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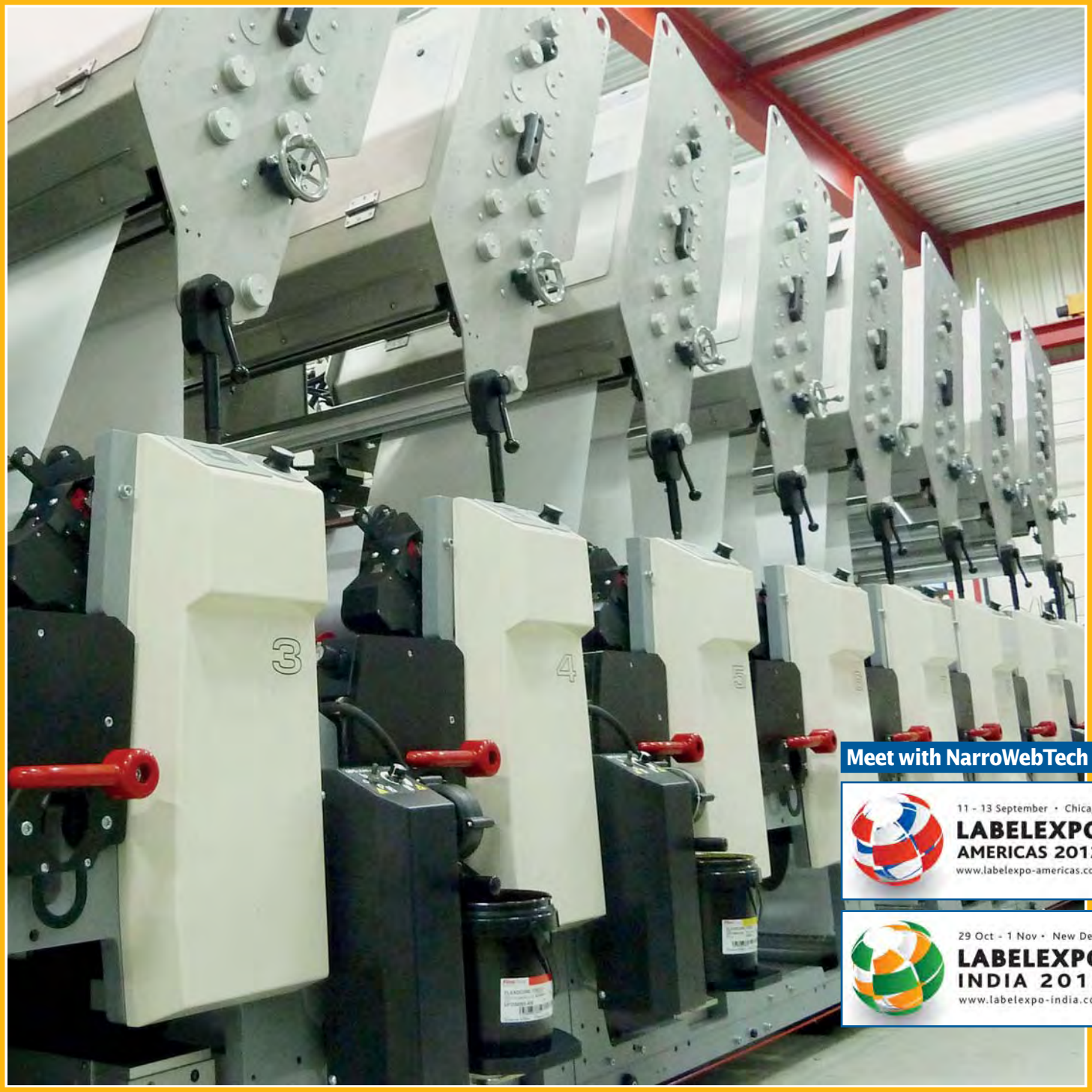

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New imaging technologies for label finishing

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At the end of the 1960's the first range of finishing equipment for printed labels was introduced by Arpeco and later by Rotoflex. They were primarily designed to convert efficiently a master roll from the printing press into smaller reels by counting the labels. Wide rolls with multiple impressions are slit into narrow reels with a single impression and a visual or automatic quality control inspects the output from the converting process. This article concentrates on the various aspects of manual and automated quality control.

Great progress in the field of quality control has been achieved in the past ten years. Automatic printing control systems and workflow solutions for demanding applications have become well established. These systems automatically control the finishing lines via appropriate control signals. An introduction into print inspection and workflow can be found in references [1] and [2]. But although today's finishing equipment increasingly uses automatic print inspection systems, conventional methods for the counting of labels via sensors and print visualization via strobe lights are still the standard. The reasons for this are the relatively high cost of automatic print inspection control systems and an increase in shorter run lengths, which would not justify the cost of setting up complex inspection tasks.

The conventional methods of quality control are discussed in more detail later. The finishing equipment must be able to produce reels with a predetermined number of labels. The counting of labels is difficult for the operator due to the variety of label products. The finishing machine manufacturers or suppliers offer the following solutions:

Single label counter

This method counts each label in one lane as it passes through the counter. The possible sensor technologies for this application would use optical principles (photoelectric or reflective light sensors), capacitive principles (c-shaped sensors with mostly very small gap) and ultrasound principles (c-shaped sensors with a large gap). Optical sensors are only suitable for applications with high contrast while capacitive and ultrasonic sensors are suitable for clear labels on clear release liner. In most cases there is a switch on the line that would allow a quick sensor selection for the different requirements. The sensors can rarely be operated with a unique adjustment, but must be calibrated for different materials.

Missing label control

Multiple sensors installed on a traverse bar monitor the complete web width to detect missing labels. It is common to monitor webs with up to 16 label lanes. Photoelectric sensors capturing and analysing the transmitted light of a linear lightsource located behind the label lane are mainly used for this application. These sensors must be calibrated for different materials and each must be moved into the proper position if the lanes are changed. Pure clear-on-clear applications cannot be controlled using this method.

Much could be written about the many types of labels and the best suitable sensing technology. It soon becomes obvious that there is no universal answer. A solution based on discrete sensors that would cover at least 80% of the applications doesn't exist. Optimal sensor calibration can be hard to reproduce and the setting can only be verified with the intensive use of measurement equipment. The requirement to cover at least 80% of the applications can only be achieved with the use of video imaging technologies. However, choosing a camera represents new challenges and is described in the next sections.

Stroboscopic lights have been used for many years for the inspection of label webs. These strobes generate a steady image with a suitable synchronisation to the speed of the current label web. Although the human eye can process about 14–16 images per second, it is surprising to see that trained operators using strobes will recognise small sporadic recurring printing errors, such as a filled »e«. The same small print error recurring constantly in a sequence of images will be acknowledged by the human eye and considered as a disturbance.

What frequencies would be experienced in a normal case? Finishing equipment typically operates at a maximum speed of 250 m/min (820 fpm). The *table* shows different repeat lengths of labels and the corresponding image refresh rates. From these numbers, the following statements can be derived:

Label repeat length [inch]	1.18	1.97	3.94	7.87	11.81
Image refresh rates [Hz]	139	83	42	21	14

Image refresh rate depending on the label repeat length at a speed of 250 m/min (820 fpm).

1. Large sized labels will have low image refresh rates. This will result in a permanent flickering of the image also at high operating speeds.

2. The eye perception has to adjust during startup and acceleration. It will range starting from individual images (individual flashes), followed by flickering images up to showing constant images. As long as the image is not constant or sufficiently small, tiny

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errors cannot be recognised due to the irritation of the eye.

Is the use of a strobe light harmful?

Strobes are often used on finishing equipment during all working shifts. During the inspection process the operator will frequently start, accelerate, slow down and stop the rewinder which will result in flashing and flickering. No health requirements or regulations are in place, which would significantly limit the use of strobe lights over a longer period of time. Nevertheless, according to most user manuals, strobe lights can cause headache, dizziness, nausea and they can trigger epileptic seizures. To avoid such seizures, the lightning frequency should be below 5 Hertz or should be high enough to avoid the perception of flicker. Today's labels are available in many varieties, which frequently lead to highly reflective or mirror surfaces. As a result, the operator often looks into the direct reflected light: a condition which he should avoid according to the usual warning from the operating manuals of strobes due to possible eye damage. Figure 1 shows reflections caused by a strobe light on the example of a label with a gloss finish and some coloured metalised surfaces.

Whether the control of quality labels by using a strobe light can cause truly irreversible damage to the operator's eyes cannot be answered adequately at this time. It poses the question of whether labels with a gloss finish, which causes extremely bright reflections and so dazzles the eye, or metalized surfaces which appear dark because of the viewing angle, can be adequately controlled. On the basis of strobes, it would be difficult to address the above concerns. Only the use of cameras can improve this situation.

What do cameras provide for web inspection?

With a view to the budget, the first choice would be a cost-effective web viewing / video system, which is today found on virtually every printing press. The picture quality is usually excellent, but most standard cameras have problems with the display of reflective surfaces. A strobe replacement unit would require the viewing of the entire web width, but these cameras have a limited field of view covering only 100–200 mm (3.94"–7.87"). In addition, a high image refresh rate would be required in accordance with the previous table. In fact, these cameras update their screen at most 2–4 times per second, resulting in a net viewing rate of a few percent in relation to the entire surface of the label web.

A more expensive but better solution would be to use a print inspection system with a video capability. It is possible to display images from the moving web over the entire web width. The operator has the option of viewing the printed web from the beginning even without creating an inspection job. However, the image refresh rate of these systems is far from reaching the required bandwidth of 20–30 images per second, which makes it necessary, in most cases, to create a complete print inspection job. The use of an automatic print inspection system provides the advantage that a steady image is generated regardless of speed. Reflective surfaces or holograms can also be properly displayed with the appropriate illumination technique.

Alternative solution to automatic print inspection systems

In fact, many video imaging systems currently available on the market cannot meet all requirements. The following list represents a wish list for an economic camera system on finishing equipment using:

Attractive price-performance ratio, i.e. costs which correspond to an equipment with conventional missing label control and strobe.

Image refresh rates of the order of 40–60 frames per second, or 20–30 images per second when at least two reports are displayed.

Easy job setup and easy operation.

Automatic synchronization without requiring a separate trigger sensor.

Cover the entire width and image display on a sufficiently large screen (> 22" monitor with

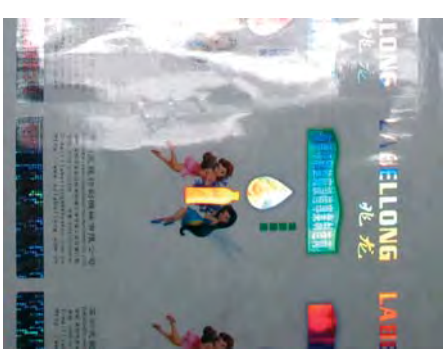

Figure 1: Labels with metalized surface and gloss finish.

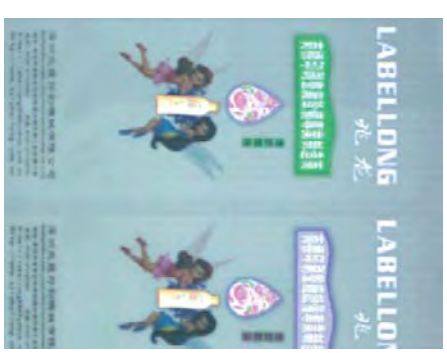

Figure 2: Digital TubeScan strobe+ with digital strobe function and missing label control.

Figure 3: TubeScan captured image (see Figure 1).

at least HD resolution).

- Viewing of reflective and metalised surfaces.
- Simple image processing functionality for label counting, missing label control, etc.
- Output error and control signals to the PLC of the finishing equipment.

The new *TubeScan digital strobe+* from *Nyquist Systems* meets essentially all these requirements. *Figure 3* shows the compact size of the system, which can also be retrofitted on existing finishing lines.

One of the most important requirements, namely the viewing of reflective or metalised surfaces is met with the new system by using a unique special type of illumination with high power LED's. The effect of the *TubeScan* technology is shown in *figure 2*. A major improvement is clearly visible in contrast to the same subject shown in *figure 1*. Metalised surfaces and holographic effects are shown in their natural colour. The image is permanently synchronised and therefore appears even at low speeds as a steady and in real-time updated image.

Conclusion

The use of discrete sensors for the detection and counting of labels is no longer adequate due to the availability of digital cameras. The many different finishing processes result in complicated setup procedures or completely prevent the utilization of discrete sensors. The use of high performance strobes was critically questioned and implies switching to cameras with high image refresh rates. With *TubeScan*, a new and innovative technology is now entering the market. It will meet all the requirements outlined in this article of modern and economic print quality control systems for the label finishing lines. This technology is provided and sold by the well established vision specialist *eltromat GmbH*.

Literature

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Dr. Stephan Krebs is CEO of *Nyquist Systems GmbH* in Landsberg am Lech/D.

Illumination technologies for the monitoring of critical materials and process workflows for the optimal integration of printing control systems on the printing press, as well as key quality assurance and automated control units are some topics for which the company has developed solutions in the past. *Nyquist Systems* is now a member of the *eltromat* group.

Ernest Schneider, CEO of *eltromat America Inc* in Chesapeake, VA/USA, has three decades of experience in the printing and converting industries. The technical knowledge spans from web handling to the vision/inspection technologies such as video viewing, process management, defect detection and 100% print inspection systems.

eltromat is today a market leader in high-quality optical measurement and control systems for inline printing processes.