THE VALUE OF COTTON GIN PROCESS MONITORING AND CONTROL TO THE TEXTILE INDUSTRY

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Abstract

The U.S. textile industry is undergoing dynamic changes through the advent of increased competition from other countries. This is challenging the industry to become increasingly competitive with spinning mills from Asia, South and Central America, and Europe. Traditional processes are being thought over and improved, including the business relationships of buyer and seller. The advent of new technology in the cotton gin to monitor and control its process is providing growers with additional tools to market raw material to cotton spinners. In turn, spinning mills are discovering the added value of custom ginned fiber according to predetermined specifications. This paper will focus briefly on key problems faced by spinning mills today and what can be done by the grower/ginner to meet these needs.

Breaking Paradigms

Today's competitive business environment is faced with increased consumer demand for excellence. This primal drive is opening opportunities for organizations and businesses to exceed the expectations of today's consumer, and results in increased competition for the consumer's dollar, yen, or franc. The international textile industry is facing increased consumer demand for higher quality products at value prices. The reduction of trade barriers has created new markets for mills outside of their traditional business partners. Spinning mills in the U.S. are returning to old fashioned values of partnerships with their suppliers and customers. This concept called "breaking paradigms" focuses on improving your business by looking at it in a different way (Figure A). Breaking paradigms opens opportunities to create win-win situations for buyer and vendor.

New technology is an integral part of this communication process. The monitoring of the cotton ginning process is an exciting startup technology that will enable growers and mills to communicate better. Growers can gin cotton by optimizing the sequence of process machinery to achieve a certain grade, thereby reducing processing costs and increasing the consistency of the grade. Textile mills can purchase cotton directly or indirectly according to specific quality ranges, suitable for their individual market needs.

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Challenges Faced by the Textile Industry

Increased globalization and reduction of trade barriers have brought increased competition from Asia, South and Central America, and South America. These are mills that have purchased the latest spinning technology. Local governments oftentimes subsidize or provide tax incentives to firms that export products for foreign exchange. Cotton spinning mills worldwide are under price pressure with recent cotton costs (not to mention synthetic fibers). At current world prices of 70 cents per pound, 60 to 70 percent of the costs to produce a 100% cotton yarn are due to the fiber costs. This fact alone has required a major paradigm shift in the mill's cotton procurement and processing procedures. Continuously tighter quality standards are placed on cotton buyers and sellers. Increased pressure for a consistent raw material usage in the mills is apparent. Foreign grown cotton is being imported into the U.S. market at rates never seen before. The U.S. textile mill is under pressure to increase the rate of automation in order to remain competitive. With increased automation fewer personnel are managing the textile process. The remaining personnel require "smart systems" that are easy to maintain. There is a strong trend to make the fiber procurement and processing a simpler process (Figure B).

Specific Challenges Relative to Fiber Characteristics

Worldwide the textile industry is faced with four key challenges relative to fiber characteristics. First, the need to reduce or entirely eliminate yarn and fabric barré (stripes). Secondly, the visual appearance of yarn and fabric is always a major concern. After all, purchases are made of both and, therefore, appearances are important. Thirdly, the textile machinery is quite a capital investment involving millions of dollars in technology. In order to amortize the equipment over a period of time, it must operate at the highest possible efficiency. Thus, yarn production is a key concern to any spinning mill. Finally, the delivery of raw material to the plant and carefully planned balanced yarn inventories for customers is the last challenge. Successful textile mills are ones that know exactly what fiber qualities are required. The raw material is shipped on time to the mill, routinely. Yarn counts according to customers' requirements are produced on time and in adequate quantities so that inventories are kept to a minimum. The concept of 'just-in-time' manufacturing is a key concern to all yarn producers (Figure C).

Fabric Barré

Figure D indicates a typical sample of fabric Barré or striping. There are several causes of fabric barré such as fiber properties, variations of yarn count, twist, and hairiness. According to applied research, the major cause of yarn or fabric barré are the fiber characteristics (Figure E). One of the key fiber properties which can cause barré is micronaire. When controlling micronaire, there should be no more than a 0.2 difference in individual micronaire values. Also, there should be no greater than a 0.1 change in the micronaire values from bale mix to bale mix. Finally, there should be less than 12% coefficient of variation of micronaire values within each mix. Care is also taken by mills to prevent the same micronaire to be placed side by side in the mix (Figures F, G, and H). Since micronaire is the relationship of fiber perimeter and cell wall thickness, it is determined during the short forty day period while fibers are inside the boll. Micronaire as a factor will vary from crop to crop since it is influenced by temperature, rainfall, nutrients, and genetic variety.

In addition to micronaire, the +b component of the Upland Color grade is critical in controlling barré as well. Since +b is the degree of yellowness in cotton caused by night time temperature, moisture or micro organisms, it is a variable that will change from crop year to crop year. Through experience most spinning mills will keep the coefficient of variation within a mix to be less than 10%. Also, the +b target of less than 10 on the Hunter-Nickerson scale is desirable (Figure I).

Yarn Production

During a recent mill study, the impact of HVI fiber characteristics on yarn production was expressed in ends down per one thousand hours. This is a quality ring spinning mill which produced an Ne 22 yarn count over a one year period. The first 22 weeks each bale of every mix was tested on an HVI and the average Spinning Consistency Index (SCI) was calculated for each mix. SCI is an index which takes into account all the HVI fiber properties into one measurement and predicts the fiber spinnability prior to processing. Traditionally, the mixes were chosen based on micronaire and gin location. Beginning in week number 23, the SCI category system was installed along with micronaire (as a second category priority) because the end use of the yarn was for knitted fabric. Yarn quality and production efficiency were monitored throughout the trial so that comparisons could be shown. Beginning with week 23, the new mixes became more consistent. This resulted in consistent and a lower level of ends down (or yarn breaks) over the following weeks (Figure J). Thus, it is paramount that consistent fiber characteristics are not only selected by the mill, but also supplied in the raw material.

Cotton Gin Process Monitoring and Control

During the past ten years, the USDA-ARS cotton ginning laboratory at Stoneville, MS has investigated the use of on-line color/trash and moisture measurements and their influence in the cotton gin. During this time period, sensors were used similar to ones found on current HVI technology to investigate this matter. Today, USDA-ARS, Zellweger Uster (Knoxville, TN), and Enhanced Management Systems (EMS) have joined together to bring such technology to the commercial marketplace. Not enough credit can be given to the USDA-ARS for their foresight and determination to bring this technology forward (Figure K).

During the 1994/95 gin seasons USDA-ARS and EMS installed a beta site gin process control system at a leading cotton gin in the Southeastern United States, Servico Gin Company. They were joined by Zellweger Uster who assisted the partnership by providing up-to-date sensing technology. The following is a brief analysis of the system following two years of operation. It is anticipated in 1998 that a full commercial version of gin process monitoring will be available to the marketplace, under the trade name Uster® IntelliGin. The system involves the following: on-line measurement of upland cotton color grade and trash code at three stages in the gin every 6 seconds. The system utilizes advanced state-of-the-art sensing technology similar to that in current HVI systems. The system provides on-line measurement of fiber moisture and automatic optimization of the drying system. Further, there is an automatic by-pass of lint cleaning stages to achieve a pre-desired grade. Finally, an off-line micronaire test is performed at the bale press on each bale (Figure L).

Improved Fiber Quality

Today's cotton spinning mills require a consistant raw material, but also fiber with low levels of short fibers and neps (both fiber entanglements and seedcoat fragments). Prior to the installation of Uster at the beta site gin, the level of short fiber content and neps were at traditional industry levels. Following off-line test of neps and short fiber content (as measured by the Uster® AFIS) the following results were discovered. Short fiber content on average with Uster® IntelliGin is at 5.8% by weight. The accepted industry average is 9% (w) or less (Figure O).

Further, the amount of fiber neps (both entanglements and seedcoat neps combined) were, on average, at 189 Neps/gram in the bale. The desired industry level of neps for saw ginned upland, picker harvested cotton is 250 Neps/gram or less (Figure P). It is an accepted industry fact that short fibers are the major cause of thick places in yarn (+200% or greater) as measured by the Uster Evenness Tester. In addition, it is accepted that high amounts of fiber neps degrade fabric appearance and significantly increase yarn defects.

Value to the Grower

A suitable return on investment (ROI) or added value is a must in today's competitive business environment. Based on the 1996 gin season at Servico Gin Company, gin processes monitoring and control increased the bale value by $17.50 / bale (based on a 480 lb. bale or 217 kg) to the grower (Figure Q). This was accomplished by increasing the amount of gin turn out of 25 lbs. (11.3 kg) per bale and optimization of moisture levels. To the grower this provided additional bale value and increased fiber quality.

This increase in bale weight was accomplished by using the optimum selection of pre-cleaners and lint cleaners when moisture levels were either too low or too high.

There are other potential benefits as well. First, key spinning mills could pay a premium for cotton with low short fiber content and neps. Also, knowing that the color grade is more consistent.

Secondly, merchants and cotton spinners could pay a premium for cotton appropriately grouped by fiber property ranges at the gin (micronaire, +b, Rd, or trash code). Then these bales with pre-determined ranges could be shipped directly to the merchants or spinning mills. Both merchants and spinning mills could reduce their handling expenses and increase warehouse efficiency.

Summary

Traditional ways of conducting business are constantly being re-thought to improve the goods and services provided to customers. Progressive growers, mill buyers, and merchants / shippers are discovering new ways to partnership. An important technology to assist in these new relationships is the monitoring and controlling of fiber qualities on-line at the cotton gin. Mill buyers are continuously searching for improved consistency of fiber measurements. The ability to measure on-line critical fiber properties provides added value for producer, merchant, and mill buyer. Cotton bales can be immediately classed and categorized at the gin warehouse. Even specific bale mixes can be shipped directly to the mill based on quality specifications. It is critical for the grower and mill that shipments are timely. Spinning mills are constantly looking for cotton with low levels of neps and short fiber content. This reduces processing requirements in the mill and further improves yarn and fabric quality (Figure R).

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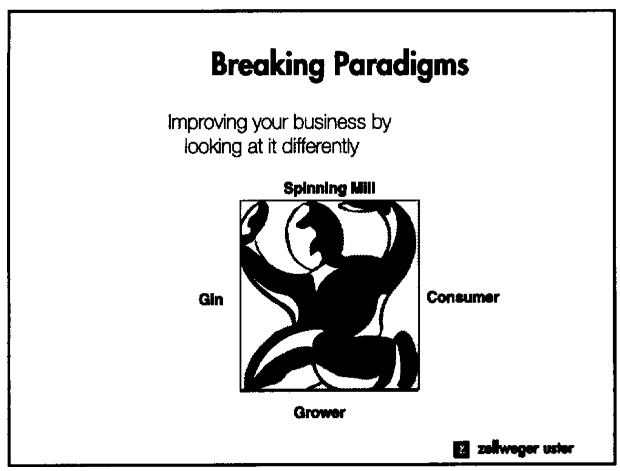

Figure A

Challenges in today's U.S. textile industry

- Increased price competition from Asia and Mexico
- Fiber costs are 50 - 70% of yarn production costs
- Increased need for consistent raw material
- Purchases of foreign grown cotton
- Trend to increase textile automation, maintain competitiveness from abroad
- Trend to make fiber business simpler

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Figure B

Key Problems

- Yarn and fabric barré
- Yarn production
- JIT deliveries of yarn and raw material
- Yarn and fabric appearance

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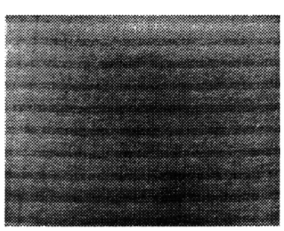
Figure C

Key Problems Due to Fiber Property Variation

Fabric Barré



Fabric Sample

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Figure D

Causes of Fabric Barré

CAUSE	*% of DEFECTS*
Fiber Variation	**70%**
Yarn Count Variation	10%
Twist Variation	10%
Hairiness Variation	10%

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Figure E.

Causes of Fabric Barré

0.2 difference in micronaire
0.1 change in average micronaire mix to mix
12% CV of micronaire within mix
Bales with same micronaire placed side by side in mix

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Figure F

Acceptable Change in Micronaire from Mix to Mix

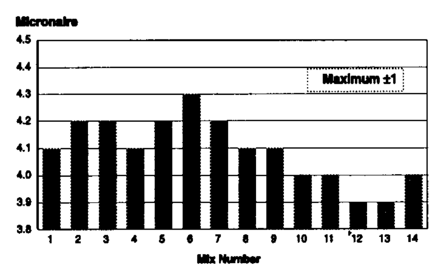

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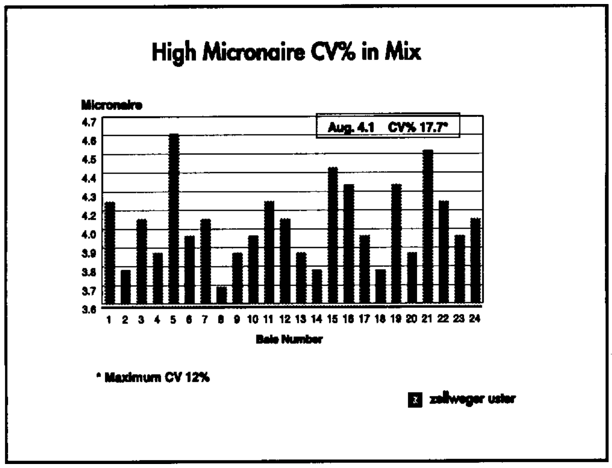
Figure G



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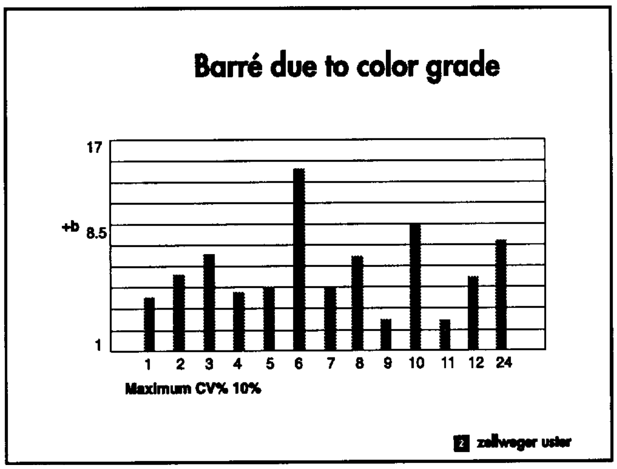

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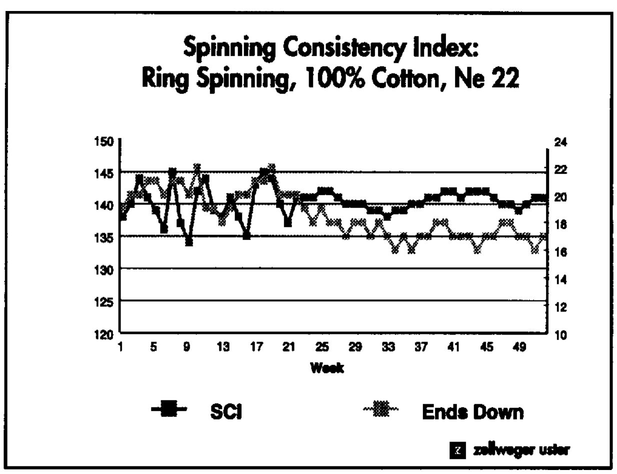

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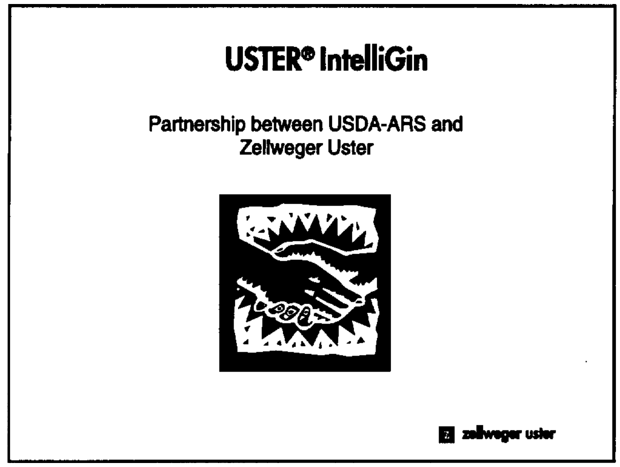

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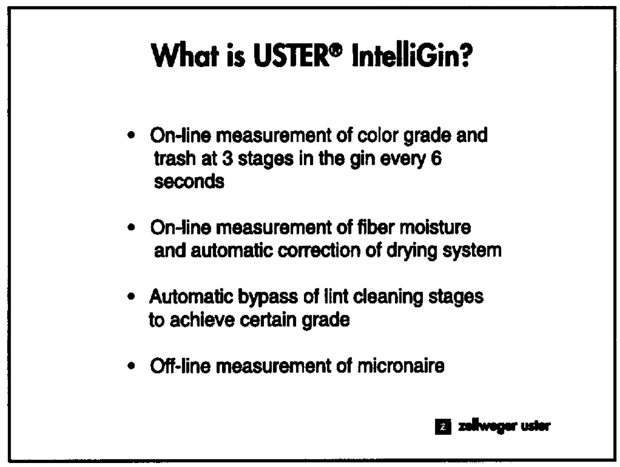

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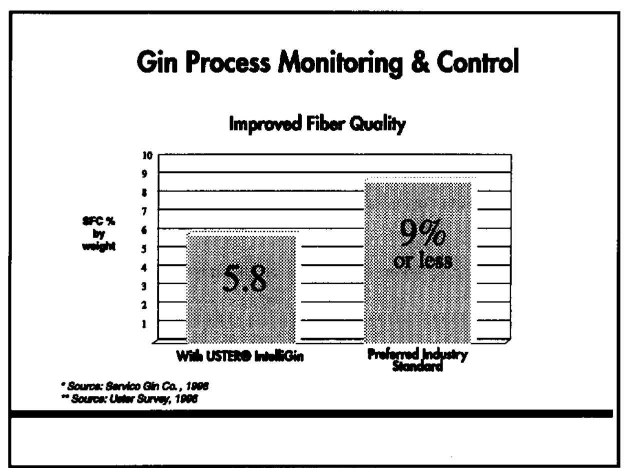
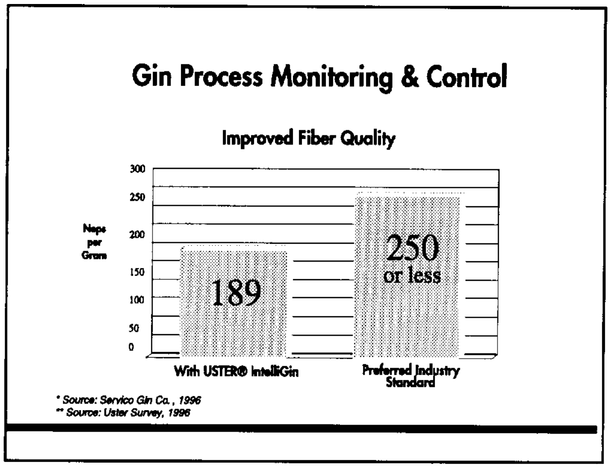


Figure O



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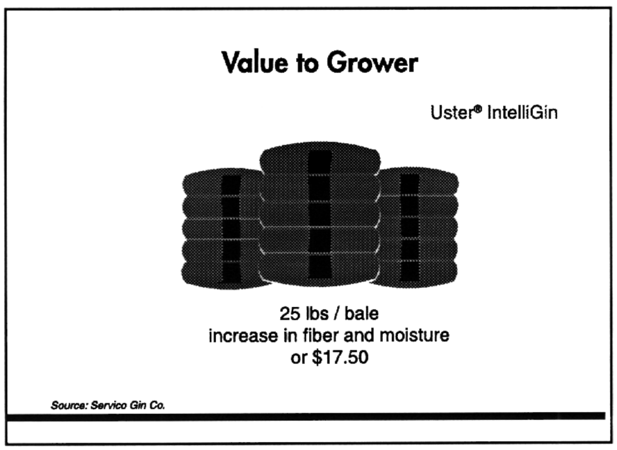

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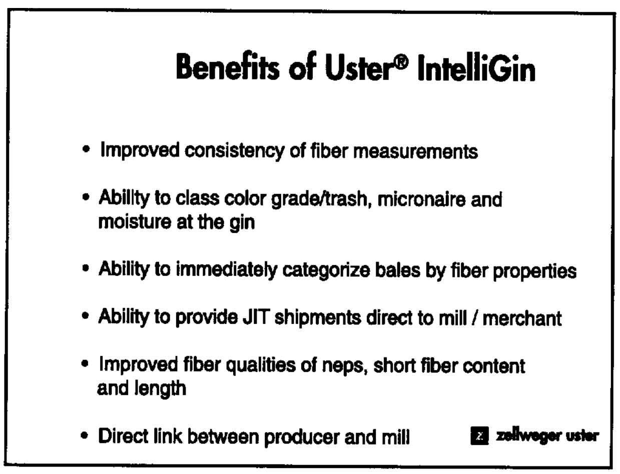

Figure R