Automated Fabric Inspection: Assessing The Current State of the Art

By Alfred Dockery

Fabric inspection has proven to be one of the most difficult of all textile processes to automate. It has taken decades for computer and scanning technology to develop to the extent that practical, consistent and reasonably user-friendly systems could be produced. In this article, we will look at three automated optical fabric inspection systems: BarcoVision’s Cyclops, Elbit Vision System’s I-Tex and Zellweger Uster’s Fabriscan.

Today’s automated fabric inspection systems are based on adaptive, neural networks. They can learn. So instead of going through complex programming routines, the users are able to simply scan a short length of good quality fabric to show the inspection system what to expect. This coupled with specialized computer processors that have the computing power of several hundred Pentium chips makes these systems viable.

They are designed to find and catalog defects in a wide variety of fabrics including greige fabrics, sheeting, apparel fabrics, upholstery fabrics, industrial fabrics, tire cord, finished fabrics, piece-dyed fabrics and denim. They cannot, at this time, inspect fabrics with very large and complex patterns with the exception of the EVS Prin-Tex system, which is specifically designed to inspect and monitor the production of rotary print fabrics.

The Human Factor

How do these systems compare with human inspection? Both EVS and Zellweger Uster say that typical fabric inspection speeds and fatigue limit most human inspectors to detecting from 40 to 60 percent of defects. Both companies gauge their systems’ capability to find fabric defects at 80 to 95 percent. Barco says that its Cyclops system is more efficient and more consistent than human inspectors but did not offer quantitative figures.

All three systems have the advantage of consistency compared to humans. Human inspectors tire over time and can become distracted making their results inconsistent. There is also a marked difference in the ability of individual inspectors. Finally it takes years to train a good human inspector, and these automated systems can be installed and “trained” in a matter of weeks.

Cyclops Inspects Fabric On-Loom

What makes the BarcoVision Cyclops system different from the EVS and Zellweger Uster offerings is that it has a traveling scanning head and can be deployed on the weaving machine itself. I-Tex and Fabriscan both inspect fabric in full width either at the batcher for greige fabrics or at the exit end of a finishing machine.

Therefore Cyclops can prevent the production of off-quality fabric by stopping the weaving process if it detects a serious or running defect. Barco currently has several Cyclops installations running in European mills.

Examples of defects that would prompt Cyclops to stop a loom are running warp defects, recurring filling defects and a high concentration of local defects. Whenever the system stops off a loom, the weaver is notified. The specific type of defect and its position are displayed on the loom terminal. After resolving the defect’s cause, the weaver makes a declaration on the loom terminal so Cyclops will release the loom for further production.

Cyclops is designed to be used with Barco’s Sycotex weave room monitoring system, all defect information, pick stamped, is sent to a fabric quality database. Sycotex then produces a defect maps and quality reports. At cloth roll doffing, the on-loom system together with the monitoring system formulates fabric quality advice. Fabrics, that are judged to be first grade, can pass the greige cloth inspection and can be sent on directly for further processing.

The Cyclops scanning head includes a camera and illumination system. The camera is based on CMOS technology. The illumination system has been specifically designed to achieve optimal detection of defects in woven structures.
The measuring head travels at a scanning speed of 18 centimeter per second.

Proprietary algorithms run on a combination of in-house designed processing hardware and an industrial PC to carry out the image processing. The embedded software is the heart of Cyclops and runs on special purpose hardware designed by Barco.

The major features of the software include: calibration of the camera and illumination, tuning of image processing algorithms for warp/weft density and weave, boundary detection and JPEG-encoded image storage of fabric defects.

The Cyclops scanners cost $5,000 each and can be used for fabric widths up to 260 centimeters. There is also a one-time Vision software license of $25,000. To estimate the payback period Barco took the following benefits into account: reduced manual inspection after weaving, labor savings due to less inspectors, reduction work-in-progress and reduction in off-quality fabric.

Thus the investment for an installation of 100 looms is about $525,000. The company estimates the annual savings for a typical application to be $200,000, giving a payback of roughly 2.6 years.

**Elbit Vision Systems Has The Most Units Installed**

EVS, which introduced its I-TEX system at the ITMA’91 in Hannover, Germany, is the most established player in automated fabric inspection. They have an enviable list of installations including: Alice Manufacturing, Avondale, BGF Industries, Burlington Industries, Dan River, Gale & Lord, Hexcel, JPS Industries, Microfibres, Milliken & Co., Mount Vernon Mills, PFG Industries, Ramtex and Springs Industries Inc. EVS claims more than 250 installations worldwide.

The I-TEX system is capable of inspection speeds up to 300 meters per minute and can handle fabric widths up to 5 meters. The system’s proprietary software algorithms were designed to imitate the human visual system. It learns the normal pattern of the fabric and detects changes. These changes in the pattern are then analyzed by multiple detection algorithms to separate real defects from random but normal variations in the fabric. Once a defect is detected, the x and y location, as well as the size of the defect, are recorded in a defect map. In addition, a digital image of the defect is saved for later review of the system operator.

The I-TEX system cost is dependant on a number of factors such as the fabric application, desired speed and fabric width. The system sells for between $100,000 and $650,000. Payback for the system is generally between six months and 2 years, according to EVS.

**Zellweger Uster Offers A New Approach**

On the surface Zellweger Uster appears to be a newcomer to automated fabric inspection market; however, this is not the case. The company began development of an automatic fabric inspection system in 1983. The system called Uster Visotex was shown at ITMA’87 in Paris. It was not successful due mainly to the limited processing power of computers at that time.

The company’s current system, Fabriscan, can inspect fabric at speeds up to 120 meters per minute and can detect defects down to a resolution of 0.3 millimeters. It can handle fabric widths from 110 to 440 centimeters. Zellweger Uster has several installations in Europe covering a range greige fabrics including apparel, denim and industrial fabrics.

What makes Fabriscan unique is that it classifies defects in a matrix called Uster Fabriclass, which is similar to the well-known Uster Classimat system for yarns. Fabriclass has two axes. On the y-axis is the contrast of the defect and on the x-axis is the length of the defect. This allows the system to tell the difference between disturbing defects versus non-disturbing defects and makes over-detection impossible.
The Zellweger Uster Fabriscan system classifies defects virtually nonexistent, according to the company.
Data on defects can also be stored in a relational database, allowing users to generate any type of report that they need. Cut optimization software is included to improve first quality fabric yield.

The cost for Fabriscan starts at $200,000. Zellweger Uster estimates that the system has a payback of about 12 to 24 months, based on labor savings, cut optimization, and improved flagging accuracy to customers.

Mill Viewpoint: Ramtex On Elbit’s I-Tex System

Ramtex Inc., Ramseur, NC, has been using an Elbit I-Tex system for two years. The company bought the system because they had a need to inspect more fabric and did not want to add people to its inspection department.

Installation and training went well. Charlie Morgan, director of Technical Services for Ramtex, gave the installation process a solid B grade. Installation did take longer than expected but this stemmed from problems with the fabric handling system not the I-Tex system. Ramtex inspects greige fabric on batchers. Morgan also said that there was a longer-than-expected learning curve to move inspectors from evaluating defects on actual fabric to evaluating images of fabric defects on a computer screen.

“There are two features that we see as very beneficial to Ramtex,” said Julie King-McDaniel, director of Weave Manufacturing, Ramtex Inc. “The first is the accuracy in which it keeps history on rolls of fabric. It allows you to map out each defect. The second feature is the ability to see an actual picture of the defect. With this feature you can make an educated decision on what type of defects you are actually having.”

Ramtex has never quantified the payback or return on investment for its I-Tex system. The company did not reduce the number of people that grade cloth, so there was no savings from labor. The department has increased the amount of cloth that it grades and decreased the amount of defects that are charged back from customers.

Ramtex, a privately held company, is an acknowledged technology leader in the US textile industry. Its products are mostly shirting, pocketing and workwear fabrics. The company produces both yarn and fabric. In the yarn mill, Ramtex makes ring-spun, air-jet, open-end and Murata Vortex yarns. The company sells yarn on the open market and uses some of its yarn internally. They are greige weavers, and produce around 1.2 million yards of cloth a week.

Mill Viewpoint: Spinnweberei Uhingen On Barco’s Cyclops System

Spinnweberei Uhingen, Uhingen, Germany, has two Barco Cyclops systems. The first was delivered in February 2000. It is installed on a batcher. The company was impressed with the system and purchased a second system in February 2001. This system is mounted inside a weaving machine.

The installation proceeded without any problems. Both systems are working as a test installation, prior to equipping the whole plant. Because of this, the configuration was changed several times and the covering factor (how many defects the systems sees) was increased each time.

“The camera is today traveling with double the speed as in the first installation,” said Georg Mayer, Dipl.-Ing. (FH) weaving mill manager for Spinnweberei Uhingen. “The training is very simple because everything works on a Microsoft Windows user interface. Every software upgrade made the system easier to work with. To get someone trained on the system requires less than one week.”

The on-loom camera system stops the loom if a defect is detected. This avoids the production of many meters of second quality. The inspection report shows the defect quantity and for every defect there is a picture available. This means, it’s very easy for the operator to have a precise quality overview of the piece of fabric.

“The systems detect about 70 percent of all the defects in the fabric,” Mayer said. This is much more than an operator can ever see. We expect to eliminate manual inspection in the future in spite of a very sensitive type of technical fabric.”

The company is projecting a payback time of less than 30 months. The calculation is based on 21 Dornier 190-centimeter air-jet machines running at 1,000 rpm. Cost savings will come from producing less second quality fabric and reduced labor costs.

Spinnweberei Uhingen produces cotton yarns in its ring-spinning mill in Waldkirch, Germany. The plant has 12,200 spindles and produces 2,300 tons of 100 percent cotton yarn a year. The weaving mill in Uhingen produces more than 10 million square meters of cotton fabric a year on 36 Dornier air-jet looms. The looms are equipped with dobby heads and cam motions. The company produces technical fabrics mainly as abrasive carriers and rubber blankets, which are used in offset printing machines.

The Future: Expect Automated Inspection To Grow
As the MFA Quotas come down in 2005, it will be possible to source fabric worldwide. Garment manufacturers as well as industrial fabrics users will increasingly need a comprehensive, consistent way to establish the quality of goods. In addition, the digital maps that automated inspection systems provide, which reliably pinpoint defects, may well be required by the cutters, particularly if advances in single-ply laser cutters continue.

EVS has been working for years to brand fabrics inspected with its system using “I-Tex Inspected” stickers. The ability of a mill to certify that its fabrics have undergone automated fabric inspection could very well become a requirement for certain applications or markets.

July 2001