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AUTOMATED CLASSING SYSTEM: STATUS OF FIRST YEAR OF PRODUCTION

Steve Grantham and Morgan Jones
USDA, AMS, Cotton Program
Memphis, TN

Abstract

The automated classing system (ACS) is the latest development in a longstanding trend in the USDA Cotton Program towards increased mechanization and improved efficiency. Ever since the first High Volume Instrument (HVI) lines were piloted in Lubbock, TX in 1976, the Cotton Program has been steadily moving away from manual grading of cotton. Although the HVI has brought numerous benefits to the grading process, including improved measurements, new measurements that were impossible in manual classing, and removal of human bias from the process, it has come with a price. A problem that most Cotton Program offices struggle with is the need to hire and retain skilled seasonal machine operator's season after season. The ACS holds the potential to remove machine operators from the system. This would further improve the grading process by reducing personnel needs, decreasing the need for training, and removing subtle operator bias from operator-dependent measurements, resulting in a more accurate and stable measurement. These benefits hold the potential to greatly aid the Cotton Program in its mission to serve the needs of the cotton industry.

Background

Prior to 1980, all official cotton classing in the United States was performed by hand. Highly trained cotton classers graded samples of cotton for color, leaf, extraneous matter, and staple length. Years of research and development were spent to develop an instrument capable of grading cotton; the result of these efforts was the HVI, which was first piloted in 1976 in the Lubbock, TX classing office. In 1980, the Lamesa, TX classing office became the first office to provide 100% testing with HVI lines. By 1991, all offices were using 100% HVI testing.

The HVI line offered numerous benefits to the agency. Several measurements provided by the HVI, including length uniformity index, strength, and micronaire, cannot be performed manually. Length could be measured to 100ths of an inch, while manual classers called only to 32nds of an inch. In addition, the HVI lines themselves became more efficient over time. The first HVI lines required two or three operators, depending on the specific model. Over the course of about twelve years, the technology matured enough to allow a single operator to run a line. Even with this improved efficiency, hiring and retaining good machine operators during the classing season remained a problem for many offices.

The ACS was conceived as a way of removing the operator from the equation entirely. The concept was introduced to the Cotton Program in 1998 by Zellweger-Uster, the manufacturer of the agency's HVI lines. The "Alpha" version of the ACS, consisting of a single HVI line, was presented to the Cotton Program in early 1999. Later in the year the "Beta" version, including a modified HVI line, loading and unloading stations, and an integrated conveyor system, was demonstrated. The installation of the ACS began in the summer of 2000, and in the intervening time the system has been greatly modified to better fit its requirements. It is expected that all testing will be completed in the 2002 season, and then the ACS will be ready to run live cotton samples.

Benefits of the ACS

There are numerous operational benefits to be realized from the successful implementation of the Automated Classing System. These benefits can largely be divided into three categories: labor efficiency, measurement improvement, and potential for future innovations.

The most obvious benefit of the ACS comes from increasing labor efficiency. One of the major problems in many Cotton Program classing offices is the need to hire and retain a staff of seasonal machine operators. Turnover is very high among machine operators, and often offices will still be hiring new personnel well past the midpoint of the classing season to replace lost operators. New operators must, of course, be trained, and it takes weeks before they reach full productivity. The ACS would eliminate this problem. No operators are necessary to operate the machine, which means no lines will remain idle for lack of an operator. This also translates to a savings in labor costs.

The ACS also has the potential to improve the measurements performed by instrumentation. Although HVI measurements are more objective than manual ones, the nature of the HVI setup makes a small amount of user variability inevitable, especially for micronaire. New operators are particularly prone to introduce error into the process. With the ACS, these measurements would no longer be subject to operator error. Each test would be performed in the same way each time on every line, which provides a sounder, more objective quality measurement.

Finally, the ACS can be seen as a stepping stone to future innovations. For some time now, the Cotton Program has had the long-term goal of going to 100% instrumentation. The ACS is an important step in that direction. For example, the computers used in the ACS have the power to measure the distribution of leaf particles in a sample by particle size. This measurement could be an important step towards a machine leaf grade, which would leave only extraneous matter to be determined manually. This and other possible innovations would greatly aid the mission of the Cotton Program.

Configuration of the ACS

The Automated Classing System consists of four main functional sections. These include a set of 6 loading stations, the integrated conveyor system, a set of 10 HVI stations, and the System Controller (SYSCON). These components are all integrated to provide an automated classing process with minimal human input.

The loading stations are located on the conveyor system entering the lab from the receiving room. Trays of conditioned samples enter on the conveyor to be untrayed and loaded into ACS cassettes. One major difference between the ACS and the current lab setup is that manual classing (for leaf and extraneous matter) takes place before HVI testing on the ACS system, which is the reverse of the current setup. This configuration allows the classer to double as a loader operator. Each loading station includes a computer terminal linked to the Tandem system, a keyboard and monitor, a classing surface, a loading chamber, a tray stand, and a cotton disposal chute. The classer grades each sample, enters the data into the Tandem with the keyboard, places the sample into the loading chamber, and hits a palm switch to activate the loader. A bar code scanner in the loading system matches each PBI to a specific cassette number to allow the sample to be tracked through the grading process. Once the sample is loaded into a cassette, it is sent onto the integrated conveyor system.

The integrated conveyor system transports samples throughout the ACS. There are several individual conveyors and elevators, all of which are interconnected into a single system. A short length of conveyor on each side of the loading area transports the cassettes to an elevator which moves them to the main conveyor. The main conveyor consists of two tiers; the top tier transports loaded cassettes to the individual HVI stations, while the bottom tier moves empty cassettes back to the loaders to be reloaded. The bottom tier is also used to transport checklot and oddlot samples to a special holding area where they may be collected by USDA personnel.

The ACS HVI lines perform all the measurements currently performed by regular HVI lines. These measurements include micronaire, color reflectance (Rd), color yellowness (+b), fiber length, length uniformity index, strength, short fiber index, and elongation. Although the measurements are the same, the ACS HVI lines have new capabilities not found on earlier versions. These include moisture measurement, improved trash measurements, and the use of Xenon flash rather than incandescent lighting for color measurements. Sample integrity is preserved by the use of barcode scanners at each HVI station. Retests are reported instantly and immediately placed in queue to be tested again. Each HVI station has a total of three conveyor spurs and two elevators, one of which also serves as an unloader. The middle spur brings loaded cassettes through the HVI for testing. The elevator/unloader removes the cotton from completed cassettes and then places them on the bottom spur to go to the bottom tier of the main conveyor, or alternately moves retests to the top spur, where the second elevator places them on the middle spur for retesting.

The System Controller (SYSCON) controls the paths of all the cassettes in the system. The SYSCON communicates with the Tandem to determine which samples can be unloaded when completed, and which ones need to be routed to the holding area. Samples sent to the holding area are scanned and have a new bale identification tag printed for them at a tag printer adjacent to the holding area. The SYSCON also controls the allocation of cassettes to loading stations to ensure that each station is sufficiently stocked with empty trays to avoid delays.

State of Testing and Implementation

Each HVI station passed a series of rigorous testing referred to as eight by eight evaluations for length and strength. This test consists of eight cottons with varying length, strength, uniformity and micronaire values. Eight measurements of the eight different cottons that represent a range of staple lengths and strength found in upland cotton. The color and trash were evaluated with a similar test containing twelve cotton samples. The cotton samples represent the entire range of the upland cotton grades. Eight measurements of each of the twelve samples were tested. A measurement of the color grade represented by the Rd and +b values were evaluated. The micronaire measurement was evaluated using six cotton samples that represent the typical range of the upland cotton crop. Each of the three tests was analyzed for level differences and within sample variability. Each HVI station was required to pass two consecutive tests for each of the three tests that were performed. In addition to the quality test, a series of volume test were required as well. The system successfully completed this evaluation by satisfying the required 3 consecutive day test of 6750 samples within 8 hours.

In the fall of 2002, the system began evaluations on “live cotton”. This refers to the cotton samples that are sent to the classing offices for the Form one original classification. The samples were first tested and the official grade was obtained on our current 900-U instrumentation. A small sampling of these samples were saved daily and measured on the ACS in order to perform mock trials of the system in a production mode. This data was analyzed throughout the classing season on approximately 20,000 samples. There were some items of concern that had to be addressed throughout this portion of the evaluation. These items were related to the instrument testing, sample distribution, and software problems. The instrument testing concerns were related to instrument setup, calibration and level differences in a few measurements. The sample distribution problems were related to the uneven distribution of the cassettes containing cotton to all of the testing instruments. The software problems were a cause for concern due to sample losses in the system related to communication between the USDA computer system and the SYSCON. Also in the event of a power outage, there was concern for the recovery of data for the samples still in process. These problems were not readily identified in the evaluation; however, they became very clear in the testing of live samples. Most of these items have been addressed at this time. This system will continue to perform some mock evaluations in the spring and summer of 2003 in order to verify that all deficiencies have been addressed. The Cotton Program will continue to move forward with the implementation of the ACS in the fall of 2003.

References

Earnest, D.W. and Grantham. S.L. 2001. The New Automatic Classing System. Proceedings of the 2001 Beltwide Cotton Conference. pp. 367-369

Table 1. Result Comparisons in Fall of 2002: ACS vs. Current Instrumentation.

Fiber Properties	Office Minimum Reproducibility	Automated Classing System	Overall Office Performance
Length	75	80	80
Uniformity	82	85	86
Strength	69	72	76
Micronaire	74	60	80
Rd	90	90	92
+b	90	93	96
Trash	81	86	86