Gin-Based Classing, Internet Classing, and Internet Trading

C. Kyle Shofner, President
Frederick M. Shofner, Chairman
and Zhang Yupeng, Senior Software Engineer

Schaffner Technologies, Inc
Knoxville, Tennessee USA

EFS System Conference
June 10-12, 2002

Abstract

A progress report is given for the measurement methods and current and future data products of 9 cotton fiber qualities. These RapidTester methods use modern instrumental technologies to provide current data products and are suitable for commercial trade. Commentary explains how orderly transitions from current data products to future data products can be implemented. Gin-based and Warehouse-based Classing, Internet Classing and Internet Trading are defined and discussed

A. Overview

In our Bremen 2000 paper, entitled "Cotton Classing in the New Millennium," we identified 9 instrumental measurements of fiber quality that, in our considered opinion, will be used extensively in worldwide cotton commerce in 2020. Our opinion was and is in part guided by historical experience, much of which was summarized in that long paper, with emphasis on the last century. In larger parts, our opinion is guided by consideration of market needs, economic impacts of the data products on cotton commerce and utilization, and where in the production-utilization system those data are generated. Current and future perspectives were carefully considered so that orderly transitions in data products can occur, preferably as extensions to measurement methods being put into place now.

Appropriate attention was given to the United States Department of Agriculture's vital role in the development of standard methods and provision of standards, particularly including instrumental methods. The enormous impacts of these USDA Agricultural Marketing Service methods and standards are well known to this audience, as are the opportunities for improvements in measurement and communication technologies, measurement location, and for correcting aberrations in the marketing system. Before substantive changes are made, it is well to ask: How did we get here? Where do we wish to go? What are the economic consequences for everyone affected?

The more relevant historical experience was the last 20 years, during which the transition from human classing to instrument classing began in earnest, with introduction of HVI in the 1980s. It is well appreciated by this audience that our industry is in a rapid and dynamic portion of the transition from 100% human to 100% instrument classification. Accordingly, it is appropriate to review progress in fiber quality measurement methods at 2002 in view of our vision for cotton classing in the new millennium, at 2020.

Our Bremen 2000 paper was intentionally historical, objective and broad. Only brief disclosure was made of one of our emerging methods, image-based Color and Trash. This Bremen 2002 paper is a progress report and is directed to all 9 measurement methods employed on Schaffner Technologies' RapidTester™. RapidTester is a modular instrumental platform, which is now moving into diverse applications around the globe. Comments on transitions to future data products are also given below. Because of its importance, comments are made about internal, Ultra Rapid Conditioning.

Robust construction, simple and reliable operation, and internal, Ultra Rapid Conditioning = URC enable the RapidTester instrument platform to operate in non-conditioned environments such as gins and warehouses. Gin-Based Classing, Internet Classing, and Internet Trading have the potential to impact global cotton economics in major, positive ways. By intentional design, RapidTesters are Internet ready.

Yes, RapidTesters can operate in unconditioned gins and warehouses and act as reliable and useful content generators for e-business! These objectives, to enable testing in any environment and to enable Internet exchanges of the data, have taken on intense mission status in our Company. Thus the focus of this paper is on the content itself, the measurement methods and resulting data products, and on defining and discussing the new ideas of Gin- and Warehouse-based Classing, Internet Classing and Internet Trading.

B. STI's Methods for Cotton Classification; Transitions From Current to Future Data Products

At this writing there are 9 RapidTester installations in the US, 7 in Australia, 5 in Brazil and 1 in Paraguay. We project as many as 15 more installations for the US in 2002, depending on economic conditions. STI has recently built 8 instruments, including the Brazilian and Paraguayan installations, which include URC and Neps in addition to the currently used "HVI" data products of Micronaire, Length, Strength, Color and Trash. These 8 are the most fully loaded of the RapidTester Platforms, having 6 of the 9 modules and URC. Two prototype RTs having a Stickiness Module are undergoing their second season of secret beta site trials. Moisture content is undergoing field trials at one US gin location. Thus 8 of the 9 modules predicted for 2020 are in production or at least in prototype form now. Only Maturity is not now available.

Descriptions of our methods of measurement and comments on transitions from current to future data products are given for each data product described below. Tables 1 and 2 concisely summarize these descriptions and comments. Table 1 here is identical to Table 1 of the 2000 Bremen paper except for revisions in the 2002/Current AMS column. There are 2 updates to reflect USDA/ Agricultural Marketing Service's transition from unofficial to official use of HVI Color in place of Classer's color call. This transition occurred in the harvesting season of 2000. Thus Classer's Color Grade is removed from the Human Measurements section and the brackets are removed for HVI Color in the Instrumental Measurements section.

Table 2 expands from Table 1 to add the measurement methods and current data products for the RapidTester and to add some detail for the 2020 data products, explained below. Orderly transitions from current to future data products are possible because the measurement methods are substantially the same.

Where applicable, current RapidTester data products conform to those in use and reproduce or track available data products. The high correlation of RT data products with HVI have been reported in ITMF 2000 and in several Beltwide and Engineered Fiber Selection Conference papers. Although the current RT data products are conventional, STI's methods are new and employ powerful, modern technologies. These include single needle tapered beards for Length and Strength, high resolution, high fidelity, color image-based methods for Color and Trash and Sticky Points/gram, and internal ultra rapid conditioning.

According to intentional design, STI's methods and system permit orderly transitions from currently used fiber quality data products to improved, future data products and to data products not now in use. That is, the consequences of this much more difficult design approach are flexibility in choices of modules at purchase or as retrofits, or in operation, fewer "new model" introductions with attendant disruptive and expensive replacements, longer product lifetime, and lower costs over that extended lifetime. In other words, we expect to find RapidTesters shipped now to still be in service in 2020 but producing the new data products expected then.

1. Micronaire

Method. This oldest, conventional measurement uses airflow permeability through a compressed sample weighing nominally 10 grams. Compressed air flow is not used since the moisture content of air delivered by the typical compressor installation is both unknown and highly variable. If it is known, as a consequence of using dried air, then the sample is dried during the measurement, leading to variable results. RapidTester uses conditioned air from the laboratory or from the internal AC, if URC is employed.

Transition. This well-known and easy measurement yields a useful data product that will remain in substantially the present form, as seen in Table 2. A transition to a new Mic data product is not expected although further improvements in hardware and software are likely.

The Maturity and Moisture Content data products described below are integrated into the Mic hardware. This facilitates the transition to add the Mat and MC data products, as seen below.

2. Length

Method. STI thoroughly considered five fundamentally different length measurement methods, with several variations in some cases. In addition to the broad factors listed in the Overview section, basic technical factors used were scientific meaningfulness, accuracy and precision, cost and speed, ease of operation and automation, and industrial robustness. Specific factors were ability to provide the complete length distribution, including a valid, meaningful, true measurement of Short Fiber Content. The time frame for the considerations was from 1999, when the design considerations began, to about 20 years into the future.

We eventually chose, perhaps surprisingly, a combined L + Str method based on a multiplicity (~4) of tapered beards, each formed with a single needle. The choice may be surprising in view of STI's pioneering work in the areas of single entity measurements with light scattering and image analysis and in the area of single fiber tenacity/elongation. From a pragmatic, business-oriented viewpoint, the criterion of tracking traditional data products, which focus on "long fiber content," dominated the choice. However, we did not compromise the SFC objective.

Our single needle, tapered beard method is new. We believe that single needle beards are “ideal” in that they more faithfully represent the complete fiber length distribution of the bulk material; that is, the sample is not length-biased. The currently employed HVI comb sampler produces a biased specimen, especially for long fibers, and is particularly unable to provide a true measure of short fiber content. True SFC, not "SFC" as indicated by HVI, will be an increasingly important future data product. Also, all single fiber methods cause inherent modifications to the complete fiber length distribution because of an aggressive opening step.

Our industry's historic and current emphasis, for commercial classing purposes, has been and is still upon long fiber content, for which the well-known data products are Upper Half Mean = UHM, Mean Length = ML, and Length Uniformity = LU. Dimensions are inches or millimeters. Our work to date has focused upon tracking these data products.

Transition. Although RapidTester currently provides the Length Uniformity = ML/UHM data product, we wish to comment that LU is only an approximate indicator of short fiber content = SFC. For example, if one compares LU for 2 monolength distributions of fiber, where all the fibers are either 1.0 inch or 0.5 inch, it follows that LU = 1.0/1.0 = 0.5/0.5 = 1 for both! Indeed, LU = 1 for all monolength fiber distributions and is thus fundamentally flawed for practical use. We therefore place a question by LU in Table 2

Accordingly, one of the primary criteria in selection of our L method was provision of a true measurement of short fiber content, SFC. We were motivated in this choice by increasingly intense and frequent mill complaints about high SFC and about the absence of sound measurements therefor. For rudimentary business reasons, the SFC data product is not currently provided. But making the transition to include the SFC data product is straightforward and largely a matter of thorough calibration, which should occur within this year.

3. Strength

Method. A second reason for the choice of multiple, single-needle, tapered beard method is inherent suitability for Strength or Tenacity (grams force/tex). The beards are ultra rapidly conditioned prior to and during the L measurement and again just prior to the Str measurement.

STI's Strength test initially used a radically different clamping approach that broke more of the fibers present, including more fibers having length near ML. It is now clear that the Str data product is very different from conventional HVI data. The clamping arrangement is being changed, again for pragmatic business reasons, to produce data basically identical to the "1/8 inch gauge" test used in HVI, which emphasizes long fibers.

Transition. The hardware and software are already in place to provide the only expected new data product, elongation E. For some special applications, E is provided now.

4. Color

Method. Color and Trash are both measured in the RapidTester by color image-based methods, the concepts and basic performance of which were described in the 2000 Bremen and ITMF papers. In our proprietary method, a high fidelity 8.5 x 11.5 inch color scanner is used to acquire, in ~ 15 seconds, a 6 MB file of a sample under test (pressed onto an 8.5 x 8.5 inch window) and, in the same scan, of reference materials (3.0 x 8.5) held permanently in a reference block and behind another window of similar optical quality. Thus a rigorous calibration is executed during every test, which currently takes about 25 seconds, total. The reference material block contains both cottons whose Rd and +b are tied to the master colorimeter at AMS/Memphis and, importantly for the transition part of this discussion below, to a Kodak Q60 target having well-known, published, traceable, and absolute or CIE color values X, Y and Z. (CIE = Commission Internationale l'Eclairage.)

The RapidTester currently provides the conventional Rd and +b data products, as seen in Table 2. Based on these readings, an instrument Color Grade = CG is calculated and provided as a data product. The transformation from Rd, +b coordinates on the "Color Chart" to CG is provided as a look-up table by AMS. The transformation was developed by AMS to make Human Classer and Colorimeter readings track.

It is significant to note that leading mills prefer the basic Rd and +b data product over CG since color resolution is better. This preference is also behind the industry's support for AMS shifting from Human Classer CG to HVI CG. Still further, this preference is a strong indication that mill Customers will prefer all 3 color coordinates, especially as we move to the modern CIE system.

Transition. Evidently our method can determine true CIE color. We force our data to fit the existing Rd, +b data from AMS because sellers and buyers are accustomed to these data products. But whenever our industry is ready to move to modern color coordinates, it is a straightforward matter to install new software and recalibrate the RapidTesters to report X, Y, Z or Lab coordinates.

We also note, with emphasis, that our method can provide the color of the cotton, without the degrading influence of the trash particles. It is impossible for any wide area colorimetric method, as used with HVI, to avoid the degrading influence of trash. Color of the lint or fiber only is in reality what is needed, particularly as the penalties for high trash aberrations are removed and it becomes economically and well as technically correct for gins to supply less-damaged cotton with higher leaf.

Another basic feature of the RapidTester method for Color may be of interest to this international audience. The reference or "target" cottons we have used so far are formed from the same bale materials as used for universal cotton color standards prepared by the USDA/AMS in Memphis. But reference cottons from any country or even from an individual gin or mill, or a mix, may be used for the reference biscuits. It should also be clear that this method can use other reference materials in addition to cottons. This will be increasingly important as we move toward absolute or CIE color measurements.

5. Trash

Method. The first 4 data products in the 2002 column of Table 1 are currently provided with RapidTester or with "HVI" equipment, such as operated by USDA/AMS, and officially accepted for commercial trade. The Trash data product is typically provided but not officially or widely used; a human classer Leaf Grade call for Trash is still the far more widely-used, official data product, in the US and in the rest of the world.

Thus there is a strong need and a good opportunity for introduction of new technologies for Trash measurement. The needs of the market and the opportunities for the RapidTester include:

a. Eliminating the last Human Measurement function in the present marketing system;
b. Providing more useful data for gin and mill process control;
c. Providing better images for Gin-based Classing, Internet Classing, and Internet Trading.

STI has made considerable progress with its RapidTester Trash method since 2000. The primary advantages over current HVI technologies are:

a. Much larger window for the sample under test (which yields much better precision and accuracy);
b. Color images versus monochrome;
c. Higher resolution/much larger image files (which, among other things, enables measuring the color of every trash particle); and
d. Powerful algorithms for measurement of Leaf and for Bark and Grass.

Recent tests show that the RapidTester Leaf Grade agrees with human classers about 70% of the time, within one leaf grade unit. This level of agreement accuracy is comparable to the agreement between Classers. The between-RapidTester agreement is well above 90%. These tests were run with multiple faces presented to a larger scan window and represent a slightly special RT configuration. Parallel work on this project will enable the scan time to be about 10 seconds. This is a consequence of improvements in scanners, in PCs, and in software.

Please note, with emphasis, that RT data are reported to one decimal place (i.e., LG = 3.7 versus LG = 4, as currently provided by Human Classers and by HVI.

Thus it follows that RapidTester's image-based technologies can and will replace the Human Classer as soon as our industry becomes comfortable with the idea.

Other recent tests show the ability of RapidTester image methods to distinguish bark and grass reliably. Because of the high resolution, color images, and powerful algorithms each and every trash entity is analyzed, as will be demonstrated in the companion paper. Shape alone is insufficient for measurement of bark and grass.

In our attempts to maximize the correlation of RapidTester Leaf Grades and Human Classer Leaf Grades, several most interesting and basic experiments were performed wherein the Classers looked at the color monitor and made their calls. (These experiments were part of studies supporting Internet Classing, described below.) Not only did the correlations between humans and the RapidTester dramatically improve, some of the Classers felt that they could do a better job of classing when looking at high fidelity images, with magnification and other image-viewing aids, than by looking at the cotton sample itself. We learned considerably about human classing and classer psychology from these experiments.

The current data products provided by the RapidTester are the same as HVI, % area and Leaf Grade = LG, as seen in Table 2.

Transition. It is clear that the technological foundation has been laid for extensions to future data products of Bark and Grass, Extraneous Matter, and Preparation, if needed, thus the question mark in Table 2. When the trade accepts these data products, the Human Classer can be eliminated. We believe this will occur long before 2020.

6. Moisture Content
Method. This data product is particularly important for gin-based classing, as it is one of the parameters that the gin wishes to control. It is also useful to confirm that the samples have proper moisture content for testing. Our MC method is based on a combined capacitive and resistive conductance method, with features, which enhance accuracy and precision, especially at low MC. A prototype is undergoing field trials at this writing in one US gin.

As noted in Section 1 above, the sensing electrodes are located in the Mic block. Thus the conductance measurement is made under known compression of the Mic plug, whose weight is known. The data product is % water, relative to the dry weight of the cotton.

Transition. This data product is unlikely to change.

7. Neps
Method. Schaffner Technologies personnel pioneered Nep measurement. STI's second textile instrumentation product, AFIS, was introduced in the early 1980s. (The first was the MicroDust and Trash Monitor = MTM.) The Neps module for AFIS was, initially, the most commonly purchased, primarily by mills for process control. AFIS technology was sold in 1989 to Zellweger Uster and AFIS has become the world standard for Neps. STI personnel extended Neps measurement technology while part of Premier Technologies in 1997-98. The currently offered method uses Electro-optical light extinction across a wide nozzle through which highly opened fibers, neps and other entities are passed. This method provides data from a larger sample (10 grams versus 0.5 gram) and in faster testing times (<1min versus >2 min). The larger sample improves reproducibility and the faster testing times improve data productivity. The basic data product is neps per gram.

Transition. Extensions are expected to include Seed Coat Fragments as a separate data product. Another extension under consideration is nep size distribution.

8. Maturity
Method. This data product is not currently available. However, most of the hardware is already in place, as part of the Micronaire apparatus, since we intend to use the principle of multiple compression airflow permeability. Thus only thorough calibration and field validation are needed---in addition to enough Customer demand to justify completing the development.

We anticipate that calibration will be based on image analysis of fiber cross sections.

Transition. Not applicable.

9. Stickiness
Method. STI also carefully considered several stickiness measurement methods. To avoid a recently discovered problem of false positives with current instruments, we chose to use the principle of the minicard, wherein a 10 gram sample is formed into a thin web and then passed between two rolls. Sticky points in the sample stick to the crush rolls and are reported on a sticky point per gram basis. We partially automated the minicard process with our Stk Module and used image analysis to count the sticky points on the detector roll. Testing time is about one minute.

Two experimental prototypes have operated in two anonymous labs for two years. Extensive experience has been gained and a production version is planned for introduction later this year.

Transition. We expect that 2020 will find additional data products of sticky point size distribution and sugar type in place.

Ultra Rapid Conditioning

We do not count URC as a measurement module but note here its increasing significance with regard to testing operations in non-conditioned or poorly conditioned test environments, such as gins, warehouses, or mill production areas. Importantly, this feature of internal and ultra rapid conditioning enables advantageous relocation of the classing function to such environments. The advantages, particularly of Gin-Based and Warehouse-based Classing are both technical and economical. With respect to economics, there are feedback and feedforward components, as explained in the next section and, by examples, in the companion paper.

With respect to technical advantages, it may be interesting to briefly note that STI's developments with RapidCon and RapidAir reduced passive sample conditioning time of 150 gram HVI or Classer's samples from 24 (minimum, practical) to 72 (rigorous, ASTM) hours to 15 minutes, with active ventilation and control of the environmental conditions entering the samples. By conditioning multiple, small ideal "beards" at the time and in the testing zone of the measurement, RapidTester's URC module is able to condition the beards in less than 30 seconds.

This has to be contrasted with present HVI practice. Although HVI samples are conditioned before testing, passively or rapidly, and the HVI equipment is required to operate in a conditioned environment, the samples are processed through an aggressive combing and brushing process that changes the conditions of the sample. Plus the internal test zone conditions are very different from the lab.

C. Gin-Based Classing, Internet Classing, and Internet Trading

STI announced the gin-based classing focus of its business plan and very generally disclosed the concept of "Internet Classing" for the first time in Bremen 2000. Gin- and Warehouse-based Classing, Internet Classing, and Internet Trading are very different ideas and are distinguished by the definitions and discussions below. All of them can involve examination of color images and other fiber quality data to facilitate buy-sell decisions.

Gin-Based Classing, by definition, means acquiring all fiber quality data products at the Gin, preferably at the uniquely advantaged location by the bale press. Warehouse-based classing is an obvious extension. The data products, including images, are organized into classing information and archived by permanent bale identification at the gin or elsewhere in a database. The data products can subsequently be communicated over the Internet or conventionally. There are obvious and significant economic and technical advantages to move the classing function toward warehouses and gins.

Internet Classing, by definition, involves acquiring raw images and other raw classing data at one location, communicating these data over the Internet, and generating data products from these raw data in one or more other locations. Fiber quality data products at the remote locations can be generated either with another computer or with a human, or both. Generation of data products at the first location are, strictly according to the definition, not necessary but are usual.

Internet Trading, by definition, means e-commerce wherein buy-sell information is handled over the Internet. Such information consists primarily of searches and offers and contractual and shipment details. Increasingly, fiber quality data, including images, will be included.

Internet Classing is a logical extension of our image-based methods and is an intended consequence of the "internet readiness" of the RapidTester. One highly noteworthy feature of the RapidTester method is that high fidelity, color, digital images of sample(s) under test and reference materials are acquired simultaneously. The reference materials may include digital cotton standards, as discussed in the companion paper with respect to Gin Wizard.

To further clarify, cotton classing takes on two primary forms or transitional combinations thereof:

1. Traditional Classing. Collect samples and ship them to remote sites for human and/or instrument classing. Archivally store many physical samples remotely and the fiber quality data in data base(s); and

2. Internet Classing. Execute instrumental classing locally (in gins, warehouses, or mills) and transfer the fiber quality measurements, including images, over the Internet. Archivally store a few samples for calibration confirmations and all data, including images, in databases.

Traditional Classing, as practiced today in ~100% of the world market, is little changed in principle since the 1600s. The primary variant is the addition of a relatively small amount of instrumental measurements and computers for their operation and for the communications and storage of the data

Internet Classing, Gin- and Warehouse-Based Classing, and Internet Trading are driven in major part by rapidly emerging technological capabilities to acquire and analyze large quantities of data, including high quality color images and other fiber quality data, and to communicate and store them over the Internet. GigaHertz PCs, GigaHertz data links, and TeraByte "Data Warehousing," along with many other exciting developments in digital electronics, including wireless communications are now available. Thus the capability for acquiring, analyzing, communicating and storing large digital image files is rapidly emerging into technological reality. The possibilities of applying these exciting technologies to the benefits of cotton are genuinely exciting and we in Schaffner Technologies regard ourselves as extraordinarily fortunate to have a role in this development.

Some applications of these technologies are already being evaluated currently for "Internet Trading." The first bale of cotton ever publicly offered and sold with an attached image occurred on 17 July 2000 in Australia. The image was acquired on a RapidTester owned and operated by Queensland Cotton, under the leadership of Mr. Robert S. Baird. The image was posted by cottonon.net.au. Numerous other non-public Internet transactions have been conducted to refine the process and demonstrate its power.

One interesting transitional combination of Traditional and Internet Classing, which we mention to stimulate dialogue, begins with acquisition of images, along with other fiber quality data, by RapidTesters located at gins or in warehouses. These data and images are then transferred over the Internet. At remote locations, humans can confirm classification and make other judgments, such as buy/sell decisions. Similarly, at remote locations other computers can evaluate the data and images, including screening, selecting, etc.

This remote examination of images and data means that classifications of Color Grade and Leaf Grade, as well as calls of Bark and Grass, etc, can be made by Human Classers looking at high fidelity reproductions of the image file on a color video monitor. We note, with extreme emphasis, that the critical importance of the fidelity, calibration rigor, and surrounding environment of the color monitor cannot be overemphasized.

Why, it may be legitimately asked, repeat the classing function remotely with either or either a human or another computer when it would be done locally in the gin or warehouse? Indeed, if the local RapidTester image measurements are sound and their integrity is assured, then it eventually might be unnecessary to communicate the raw image and other data files for most selling/buying transactions; the gin-based data products will be reliably adequate. (The raw images and data, both fiber quality and production data, would always be saved for arbitration.)

The best answers to this good question are these. In the initial stages of gin-based classing, buyers will wish to continue their age-old practice of "seeing" the cotton. (Sorry, we cannot help at the present with feeling, hearing or smelling it!) Also initially, local analyses of the images by the RapidTester will proceed with one or more STI algorithms for each of the C + T or Stk data products; other algorithms may be applied remotely to the raw data to suit the buyer's point of view. Further, human or remote PC examinations of the images will be part of the integrity assurance program.

It is easy to extend these arguments to build the case for Gin-based Classing. The economic benefits are significant through feedback and feedforward applications of the gin-acquired fiber quality data. Production and processing information associated with the cotton or with the manufacture of the bale (variety, maximum drying temperatures, number of lint cleaners, process waste, process turn-out, etc) can also be included.

Except for a few random check test samples to assure data quality and integrity, there would be no need to collect, store or ship bale samples since the digital data files are stored and can be communicated digitally, almost error-free.

With proper attention to testing quality controls, including auditing and confirmation by third objective parties, data product quality and data integrity can be assured. Confirmation will include random check tests and a small amount of on-site audit inspections.

Internet Trading, which will dramatically build on Gin-based Classing, will be based primarily on the image files and the other associated data products acquired where and when the fiber quality measurements can first be made---at the uniquely advantaged location by the bale press. Since most of the technology to achieve this goal is already in place or rapidly emerging, and the economic incentives are strong, we restate with rising confidence that Gin-based or Warehouse-based Classing, Internet Trading, and Internet Classing will be firmly in place by 2020.

We close this section with an Internet Trading example to more clearly define the process. Let us assume for simplicity a buy-sell interaction between a Ginner, acting on behalf of his/her Producer Customers, and a Merchant, acting on behalf of his/her Mill Customers.

The RapidTester images and associated fiber quality data, production data (varieties, seed cotton moisture, etc) and ginning process data are archived locally. This data "content" can be first sent to a local network, for viewing by the Ginner (or by the farmer if he/she wishes). Upon release, these data are then communicated to the Internet to be viewed by the Merchant. The communications to/from the data base can be an immediate posting or upon password-protected linkages by authorized parties, for selling-buying purposes. The Merchant will be able to define the range of fiber properties to match the textile products and processes for his/her Customers, the Mills. A search engine, such as STI's Digital Cotton Warehouse™ will display all possible bales of cotton, which meet the mill's criteria. The Merchant selects the bales that meet the mill's criteria and makes an offer/bid to the Producer, through the ginner. If the offer is accepted, a contract is established between the willing buyer and willing seller.

This simple example defines the essence of Internet Trading. Of course, there are and will be many variations.

D. Summary and Predictions

A progress report on RapidTester fiber quality measurement methods reveals that 8 of 9 expected data products have at least come to the prototype stage on the RapidTester platform by the end of 2001. The 9 expected data products were predicted in our Bremen 2000 paper to be widely used for commercial purposes in 2020. (3 Human and 4 Instrumental Measurements are used currently.) The new RapidTester measurement methods produce conventional data products, which are forced to track data products from older methods, for pragmatic business reasons.

But importantly, and by intentional design, RapidTester methods enable an orderly transition to improved data products and to data products not now in use. The RapidTester features of internal, Ultra Rapid Conditioning and Internet readiness were discussed. These features, in addition to the new methods, are very important in view of making such orderly transitions, in view of achieving wide-spread commercial use, and in view of shifting the classing function toward the unconditioned environments of gins and warehouses.

Also importantly, and by intentional business plan objective, the RapidTester platform and methods enable Gin-based, Warehouse-based and Internet Classing and Internet Trading. These very different concepts were defined and discussed. All of them are expected to increase significantly over time. It is very clear that Internet Trading will particularly profit from Gin- and Warehouse-based Classing.

We note that these transitions to improved and new data products, to relocation of the classing function, and application of classing data so generated to Internet Trading will require competent, objective and thorough leadership. Indeed, industry-wide leadership, from field to fabric, is essential for introduction to and acceptance by sellers and buyers of cotton of these new ideas. "Acceptance by" is the key idea. Third, objective and impartial parties, such as USDA/AMS or private firms which neither buy nor sell but only class cotton will, of course, have an important role to assure data quality and integrity.

We would like to close with some predictions of achievements by 2004:

1. Good progress toward eliminating the Human Classer through use of high fidelity images for Trash (and also for Color);
2. Even broader recognition of the importance of true Short Fiber Content as a data product;
3. Rising recognition of the importance of true, CIE color of the fiber only and thus use of color coordinates X, Y,Z or Lab.
4. Several Gin-based Classing trials;
5. At least one Internet Classing trial;
6. Extensive Internet Trading or e-business, with a significant portion relating to Gin-based or Warehouse-based classing.

E. Acknowledgements.
We are grateful for the enthusiasm and patience exhibited by our Customers and for the extreme efforts made by our Colleagues during the past year. We are particularly appreciative for the support and understanding by our wives, Betty Jo, Melissa and Yang Wen.

Table 1. Fiber Quality Data Products For Classing Purposes

< 1965[1] Pre-Mic	< 1980 Pre-HVI	2000 Current AMS	2020[2]
HUMAN MEASUREMENTS			
1 Grade 2 Extraneous Matter 3 Preparation 4 Staple	1 Grade 2 Extraneous Matter 3 Preparation 4 Staple	1 Color Grade 2 Leaf Grade 3 Extraneous Matter 4 Preparation	
INSTRUMENTAL MEASUREMENTS			
	Micronaire	1 Micronaire 2 Length UHM LU 3 Strength Tenacity (gm/tex) [Color] Rd, +b (Fiber + Trash) HVI Color Grade [Trash] % Area HVI Leaf Grade	1 Micronaire 2 Length UHM LU SFC 3 Strength Tenacity (gm/tex) Elongation 4 Color CIE (Fiber Only) Instrument Color Grade 5 Trash % Area Size, Shape, Color Type (Extraneous Matter) 6 Moisture Content 7 Neps, Seed Coat Fragments 8 Maturity [Fineness?] 9 Stickiness
4[3]	5	7	9

[1] Prior to 1909, no measurements were used for classing; "classes" were based on variety and region of growth. Cotton Standards were introduced in 1909 and became "Universal" in 1923. Micronaire was introduced into classing by AMS in 1965 and HVI in 1980.

[2] We envision these measurements to be widely used for classing in 2020. Long before 2020, indeed, in only a few years' time, they will be used by progressive gins, merchants, and mills.

[3] This row gives the number of individual measurement methods in official use for trading purposes. Unofficial measurements are in brackets.

Table 2. RapidTester Measurement Methods and Data Products

Basic Fiber Quality Measurement: RapidTester Methods	2002 Data Products	2020 Data Products
1. Micronaire; Air flow permeability of ~10g sample. Same automated apparatus is used for Maturity and Fineness and for Moisture Content.	Mic ✓	Mic
2. Length; "Ideal," tapered beards formed with single needles; multiple beards ultrarapidly conditioned and simultaneously tested; same beards used for Str test.	UHM, inch, mm ✓ LU ✓	UHM LU? SFC
3. Strength; "Ideal" tapered beards, ultrarapidly conditioned.	Strength, g/tx ✓	Strength Elongation, %
4. Color; Image-based scanner views sample under test and reference materials for every scan, thus "calibrated" each test.	Rd, +b ✓ Color Grade ✓	CIE (Fiber Only) Color Grade
5. Trash; Image-based; same image file as for Color is analyzed for Leaf, Bark and Grass,Extraneous Matter, and Preparation. LG has decimal resolution.(Example: 3.7 for RapidTester versus 4 for Classer or HVI.)	% Area ✓ Leaf Grade ✓	% Area Leaf Grade, Size Dist. Bark and Grass Extraneous Matter Preparation?
6. Moisture Content; Combined resistive and capacitive electrical conductance. Electrodes built into Mic module.	% ✓	%
7. Neps, Seed Coat Fragments; Electro-optical extinction mode sensor. Gold filament, automatic EO Calibration.	Neps/g ✓	Neps/g Size Dist. Seed Coat Fragments
8. Maturity and Fineness; Multiple compression air flow permeability in same apparatus As Mic.		Mat Ratio Immature Fiber Fraction
9. Stickiness; Automation of Minicard Principle. Sticky points formed from ~5 to 10 g in thin web passed between 2 rolls; sticky points/g detected by scanned image of detector roll.	Sticky Points/g ✓	Sticky Points/g Size Sugar Types