Keeping track of defects

Part 2: »100% print image inspection« in the workflow of label printers.

ERNEST SCHNEIDER [1], DR STEPHAN KREBS [2]

The second part of this article concentrates on the use of print inspection technologies in the different operation sequences from pre-press, on-press and post-press. The described concepts have an immediate productivity influence on the entire production line.

Process control and quality assurance

In print shops communication takes place on two levels as shown in *figure 1*. Production related information is passed on horizontally and more or less automatically from one production step to the next by means of job tickets. If so required, the data that is produced during or after each of these production steps may be passed on vertically and in a condensed form all the way up to the management of the company. The purpose of this overall transparency is to provide information at any time about the production status and the delivery situation. Reliable planning of a delivery date for a product is only possible if the quality of each production step can be measured. Defects that are detected at the end of the production process will have an immediate impact on the planned delivery date. Defects that are not detected will automatically reduce the quality of the delivered product.

Missed defects have always been a focus for critical products such as pharmaceutical labels. This explains why 100% print inspection systems were applied on finishing lines as soon as such technologies were available. A certain standard was achieved with these quality assurance measures but, as it will be shown later, print inspection is not really always able to meet the accuracy. However, if quality control is applied to each individual production step, it will result into an optimization of each individual process. This also means that the quality of each production step will be controlled by a print inspection system. Early defect detection in the process will result into waste reduction or even waste avoidance.

Pre-press control step

Systems that electronically compare approved proof (e.g available as PDF file) with a print sample placed on a scanner are common practice. A typical example could be found in the printing of folded boxes. A sheet sample will be taken at regular intervals during production and be compared with the approved original.

To carry out such a comparison in roll-to-roll label printing is much more complicated. This is why samples are only taken at the beginning and end of the roll production. This procedure, of course, is far away from a 100% print inspection, but reliable for the print content. If a final comparison is carried out at the end of the printing job plate defects can also be ruled out.

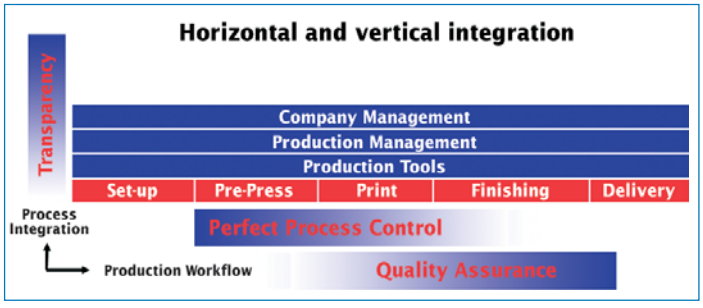

Figure 1: Communication in print shops.

What is driving the use of proofing systems?

Regulations that apply to different markets may require the use of a proofing system. Even if the print quality is only checked on a random basis, the production quality is predictable. Random checks will engender a reduction of waste particularly in those cases where checks are made at short intervals. Many printers have to produce labels for the worldwide market and therefore include texts in foreign languages. If you have ever tried to compare two copies with Chinese characters or to check content of a foreign language text, you know that small but significant differences are easily overlooked. A proofing system detects these differences electronically and submits them to the user for sequential inspection. *Figure 2* shows a PDF master copy that has to be compared to a series of labels. A report of the electronic inspection will be prepared by the system, which will show the quality of the print. Contrary to word processing and typesetting programs, proofing systems are not designed for spell checking or grammar corrections, and do not inspect the individual document or the quality of the print. Also, normally neither OCR nor OCV functions (Optical Character Recognition/Verification) are included. Functions such as barcode decoding on the other hand are very useful for print validation.

As a final remark let us point out that manual sampling within the workflow is very demanding on the operator. The next chapter will therefore refer once more to this method and will explain how the image taken by the camera on-press during the printing process can be used directly for proofing and will avoid the additional step with a scanner.

Sampling during production

- *Manual inspection with strobe light.* Printers frequently use a

[1] Sales Manager Print Inspection, *Erhardt+Leimer Inc*, Duncan, SC/ USA.
[2] Business Unit Manager Print Inspection, *Erhardt+Leimer GmbH*, Augsburg/ D.
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strobe light to inspect the printed web. This tool with a flash synchronized to the web speed gives the operator an impression of a stable image.

Since the concentration of the operator diminishes in the course of time this sort of inspection is not highly efficient. There will always be defects, sometimes more and sometimes less, which will not be detected and which will therefore be part of the roll delivered to the customer. Detailed studies have been conducted on this so-called declining vigilance. This topic, however, will not be pursued further in this article.

- *Random checks with a video web viewing system.* Video web viewing systems as shown in *figure 3* are today standard equipment on printing presses. This is a valuable tool for the operator and primarily used in setting up a new job on the printing press. The zoom function will provide a magnified view of the register marks during the adjustment of the different colours and details on colour reproduction. Traversing camera systems are sometimes provided today with process control and or print inspection functions. Given the good colour reproduction, these systems are definitely appropriate for certain applications, for example for those where colour deviations, which arise over a longer period of time, must be detected. However, bear in mind that these are sampling systems and they will only cover a small part of the total printed web as can be seen in figure 3.

Let us presume that the printing press operates at 120 m/min (400 fpm). If the video web viewing system covers an area of 125 x 100 mm (5" x 4") and the web width is 300 mm (12"), the web coverage will be barely 2% presuming that one image is taken every second. A video web viewing system with inspection functions is therefore nor suitable for comprehensive printed web inspection.

Locations for inspection – printing presses vs inspection rewinders

When weighing against each other the two possible locations of 100% print inspection – printing press or inspection rewinder – it should be kept in mind that in most shops the rewinder is used for several post-press jobs and not just for inspection. The *table* shows the respective pros and cons.

It shows some benefits in favour of using the inspection system on a printing press. Inspection results are better. Most important, however, is the positive influence on the amount of rejects, as the amortization time for the investment in print inspection depends on the material costs.

Avoiding waste on the printing press is not all. Defect treatment in the following finishing process is also required. Defects, which have been detected by the print inspection system, small misprints, hickies or just missing labels, must be eliminated before delivery. At this point the so-called »Scheduling« completes the process workflow.

Optimized finishing

Once it has been decided to locate the 100% print inspection system on the printing press the question is how to process the information of the found print defect. Given today's PC technology it is possible to save the images of all the detected defects in a database. This complete documentation of the printing production is called »Roll Map«. Basically, a »Roll Map« is the digitalized, virtual equivalent to the printed roll. It can be visualized on the screen for further analysis during and after the printing process. For the subsequent real processing it is necessary, however, to allocate each image of a defect to its correct position on the web. Given the »endless feature« of the printed web it is necessary to apply a position code during the printing process, for example on the backside of the liner. General practice is to use either bar codes or a simple, distinct binary code as shown in *figure 4*. The binary code has the advantage that the code reading on the rewinder can be

Figure 2:
Proofing software, comparing a print with the original PDF.

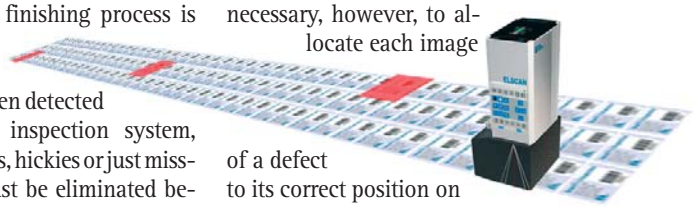


Figure 3:
Web sections covered by a traversing camera of a web viewing system (in red).

100% print inspection on an **inspection rewinder**
+ Final roll inspection before delivery.
+ In most shops there is one rewinder for several printing presses.
– Permanent stop and go frequently causes false defects. Therefore the sensitivity of the 100% print inspection system has to be reduced in most applications.
– Personnel are usually not so well acquainted with PC operation.
– 100% print image inspection is usually slower than the maximum speed of the rewinder.
– Since the printing process is already concluded waste can only be reduced at the expense of quality.
100% print inspection on a printing press
+ Significant waste reduction as rejects are avoided in advance, therefore high productivity.
+ Print inspection system pays for itself by substantially reducing rejects.
+ The even web movement reduces the number of false defects. The 100% print inspection systems can operate at high speeds.
+ Personnel are already well trained for PC operation.
+ The speed of print image inspection systems just about matches the speed of the printing press.
+ Optimal rewinder control when used with »Scheduling« feature.
– A separate print inspection system is required for each printing press. But the individual system pays for itself by contributing to waste avoidance.
– A marking code must be applied when »Scheduling« is used.
– As final control on the rewinder is not available, strict process conformance is required.

Table:
Pros and cons of 100% print inspection on a rewinder versus printing press.

done at practically full operating speed.

100% print inspection on a rewinder causes a machine stop each time a defect is detected. Following the stop, the defect must be located and analyzed before the process can start again. Each stop takes approximately 20 to 30 seconds whether the defect is significant or not. The strong benefit generated by a combination of 100% print inspection and »Roll Map« processing on the rewinder becomes fully obvious at this point.

Before using the »Roll Map« on the rewinder the defects can be analyzed offline on the PC. The defects can be evaluated individually or by category and can also be hidden before further processing. This so-called »Scheduling« takes only a fraction of the time required for an evaluation on the rewinder. Also, defect placement will take place only for those defects, which are relevant. In practice this does not only mean an increase in productivity, it also means that the inspection process on the printing press has been controlled. This is not comparable to an increase in productivity by simply lowering the tolerances of print inspection on a rewinder, which means that the system will allow certain defects without clarification of their impact.

Figure 5 shows a »Roll Map« of a finished printed roll. The label lanes are clearly laid out. If so required the »Roll Map« may be mirrored and tilted according to the web run direction and defects which are to be analyzed may be selected and displayed at the right side of the screen. If there is an accumulation of defects within one area, the zoom-in function can be used for a closer analyze. The zoom-out function gives a clear overview of the situation of the »Roll Map«.

Summary of the benefits of »Scheduling«:

- The »Roll Map« can be analyzed offline to hide defects that are not relevant.

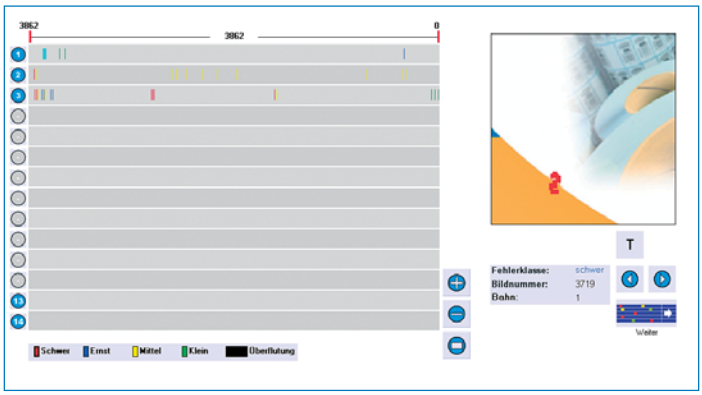
Figure 4:
Application of a position code by inkjet printer.

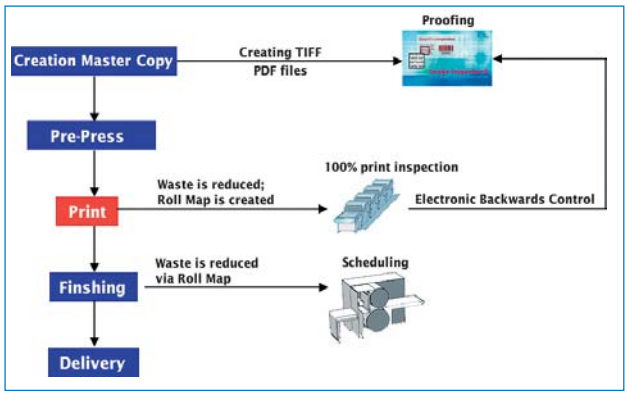
- Only »real« defects will be placed by the rewinder
- The operator always knows which defect comes next. Where appropriate he may therefore skip the defect to increase productivity even further.
- The rewinder can be used at max. operating speed.

Workflow interaction

Now that the use of print inspection in the different production steps has been explained, we will take a closer look at the interaction within the workflow. *Figure 6* shows a sequence of the operation diagram. The decisive role is played by 100% print inspection on the printing press. The inspection system registers the defects continuously and saves them together with their respective position in a database. In the same instance an inkjet printer marks the defect position. Since the machine is stopped only when substantial defects occur, the sensitivity of the inspection system may be set rather high so that general trends will also be recorded. These trend defects may later be hidden. At the beginning of production a defect image will be taken which will then be compared backwards with the original PDF file via the proofing software. A comparison with the specifications of pre-press is thus guaranteed.

After the printing process the databases are checked in their capacity as »virtual rolls« and those defects, which are commercially acceptable, are hidden. Quality assurance for example may do this, or, once the system is firmly established, can be done by the operator himself. After the database has been completely checked, a process that usually takes just a few minutes, automatic fault placement starts on the rewinder. Now the rewinder will stop at previously defined defect





positions only, otherwise it will run at maximum speed. The result of this process is not just a roll, which has been carefully inspected and includes only minor waste. The result is also a continuous roll report, which includes all those defects that have been hidden during »Scheduling«.

Conclusion

100% print inspection is still considered as a rather young technology. The further developments, which we can mainly expect in camera, and computer technology as well as innovations in lighting procedures will therefore continuously expand the possibilities of quality management in the label, film and flexo printing industries. Networking within the workflow and integration of data management processes becomes even more important and the ease of use aspect always plays a major role.

A recommendation at the end: selection of the right print inspection system should always include intensive tests with your own typical printed material to be inspected. Special attention must be paid to such features like holograms, metal foils, embossing or the entirety of small prints.

This will allow you to differentiate great inspection systems from average systems. ■

Figure 5 (left): A roll that has been produced is shown as »Roll Map«.

Figure 6 (right): The complete workflow.