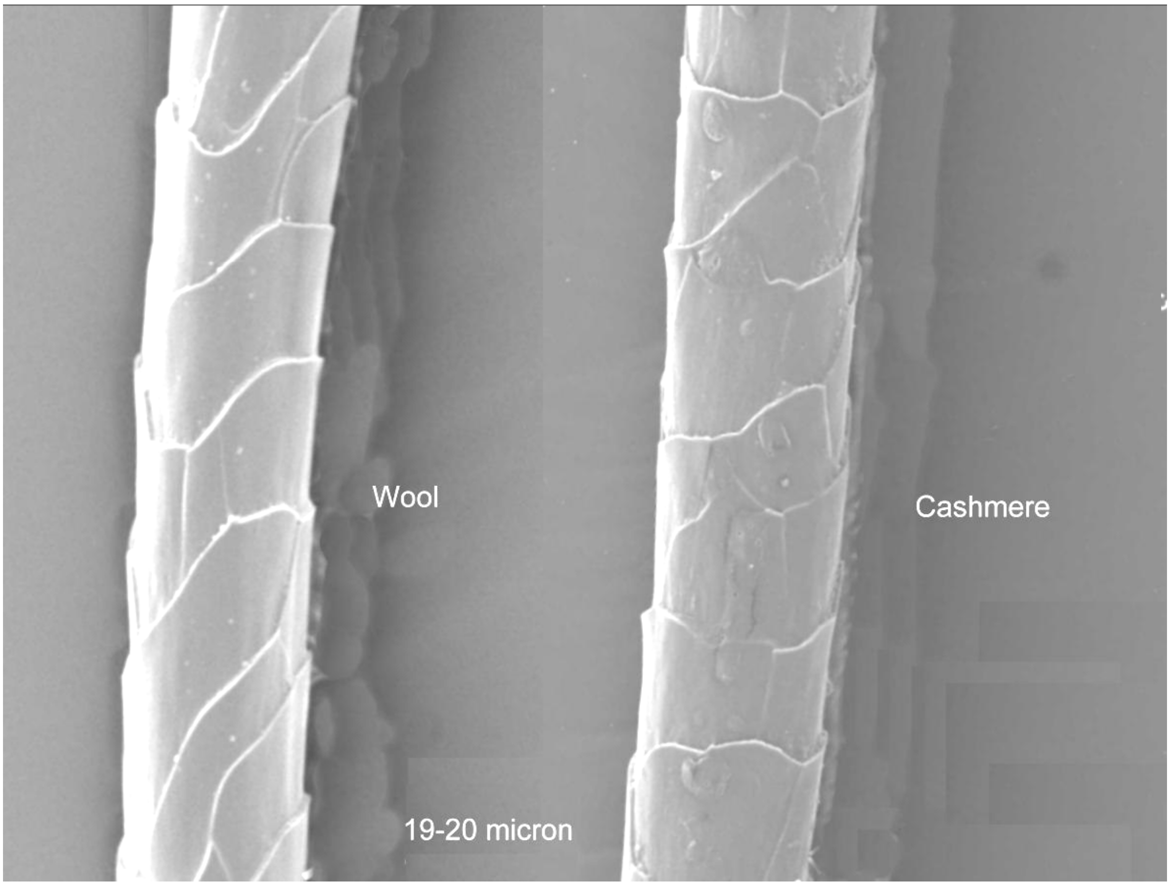

FIGURE 7: SEM IMAGES OF 20 MICRON CASHMERE AND WOOL FIBRES.

The Operative then practices identification on selected sets of fibre images which cover a range of fibre diameters and sources. The operative views an image (either SEM or OPTICAL) and makes an identification. This is supported by feedback as to the correctness of otherwise of the identification.

If a fibre is misidentified then the Operative is shown other images to demonstrate the error. For example he could be shown a fibre image which agreed with his identification for comparison with the original fibre, and possible a series of fibres (all of similar diameters) of the two fibre types to reinforce the visual differences.

Once an operative has reached a suitable level of expertise on “set” training exercises, further experience would be gained using “random” testing from the fibre database.

Finally the Operative would carry out training on actual samples to see how well the “electronic” experience transfers to the real world. **This is of course not a trivial step.**

With **SEM** procedures the images used for training will be virtually identical to that used in an actual test so the abilities learnt should transfer well.

However for the **Optical** microscope, **which is the bulk of the testing done today,** the images viewed in real time are not identical with the images used for training. In real time the focus of the fibre can be varied to bring different aspects into focus, and the fibre can be viewed along its full snippet length if necessary.

This effect is demonstrated in Figure 8, where several different points of focus are shown for the same fibre. From the left to the right we are focussing on the upper surface, the fibre edges (as required when measuring diameter) and at the bottom surface.

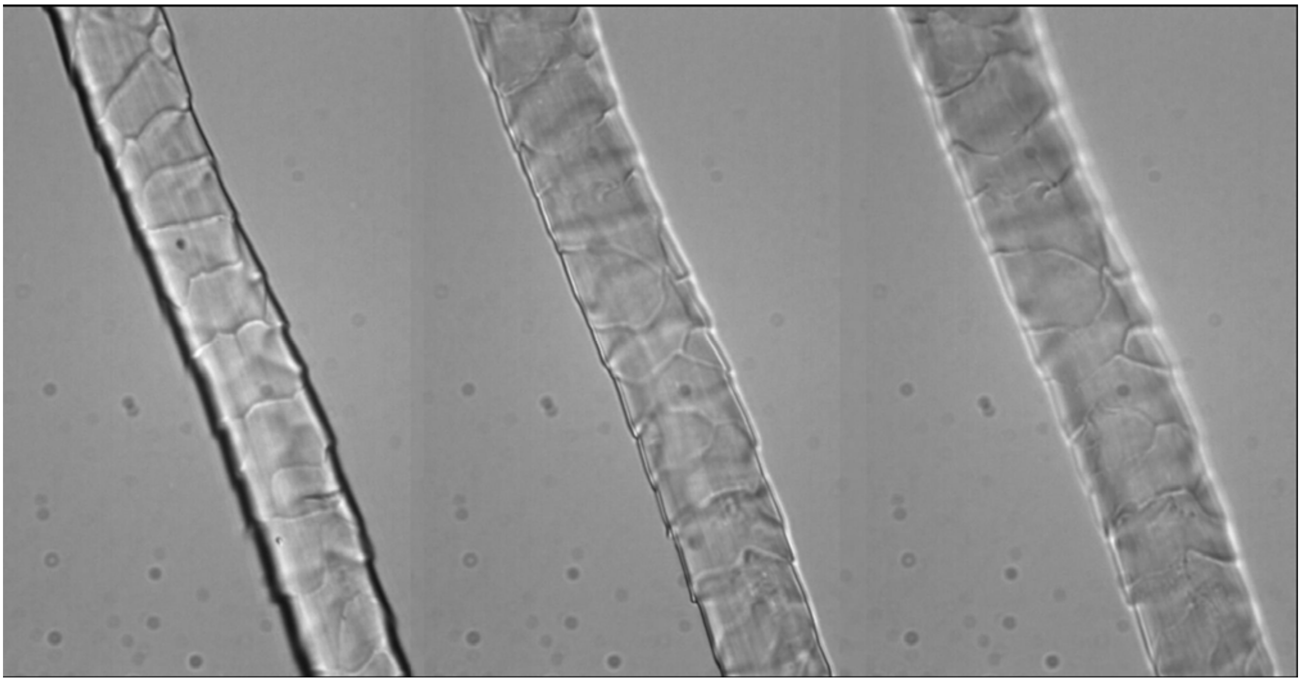

FIGURE 8: FIBRE IMAGE AT 3 FOCUS POINTS - OPTICAL MICROSCOPE

In essence the Operative has more information to work with, which will hopefully make the transition to "live" microscopy more accurate even if more difficult.

It cannot be emphasised enough that the procedures proposed above still require Operatives to gain experience, and it will still take a long period to become expert enough to carry out real analysis.

The advantages in using such an approach are:

- **Standardisation** of the training, both in **how** and **what** Operatives learn.
- Fibres used for training are **traceable.** That is we can certify exactly the samples we use.
- The procedure can be provided as a **computer package**, greatly reducing the time required by trained staff for training purposes. Hopefully also reducing training time for new operatives.

3: Monitoring of Operatives.
No matter how much training is carried out, or how detailed and dedicated it is, it is still necessary for Operatives to demonstrate there abilities before commercial testing can be carried out.

For this purpose SGS has instigated internal proficiency testing of all operatives. Provision of Quality Control, in the form of proficiency testing trials leading to an internal accreditation of **individual operatives,** is an essential ongoing requirement to ensure the quality of results.

These trials are designed to monitor and/or train **OPERATIVES** with regard to identification of cashmere/wool/other fibres and measurement of fibre diameter.

Each Operative is provided with a test specimen and is required to **independently** carry out **all** the operations for measurement of fibre composition. The sample may be loose fibre, sliver, yarn or fabric. Each operative at each laboratory is required to independently identify, and measure the diameter of, the cashmere and/or wool fibres on each of 2 slides, using specific procedures. **It is essential that each operative acts in isolation from other trained operatives so that performance of each operative can be assessed independently.**

A summary report of the results is provided to each laboratory with indications of any problems that arise. Where appropriate, differences between Operatives will be highlighted and suggestions regarding possible corrective actions made. This takes the form of a standard EXCEL analysis with appropriate graphs covering both %Composition and Mean Fibre Diameter measurements.

Results are compared to either the “nominal” (or technical) value or the average of the results (excluding outliers).

Examples of the Cashmere% Results for a round trial re shown in Figure 9 below. (Note that a similar analysis of micron measurements is also carried out.)

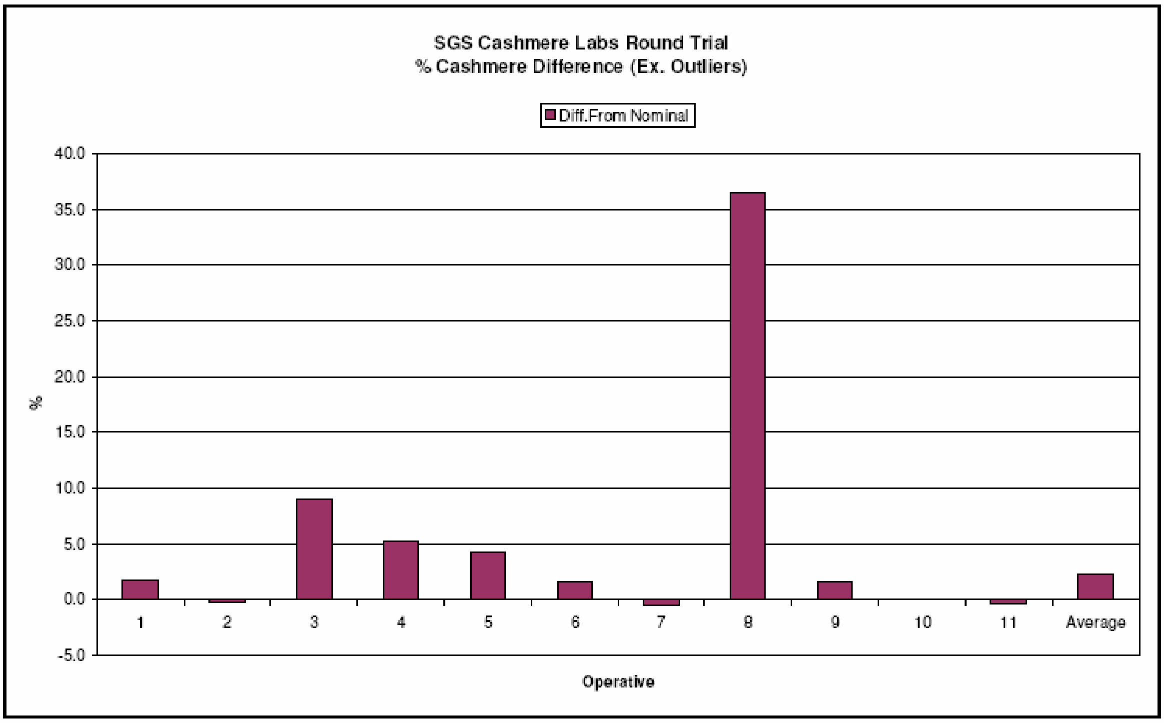

FIGURE 9:ROUND TRIAL RESULTS

This shows that Operative 8 (a new trainee) had serious problems with this sample, and that 3 and 4 were borderline. All other operatives had acceptable results.

The results of all trials for each operative are also monitored as shown below in Figure 10.

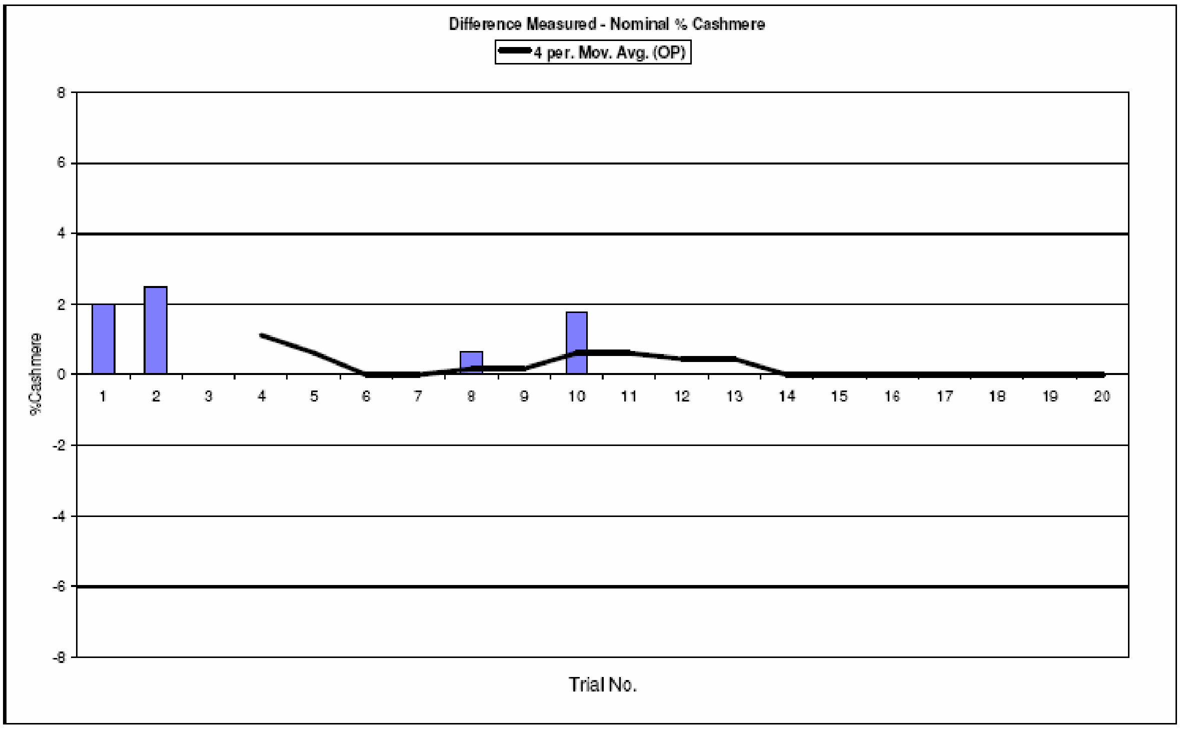

FIGURE 10: SUMMARY RESULTS FOR A “GOOD” OPERATIVE

In this manner we can check that operatives are performing within acceptable limits compared to other operatives, and over time. For example we would expect a good operative to be within 4% of the Nominal Value and with a Moving Average (that is the average over the last 4 trials) be within 2% of the Nominal Value.

SGS also monitors in a similar fashion the micron measurements of each operative.

SUMMARY

Measurement of cashmere and animal fibre blends currently rely predominantly on Optical Microscope and Scanning Electron Microscope methods.

Both methods rely heavily on training of operatives to identify the individual fibres, and this is a source of within and between laboratory differences.

To ameliorate this problem a SGS has decided to co-ordinate the training and operation of these laboratories by use of a centralised facility based in the UK. This training is based on the development of:

- Standardised technical procedures
- Traceable electronic and physical fibre samples
- Computerised training for fibre identification
- Ongoing monitoring of operatives.

In this manner the consistency and accuracy of results should be improved, and the cost and time for training of operatives reduced.