2003 BELTWIDE COTTON CONFERENCES, NASHVILLE, TN – JANUARY 6-10

TRUE SHORT FIBER CONTENT: COMPLETE FIBER LENGTH DISTRIBUTIONS FROM TAPERED BEARDS

Yupeng Zhang, C. Kyle Shofner, and Frederick M. Shofner
Schaffner Technologies
Knoxville, TN

Abstract

Market needs, design objectives, principles of measurement and test results are given for a new, image-based method for measuring the important fiber quality of length. The complete fiber length distribution of a new form of tapered beard sample is provided, from which "true" long fiber content, LFC, and "true" short fiber content data products, SFC, are determined. These new length measurement technologies enable significant improvements in accuracy and precision and are part of the IsoTester® platform, a next generation high volume fiber quality testing instrument.

Introduction

Cotton fiber length data products are among the most important descriptors of fiber quality. They strongly correlate with spinning process costs and with yarn and fabric qualities. In order of historical use for commerce, useful length data products include: Classer' Staple, Upper Quartile, 2.5% Span, Upper Half Mean, and, recently, Short Fiber Content. Accordingly, these and related data products strongly impact commercial market values of cotton. In order for any fiber quality to be genuinely useful, it is imperative that its measurement be correct, widely understood, and accepted for commercial trading by all parties concerned.

The market has historically caused cotton producers to favor varieties having larger proportions of Long Fiber Content, LFC, when all other things, notably yield, but also Micronaire and Strength, are comparable. Satisfactory LFC measurements are available and widely used in commerce. Contrariwise, satisfactory SFC measurements are not available, despite numerous complaints, primarily from parties in the mill, merchandizing and research segments, about the "rising short fiber content" problem. Current market forces are increasingly causing producers and ginners to favor gin processing equipment and methods, which minimize damage and preserve the length qualities of the fibers, so correct and accepted measures of SFC are urgently needed.

Provided it is implemented correctly, SFC is the best measure of fiber damage, as well as the inherent proportion (i.e., due to varietal, environmental, harvesting factors) of fibers <0.5 inch = 12.7 mm. Length Uniformity is an insensitive indicator of damage and has basic problems in definition. These are discussed later. SFC is thus increasingly appreciated as a vital data product for both gin and mill process optimizations. SFC data products report percentages by weight, for broad use, particularly for trading, or by number, for specialized process optimizations. SFC(w) and SFC(n) are also discussed later.

Better stated: SFC is an increasingly important fiber quality; the lower the better. The more correctly it is measured, the better. And the more widely the measurement is understood and accepted by the parties affected, the better. Only with correct and widely accepted SFC data can producers of cotton and designers and operators of gin and mill processing machinery evaluate the quality of their work and, thereby, realize the financial incentives to improve or to justify their risk-taking.

Since new length measurement methods are needed for commercial trade, it follows that the first of two primary design objectives was provision of the complete fiber length distribution, on a scientifically correct basis. The second objective was making the apparatus and method compatible with next generation, high volume, fiber quality testing instruments. This latter objective was enlarged to make the instrument operable anywhere, classing offices, gins, warehouses or mills, and thus made this objective even tougher.

This paper presents, for the first time, the principles and results for a new, image-based method for measuring, in scientifically basic terms, the complete fiber length distribution from a new form of tapered beard. The precision and accuracy of both LFC and SFC data products derived therefrom will be shown to equal or significantly exceed the best available current technologies. SFC performance results will be seen to be "true" and especially interesting. We can enthusiastically conjecture now that the stored images of the tapered beards will be useful for Internet-based commerce. It will be appreciated that this length by image analysis or Li method represents a major improvement, perhaps even a "break-through," in fiber length measurement technology.

We wish to note, with emphasis, that any length data product may be determined from the complete fiber length distribution. Further, any data product so derived is termed a "True" data product, as contrasted with inferential measurements that depend on reference cottons. The data products reported herein for our Li method are True, except as noted for comparisons, and are precisely those with which our industry is familiar and upon which commercial trade is based: Upper Half Mean Length, Mean Length, Length Uniformity, Classer's Staple and SFC.

We also note that the terminologies of complete fiber length distribution, fiber length histogram, or fiber length probability density function, pdf, are interchangeably used herein and in the literature on length measurements. We interchangeably use complete fiber length distribution and pdf in this paper. The basic pdf derived from our image-based method is by number, as will be seen in the Principles Section below.

To prevent this lengthy Introductory Section from being academically sterile, and to add some practical and interesting points of view, POV, we close it by providing some simple but realistic examples which relate market prices to gin-based fiber quality or "Classing" measurements, which terms we use synonymously. These examples, upon logical extensions to mills, and upon obvious amplifications in breadth and depth in both gins and mills, facilitate understanding and acceptance of improved length measurement methods, including where in the system they can be made. Such considerations have certainly been important in internal justifications of STI's technical and business plans, particularly those which involve gin-based classing measurements. We elaborate briefly here on this concept and return to the subject in Section 4.

The best place to make fiber quality measurements for gin process control is, obviously, at the gin and, more specifically, at the bale press, on samples having the bale's permanent bale identification number. We generally refer to such gin process control as feedback, although it will be appreciated that optimal gin process control will involve other inputs than fiber quality. Bale fiber qualities measured at the bale press can include data products which are also used in "official" classing, such as length or trash, and those which are not, such as moisture content or stickiness.

If all of the official fiber qualities could be satisfactorily measured at the gin, it follows that, eventually, it would be possible to execute "Gin-based Classing," preferably, of course, under supervision by third parties. It follows further that gin-based fiber quality or classing measurements can facilitate internet-based sell-buy decisions and logistics actions. These capabilities enable optimization of commerce, to which we refer as feedforward. Thus gin-based fiber quality or classing measurements, as in the examples now given, enable both feedback optimizations of the production and ginning processes and feed-forward optimizations of commerce.

Example 1

A bale of Staple 34 or UHM = 1.06" cotton having SFC(w) = 8% is fundamentally more valuable to the spinner than a bale ginned to the same UHM but having 12% SFC, all other fiber qualities being the same. By extension, an 8% bale is more valuable than a 9% bale. And so on. Thus, from a practical POV: Both LFC and SFC measurements must be correct and accepted. Unfortunately, our industry cannot develop broadly acceptable SFC quality-price relationships because of the current unavailability of useful SFC data.

Consider further the current realities, using current generation HVI, where 8% is, on a bale by bale basis, barely statistically significantly different from 12% and 8% and 9% are statistically indistinguishable. Yet the range of SFC in the majority of bales in the US upland crop is about 8 to 15%! Correct measurements, having accuracies and precisions of 0.5%, even eventually 0.1%, are needed.

Or consider cases where the SFC measurements are on different levels due to sellers and buyers using different instruments, or improperly calibrated instruments of one type. Meaningful communications or negotiations are practically impossible or, at best, extraordinarily difficult.

Again, from a practical POV, improved SFC measurements are urgently needed and length and other fiber quality measurements, which can correctly operate in gins or warehouses are especially advantageous.

In the next 2 examples we assume that all measurements are correct and understood by all parties and that the economics implicit in CCC loan schedules (or other price-quality terms) are valid and understood by all parties.

Example 2

Most importantly to the ginner and producer, processing a given module to UHM = 1.06 and SFC = 8% is exceedingly more desirable than processing the same raw module material to 1.05" and 12%, all other fiber qualities being the same, because of severe penalties for Staple 33 versus 34. From a practical POV: avoid the discounts.

Example 3

But all modules are not created equal, so what if the other fiber qualities in the bales are not or cannot be or should not be the same? The ginner must provide maximum value from the module for the producer. Ginning a given module to UHM = 1.06", SFC = 8.2%, Bale Moisture Content = 7.8%, and Leaf Grade = 4.3 is currently far more economically desirable than ginning the same raw module material to UHM = 1.05", SFC = 11.5%, MC = 4.9%, and Leaf Grade = 2.7! From a practical

POV: maximize the turnout and minimize the discounts. (Note the decimal resolutions in the SFC, Moisture Content and Leaf Grade data products. These resolutions are urgently needed, too.)

We provide further real world economic realities in a companion paper entitled "Gin-based Classing: First Steps." Provision of Decimal Leaf Grade and traditional Color Grade, also by image-based methods, and Moisture Content are described therein. The interested reader may wish to explore fiber quality – price relationships more broadly and more deeply using STI's COTTON CALCULATOR™, which may be downloaded from our web site.

Objectives and Principles of the Li Method

Primary Objectives:

1. Provision of Length Probability Density Functions, pdfs
2. Compatibility with Next Generation High Volume Fiber Quality Testing, IsoTester ®

It has been Schaffner Technologies' privilege and challenge to address the fundamentally important and scientifically basic measurement of the complete fiber length distribution or pdfs on two occasions. In 1984 the only practical length measurement technology which could provide pdfs was the comb sorter or array method, such as provided by Suter-Webb Array or Zweigle apparatus. These known comb sorter methods were and are unacceptably expensive, imprecise or slow. They were not and still are not candidates for routine, high volume testing for commercial trading purposes. We had to invent a new method in 1984.

The first visit to the problem led to the invention and development of the Advanced Fiber Information System, AFIS, which was and is a modular platform enabling a multiplicity of fiber quality measurements. (Comb sorter methods were used extensively in the early validations of AFIS L.) One of the most important measurement modules was for Length + Diameter, L + D. The design focus then, as now, was indeed provision of the length pdf, which enabled a "true" measurement of SFC. (Diameter, or better, ribbon width, pdfs were also provided. Even bivariate pdfs for L and D were provided.)

Schaffner Technologies eventually achieved provision of scientifically correct, accurately and precisely useful, complete length pdfs, inherently by number, from which a wide variety of length data products were and are provided. AFIS technologies were sold to Zellweger Uster in 1989, which firm, recently under new ownership and a new name, Uster Technologies, still manufactures and sells AFIS instruments. A major paper was presented by the third author in Bremen 1992 on processing applications of the complete fiber distribution.

Significantly, AFIS has become the reference method for SFC (and also for Neps). Unfortunately, however, current AFIS is too slow and too expensive for routine, high volume SFC testing. It also suffers from known excessive fiber damage in its Fiber Individualizer, thus making its SFC measurement too high, particularly for the important class of long fibers.

In our second visit to the pdf measurement problem, starting in 1999, we carefully reconsidered all candidates examined in the first visit beginning two decades ago, including new versions of AFIS, and a variety of new methods, including several variations of image analysis. Performance capabilities of image-based technologies, and the associated personal computers and communications links, have come to the levels required for Li only in the past couple of years. Exploratory prototypes were evaluated for several of the candidate design concepts, both traditional and image-based.

Besides provision of pdfs and all the usual measurement performance requirements, we also added the very tough requirement that the resulting method be compatible with next generation high volume testing for commercial purposes and that those tests could be performed anywhere, including gins and warehouses. One such next generation instrument platform is called "IsoTester" and is described in the companion paper. This latter requirement led to the conclusion that our new method should test a new form of tapered beard. If this could be achieved, then the same apparatus yielding pdfs, and thus both LFC and SFC data products, could also yield tapered beard tenacity or strength and elongation. HVI users will certainly appreciate the advantages attendant to realizing this tough objective.

The Ultra Rapid Conditioning and force/elongation measurement technologies that make this "test anywhere" L + Str module reality are beyond the scope of this paper. It can be appreciated, however, that these tough design constraints, now realized, greatly advance the art of fiber length and strength measurements for traditional Classing Office Classing.

Importantly, these developments have also advanced the point in time when Gin- and Warehouse-based Classing can become practical realities. We clarify these statements in Section 4.

In summary, STI's objectives in a second visit to measuring the fiber quality of length included:

a. Provision of the monovariate length probability density function, pdf, from which all length data products may be derived;
b. Utilization of modern digital and scientifically basic methods, for data product quality, for internet communications, and for broad understanding;
c. Robustly reliable and easily maintained apparatus, including Internet-ready communications with the internal PC(s), for remotely monitoring performance and for remotely implementing calibrations;
d. Accurate;
e. Precise;
f. Fast;
g. Cost-effective; and
h. Compatible with the IsoTester® Platform and Gin Wizard™, Mill Wizard™, etc.

The primary objectives were a and h. All 8 objectives jointly defined the development and design paths that led to our image-based method for providing pdfs, Li.

Item h is an STI-internal, on-going objective; please see the companion paper for more about IsoTester® and Gin Wizard™. IsoTester® provides a platform for next generation fiber quality measurement modules and is thus an information content generator. Gin Wizard is an I/O = Input/Output system for collecting and presenting data from a plurality of content generator instruments, such as IsoTester®, and thereby controlling fiber processing equipment manually, semi-automatically, or fully automatically. Gin Wizard developments have been in process for only a couple of years but it is already clear that this I/O System has enormous potential for optimizing the ginning process via feedback and the marketing process via feedforward.

Principles of Li

Figure 1 shows bottom and side schematic views of a new form of comb sampler which is placed on the glass window of a high quality scanner. The scanner is preferably a color scanner operating with 75 to 600 dots per inch resolution. Needles in the comb sampler may be spaced closely, as with traditional Hertel comb samplers, or widely, so that they operate as a multiplicity of single needles. Multiple sets of either type may be constructed into the nominally 8.5 inch = 216 mm sampler bar and presented for simultaneous measurement by the scanner. Note the elastomer fiber locking mechanism, a major improvement.

After combing and brushing, the comb sampler is transported to the suction orifices, as seen in Figure 1. The transport can be manual or automatic. Air flows draw the tapered beards into the orifices, where they are held until the scanning operation is complete.

Figure 2 provides the complete image of a comb sampler having 2 sets of closely-spaced needles and the tapered beards thereto attached. The beards are drawn in, tensioned and aligned by the suction. The cotton under test is a staple standard 35. Note the 0.5 and 1" green reference stripes. Zero length is defined at the bottom, in the plane of the sampling needles, which plane is perpendicular to the scanner glass. This zero base distance and the high, two dimensional resolutions of the scanner image are also major improvements.

Every Li measurement image, after analysis, can be compressed and archivally stored in the IsoTester's database. This image may be made part of the sell-buy negotiations or trading record. It may be accessed and communicated over the Internet for remote inspection or even analysis. This, too, is an important advancement.

Figure 3 is a composite image showing part of one of the 2 beards seen in Figure 1 for 3 Staple Standards 32, 35 and 38. In one form of data presentation, the sample under test is similarly shown between samples whose length properties are known. This is a powerful tool for assuring data product quality, for process control, for training and for communications between specialists.

The amount of light reflected by the beards into the scanner optics has been found to be a remarkably faithful analog of Hertel's "amount." When plotted versus displacement of the scanner head, relative to the needles, an image-based fibrogram is produced. Analysis of this amount versus length, Ai versus x, by either traditional methods or by new, proprietary methods developed specifically for the Li module, yield superior LFC and SFC data products.

Importantly, the new methods of analysis enable provision of the complete fiber length distribution or probability density function, pdf. We have thus realized one of the prime objectives: provision of pdfs. For emphasis, our new methods of analysis provide "True" data products, meaning that the data products are derived from the pdfs, without any reference to calibration materials whatsoever. This will be appreciated as an extraordinarily important improvement.

Because the Ai is a faithful analog of amount versus x, it follows that the beards may be tested advantageously for tenacity and elongation. This is also fundamentally important for use with next generation fiber quality measurement instruments, as with IsoTester®.

To evaluate meeting the objective of compatibility with next generation high volume testing, we have initially focused on the traditional data products, UHM, ML, LUI and SFC. These results below were obtained on a prototype built for USDA/SRRC and independently analyzed and separately reported in the related BeltWide paper by Drs. Cui and Thibodeaux of USDA/ARS Southern Regional Research Center, SRRC.

Results

All of the following results are for staple standard materials kindly provided by USDA/AMS, independently and at different times, to SRRC and STI. Collectively, they cover the range of 29 to 39. Li data were acquired by both SRRC and STI personnel. HVI and AFIS data were acquired by SRRC and also by Cotton, Inc.

Figure 4 shows UHMi versus UHM HVI, including half error bars of one standard deviation, for clarity. Average CVs are shown in the inset on the Figure. Also shown is a Performance Index, which is essentially a signal to noise ratio used internally by STI. Evidently, Li performance, as measured by average CVs, is superior to that of the HVIs used to produce the corresponding LFC data. This surprising and most favorable result appears to be generally valid.

The data shown in Figure 4 are based on traditional analyses, not on the pdfs, and thus do rely on calibration cottons. These readings were forced to fit HVI readings in a conventional "Calibration Procedure," the results of which are seen in Figure 4. Note that the linear regression line is not coincident with the HVI 1:1 line. This is because the Li and HVI were calibrated on a different set of calibration cottons in different laboratories.

(For completeness, we did produce "True" UHMi data products. They were found to be highly correlated with HVI UHM but different in level and structure. We are further investigating the differences between the LFC data products of UHMh, derived from HVI, and the more basic UHMi, derived from our image-based pdfs. The reasons quite probably do not originate with errors in the Li method.)

Figure 5 shows True LUIi versus HVI LUIh. True LUIi means that LUI was derived directly from the image-based pdfs, using the basic definitions, not using fibrogram procedures, and without any use whatsoever of calibration cottons. Again we observed superior performance, based on average CVs. We also note the relatively small level difference in the two completely different methods for LFC data products, LUIh and LUIi.

Figure 6 shows the same Li and HVI data, on the same set of cottons, but this time the Li data were forced to fit the HVI LUI levels given by AMS for these staple standards, via a conventional "Calibration" procedure. Thus the regression line is nearly identical to the 1:1 line. Note the orderly curvature in LUIi in either Figure 5 or 6. This observation may also be relevant to the investigation into UHM differences just mentioned.

Figure 7 shows True SFC(w) via Li versus AFIS SFC(w), along with data from HVI. AFIS may be regarded as a reference method for SFC for these tests. It cannot be overemphasized that the three methods, AFIS, HVI and Li, are based on completely different scientific principles. However, both HVI SFC methods are "calibrated" to AFIS data. Li data are completely independent of AFIS data.

Since the Li SFC data reported are independent of any other methods, and also of any calibration cottons or other calibration fibers whatsoever, it follows that Li method qualifies as a reference method for SFC. Importantly, the Li method also qualifies as a reference method for LFC. Thoroughly establishing the validity of the Li method as a reference method for LFC and SFC will occur in due course.

The HVI SFC data in Figure 7 are provided directly by current HVI. A second SFC data product, based on HVI data, SFCpred is also given. SFCpred is derived from a prediction equation based on LFC properties from HVI, UHM and LUI. This equation, developed by Knowlton et al at AMS, was applied by us to these HVI data generated at SRRC or CI.

The fact that the Li and AFIS SFC(w) levels are so near, broadly speaking, in absolute levels is a truly remarkable confirmation of basic accuracy for both methods! It is also truly comforting, as our industry begins to rely on SFC data products for commerce. That is, mills, which predominantly use AFIS, can rely on Li SFC readings on candidate bales for purchase to be on the same level and at the same precision.

The fact that the HVI data are on the same level is expected. This level agreement follows from the fact that HVI SFC readings are "calibrated" to AFIS SFC. It would be remarkable if they were not on the same level.

We now turn to the matter of precision, which is critically important for comparing SFC readings on a bale-by-bale basis or process sample-by-sample basis. CV = sd/mean is determined from replicate measurements on the same samples, typically with n = 5 to 10 replications. The average of these CVs is thus a measure of precision.

The average CVs and structural differences are seen in Figure 7. These results, along with the discussions above, lead to several important conclusions:

a. All SFC(w) data products are on the same level and cover the range of about 5 to 20% for staples 29 to 39. For the bulk of the US upland crop, the range is about 8 to 15 %.
b. It is remarkable that the independent AFIS and Li methods both provide true SFC readings that are on the same level.
c. The HVI - related SFC data products are dependent on, ie, calibrated to, AFIS levels.
d. The independent AFIS and the Li methods have by far the best precisions or reproducibilities for SFC, with CVs ~ 5% or standard deviations ~ 0.5%.
e. From a, b and d, it follows that Li and AFIS methods are acceptable in accuracy and precision for trade or for gin and mill process optimizations.
f. From e and the discussions above, we conclude that only the Li method for SFC is accurate, precise and fast enough for trade.
g. Both AFIS and Li, in providing pdfs on different, scientifically correct bases, qualify as reference methods for both SFC and, importantly, also for LFC.
h. The structural differences in the various SFC methods versus AFIS SFC all show the same "kink" at SFC ~ 17%. This suggests that the AFIS data may not be as orderly as expected.

Summary, Recommendations, and Clarifications

Commercial market needs for an improved length measurement method, broad technical objectives, and principles of measurement for a new, image-based method were given in the Introduction and Principles Sections. Detailed conclusions about performance and market application, based on the detailed data results, have been given just above. We close with a broad summary and some recommendations and clarifications.

Cotton fiber length measurements are vitally important descriptors of fiber quality. Length data products include both long fiber content, LFC, and short fiber content, SFC, components. LFC data products, such as UHM as provided by current HVI, have received emphasis for a long time and are generally satisfactory for commercial trade.

Contrariwise, SFC measurements, of recent and increasingly wide-spread interest and concern, are not currently satisfactory for commerce. Those that are correct, meaning basic and accurate, namely array or AFIS methods, are too slow, expensive, or imprecise for high volume testing associated with commercial trade. Those which are fast enough, namely HVI-related measures, are neither basic nor accurate nor do they have sufficient reproducibility or precision for trade.

We note that SFC is the best measure of fiber damage in the gins and mills. SFC is the best measure of processing performance and of yarn and fabric qualities in the mills. Length Uniformity is an insensitive indicator of damage and has basic problems in its definition. See below. Alternatively and better stated: SFC is an increasingly important fiber quality; the lower the better. And the more correctly it is measured, the better. Only with correct and widely accepted SFC data can producers and designers and operators of processing machinery evaluate the quality of their work and, thereby, realize the financial incentives to improve the performance of the processing machines that they design, operate and maintain.

It follows, obviously, that new length measurement methods were urgently needed. Preferably the methods can provide pdfs and also be compatible with next generation high volume fiber quality measurement instrument systems, along with improvements in other fiber quality measurements. Methods which provide the complete fiber length distribution or probability density function pdf are especially preferable because such basic methods provide "true" length data products, meaning that the measurements do not fundamentally depend on calibration materials. Preferably the methods can provide improved precision and accuracy for both LFC and SFC components at comparable speeds, reliabilities and costs to existing methods.

Principles and initial results are reported for a new, image-based method for measuring, in scientifically basic terms, the complete fiber length distribution from a new form of tapered beard. The precision and accuracy of both LFC and SFC data products derived therefrom are seen to equal or significantly exceed the best available current technologies. The Li SFC data product is seen to be "true" and should be especially interesting to this audience, as better seen in the related paper by Drs. Cui and Thibodeaux. It will be appreciated that this length by image analysis or Li method represents a major improvement, perhaps even a "break-through," in fiber length measurement technology.

All of the design objectives set forth for this second visit by Schaffner Technologies to the problem of fiber length measurements have been met or can reasonably be expected to be met. Confirmation of other objectives (Speed, Costs, Reliability, Utility of Internet Communications, etc) must wait until sufficient production units are evaluated in field service within the next year.

Several patents are pending on the Li and related Strength methods.

We close with some brief recommendations and clarifications.

Length Uniformity Index, defined as LUI = Mean Length / UHM, is commonly interpreted as an indication of the amount of fibers that are uniformly long, with the implication being that high LUI means lower SFC. This is not rigorously true and is only approximately valid for commercial cottons. Accordingly, we note here its fundamental insensitivity and general invalidity. The entire range of useful LUIs is about 0.77 to 0.83, so the measurement is grossly insensitive for commercial cottons. With regard to basic validity: Monolength fiber distributions having fibers of 0.5 and 1.0 inches both have LUI = 0.5/0.5 = 1.0/1.0 = 1.0! Thus LUI is fundamentally, by definition, incapable of providing rigorously useful SFC information. It is not difficult to describe processing conditions where increasing damage to the longest fibers <u>raises</u> LUI. And so on.

Although, commercially, premiums and discounts have begun to appear for high and low LUIs, respectively, we recommend moving away from LUI and toward SFC(w). Never-the-less, we will continue to report the LUI data product as long as it is in use.

Short Fiber Content, SFC, as noted above, may be expressed on a weight or number basis, as follows.

SFC(w) is, by definition, the percentage by weight of the complete fiber length distribution for those fibers whose lengths are < 0.5 ". SFC(w) is commonly used for commercial trade and is widely understood and accepted.

SFC(n) by number is defined similarly and is also used, sometimes with advantage, as this measure is inherently more sensitive to the effects of processing damage, particularly lint cleaning in the gins or mills.

For consistency, and to facilitate communications between all parties, we recommend use of SFC(w) for all bale trading and gin processing optimizations. We also recommend SFC(w) over SFC(n) for all but the most specialized mill processing machinery optimizations. Either, of course, can be determined from the pdfs.

We note that other measures of the short fiber component, such as “floating fiber index” or normalized SFC, have been proposed. We further note that these measures may also be determined from the pdfs and are thus "true." If our industry chooses any other measure of SFC, it can be provided on a “True” basis by Li.

Classer's staple length, usually reported in 1/32 increments of one inch, is the oldest and is still a very common data length data product used for commercial trade. Classer's Staple, and its HVI "equivalent" Upper Half Mean, UHM, are reported in 1/32nds and decimal values, respectively. In our method, we first determine UHM and present, where desired, the Classer's Staple =UHM x 32. Thus a cotton having UHM = 1.06" has Classer's Staple = 33.9.

Finally, recall that one of the primary design objectives for the Li method was to be compatible with STI’s IsoTester Platform and its Gin Wizard I/O monitoring and control system. This compatibility enables progress towards Gin- and Warehouse-based fiber quality measurements or “Classing,” which concepts need some clarifications, in view of some unexpected negative reactions to them.

STI has very broad and long term points of view about the concepts “Gin- and Warehouse-based Classing.” STI has openly shared its visions for these concepts, since we first published them in a major invited paper in Bremen 2000. We have shared these visions to define our instrument design objectives and to explain how some emerging and important technologies (digital color imaging, PCs, communications and, of course, the Internet) can be made to serve cotton. We have also freely shared them in the interest of stimulating discussions. We certainly did not share them to confuse anyone, or to recommend abruptly tearing down and replacing any widely-accepted, well-understood, and proven system. Never-the-less, these concepts have been misinterpreted, sometimes vigorously, so the following clarifications are offered.

By “Classing” we broadly mean measurement, anywhere, of any fiber quality, or a plurality of them, which affects price and which quality-price relationships are used by willing sellers and willing buyers of cotton in free market commerce. This broad view of Classing thus includes, for the USA, data products which are currently part of the Official USDA/AMS Classification System, such as Trash and Length, and data products which are not official, such as Moisture Content or Stickiness.

By long term, we expect a slow and orderly transition from 100% official classing in AMS classing offices to mostly official classing in gins and warehouses, under AMS supervision. We project that “official” Gin- and Warehouse-based Classing will be in widespread use only by 2020 and then only if our industry wants it.

USDA/AMS will always need to supervise official, Smith-Doxey Classing in the USA. The third party nature of official classing is vitally important to the integrity of the US marketing system. For obvious economic reasons, official Gin- or Warehouse-based Classing can never cover 100% of the installations, so AMS will always need to test some samples while supervising the rest.

Gin and warehouse people can, of course, measure, i.e., unofficially "Class” in their facilities any fiber quality they and their Customers can justify. Importantly, starting in 2002, comparing Unofficial Gin- or Warehouse-based results with Official AMS Classing Office results can lead, via a slow, orderly transition to doing it right, early and once, in most of the leading US gins and warehouses, eventually. This can be a win-win scenario for everyone involved in cotton commerce. Some comparisons of gin and AMS Classing Office Trash or Leaf Grade data are given in the companion paper; these initial results are very encouraging.

Indeed, significant first steps in Unofficial Gin- and Warehouse-based Classing are already being made. One testimony to progress is reflected in the commitments of leading gins and warehouses to install fiber quality or classing instruments and by the willingness of their Customers, and also by Merchants and Mills, to pay attention to these “Unofficial Classing” data products. Progress is also evidenced by a milestone session devoted to the subject of Gin-based Classing at the June 2002 Cotton Inc Engineered Fiber Selection Conference. And we respectfully submit that this paper and the companion paper, and the related and much larger efforts in STI on IsoTester® and Gin Wizard™, are further evidences of progress.

Acknowledgements

Schaffner Technologies gratefully acknowledges the support of Cotton Incorporated (Preston Sasser, Michael Watson) and USDA/ARS/SRRC (Devron Thibodeaux, Leon Cui). USDA/AMS (Norma McDill, Darryl Earnest, Jimmy Knowlton) supplied the cottons for which data are reported here and encouragements. Many other textile leaders have encouraged us during this challenging endeavor. They are too numerous to individually acknowledge, except for two. Ken Bragg provided in 1984 and following years technical leadership and moral encouragement for the development of AFIS L + D, as well as financial support, via USDA/ARS/Clemson. Donald van Doorn of the Lummus Corporation, over the past 3 years, never let us lose sight of the importance of correct SFC measurements for enabling financial incentives. Strong financial incentives are indeed needed for ginners and gin machinery builders to incur the costs and risks of minimizing processing damage and preserving fiber length quality. Thanks, all.

The authors also thank their STI Colleagues, Bill Floyd, JPCaux, Kipp Julius and Missy Shofner, and especially their long-suffering and supportive wives Wen Yang, Melissa and Betty Jo. We hope it will prove to be worth it.

References

“Application of the Complete Fiber Length Distribution to Mill Processing,” Frederick M. Shofner et al. 17th International Cotton Conference, Bremen 1992.

“Cotton Classing in the New Millennium,” by Frederick M. Shofner and C. Kyle Shofner, 25th International Cotton Conference, Bremen 2000.

“Gin-based Classing: First Steps,” by Kipp W. Julius, C. Kyle Shofner and Frederick M. Shofner. Presented in the Ginner’s Conference at this same BeltWide 2003 meeting.

“Update on Our Short Fiber Content Research,” by Xiaoliang “Leon” Cui, Devron Thibodeaux, et al. Presented in the same Cotton Quality Measurements Conference at this same BeltWide 2003 meeting.

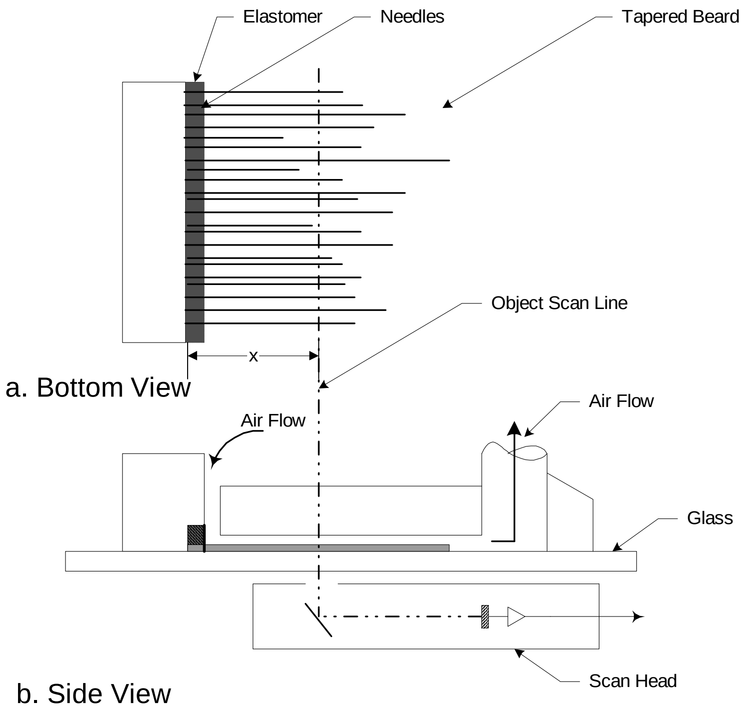

Figure 1. Li schematic.

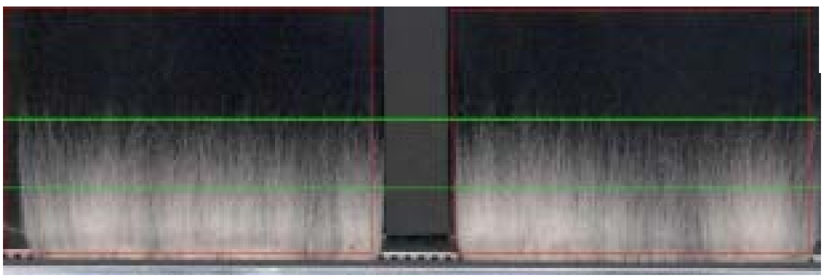

Figure 2. Staple 35 image.

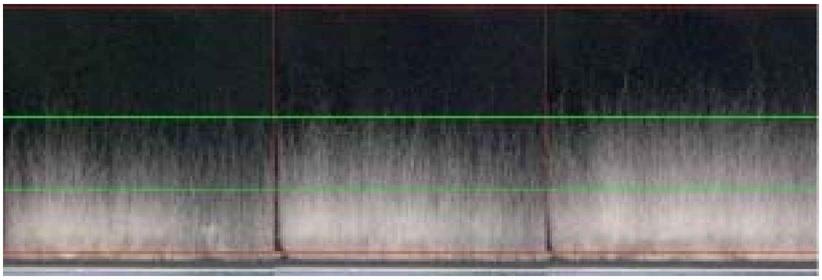

Figure 3. Composite Image Of 32, 35, 38.

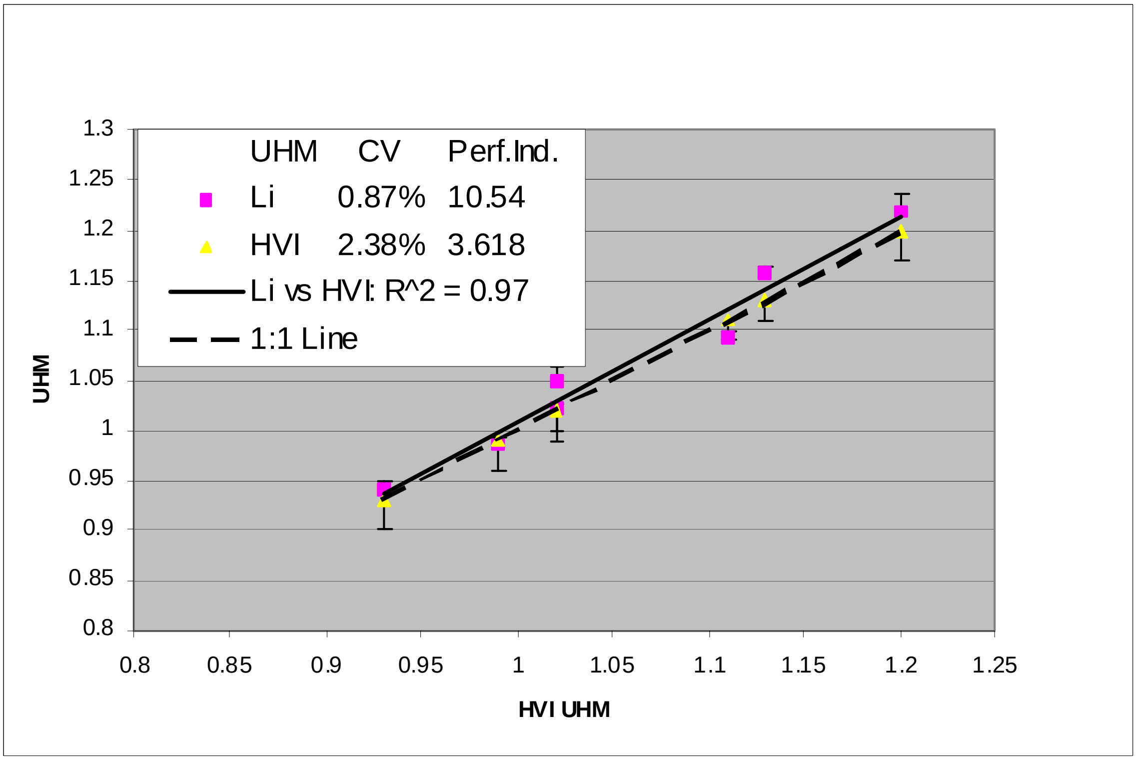

Figure 4. UHMi versus UHM HVI.

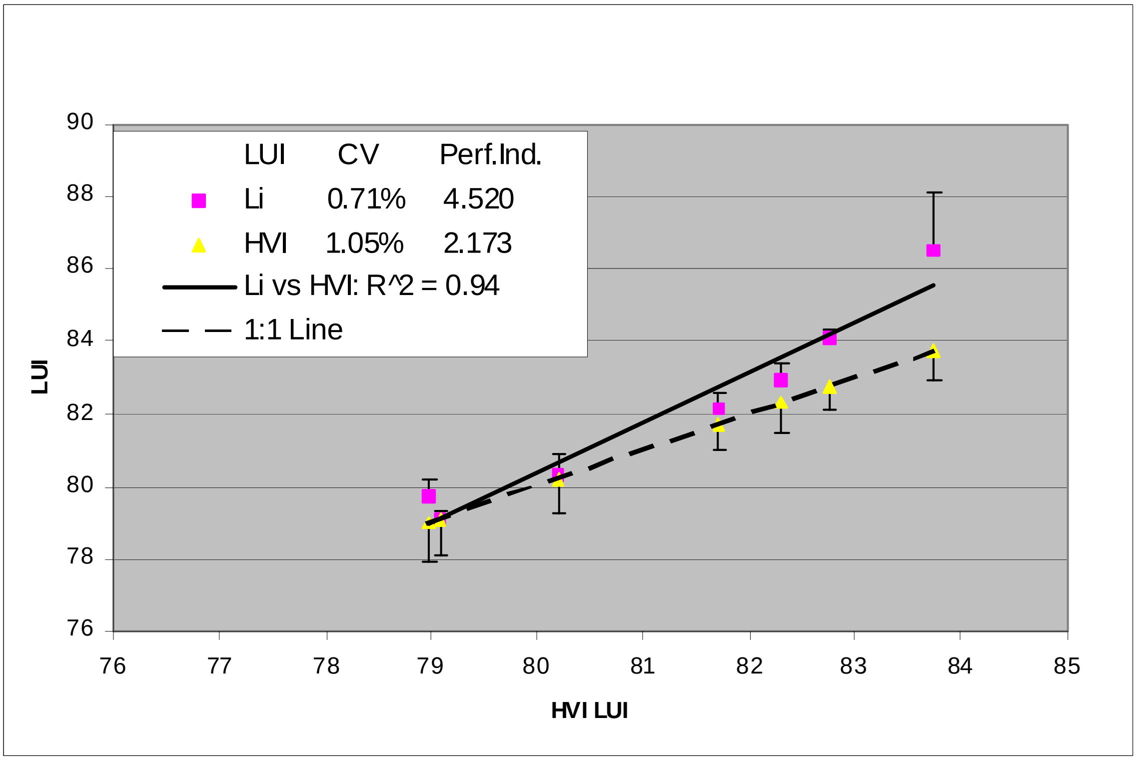

Figure 5. LUIi versus LUI HVI.

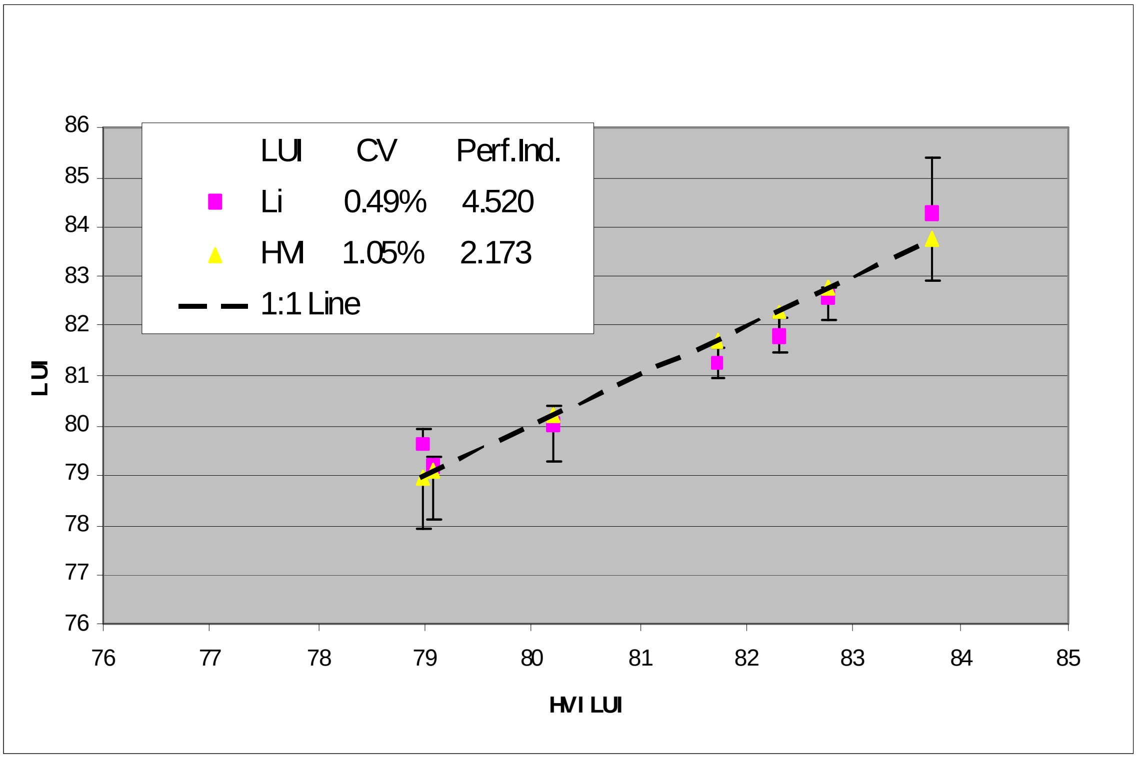

Figure 6. LUIi versus LUI HVI Cal.

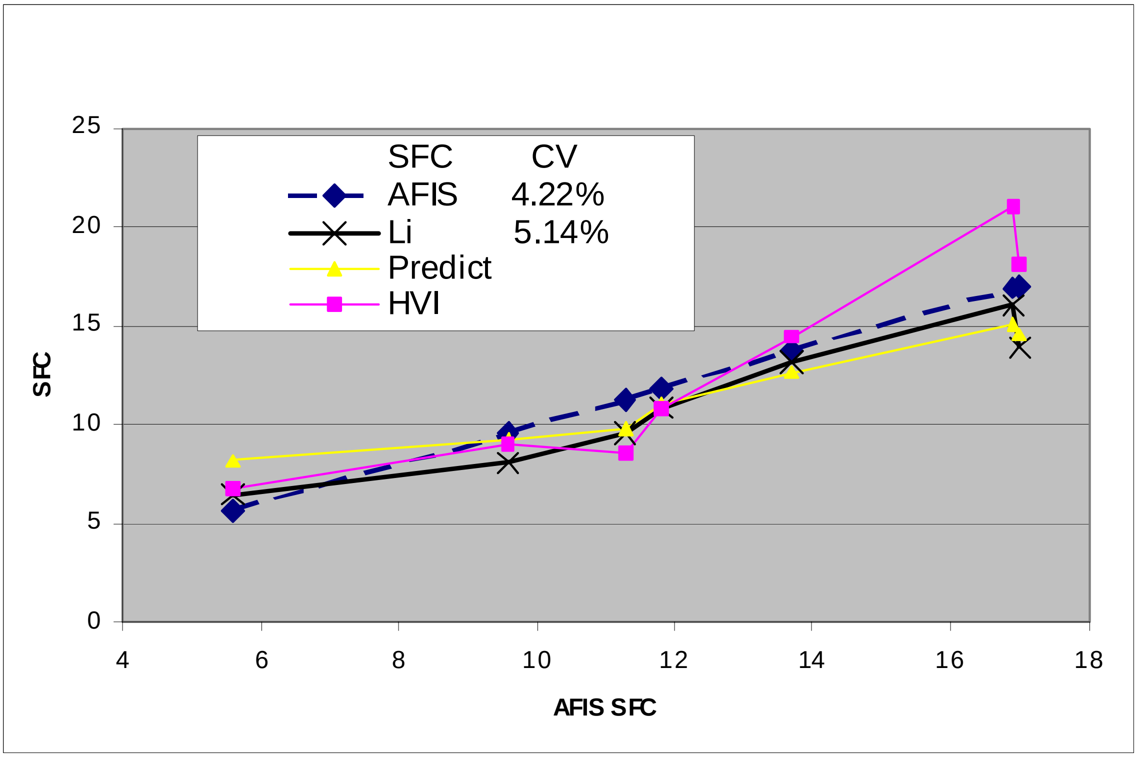

Figure 7. SFCvia Li, HVI SFC, HVI Prediction versus AFIS.