DIGITIZATION OF FILMS FOR ELECTRONIC PAGINATION - AND COMPUTER-TO-PLATE

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Abstract: Digital scanning of existing screened films combined with electronic page assembly is an interesting alternative to manual stripping when output is film, and a must for computer-to-plate.

However, most scanners are not ideal for this task, because they were developed for other applications. Drum scanners have the required format and resolution, but they are terribly slow for this resolution and format. Most CCD scanners apply an optical zoom system, which only yield the required resolution over a small area. Some flatbed laser scanners have the resolution and format, but only for reflective copy.

Furthermore, scanning of screened material on a digital scanner is not trivial. The digitizing can generate moiré, which has to be eliminated. The threshold must be adapted in order to reproduce the full dot range. Register between colour separations can be improved automatically by optical pattern recognition. The scanner must generate low-resolution previews for efficient page assembly. File sizes must be reduced by efficient data compression. Sometimes screen ruling or gradation must be changed using digital descreening.

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Introduction

I am very pleased to have this opportunity to share with you our experiences regarding digitization of films. This has been the main application of our flatbed scanner over the last two to three years, especially at newspapers.

Problem Definition

First I shall try to define the problem clearly. Let us assume that we want to produce a newspaper using fully electronic pagination, which is mandatory for computer-to-plate, but also relevant for output to film.

Figure 1. Ad received as set of four colour separations on film

We now receive a four-colour advertisement ("ad") as a set of four films from an advertising bureau, accompanied by a colour proof. We want to use electronic pagination to position the ad on the electronic page. The colours in our newspaper must closely match the supplied colour proof. How do we proceed?

Work Flow

I shall now describe a possible workflow, and as illustration use the EskoScan flatbed scanner. Other scanners might do it slightly differently. For this application it is absolutely necessary that the scanner is equipped with a pin register system, which makes is possible to scan separate films in register. On the EskoScan the same pin register system is used in the scanner itself, on the Job Preparation Station and on the light table, where the separations are mounted in register, exactly like conventional four-colour work.

Figure 2. Mount all four films visually in register on four transparent, pre-punched carrier foils.

Figure 3. Place one of the mounted foils on register pins of the Job Preparation Station.

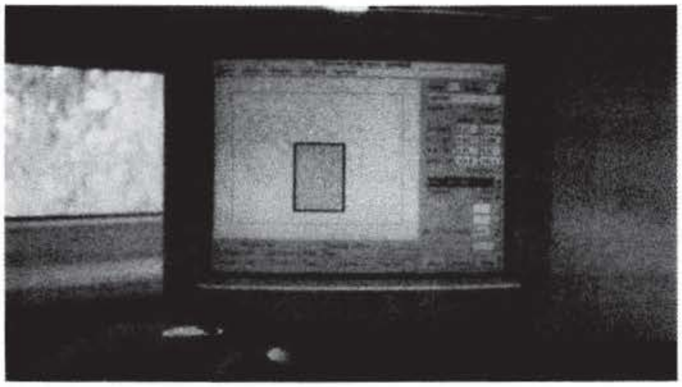

Figure 4. Define scan area, size, scan resolution, and number of colours in the set.

Figure 5. Load first foil into the scanner, using the register pins for accurate positioning.

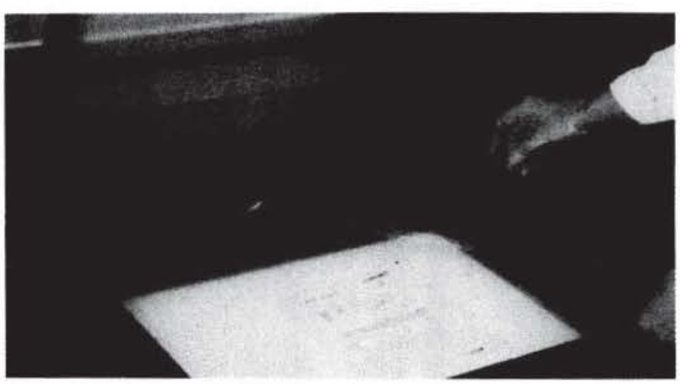

Figure 6. Select colour and start scanning. The job is finished when all pre-selected colours have been scanned.

During each scan, the scanner extracts enough information from each colour separation to generate a low-resolution colour preview image, which is stored as a fifth file with references to the four high-resolution files.

Figure 7. RGB colour preview image generated from the scans of four colour separations.

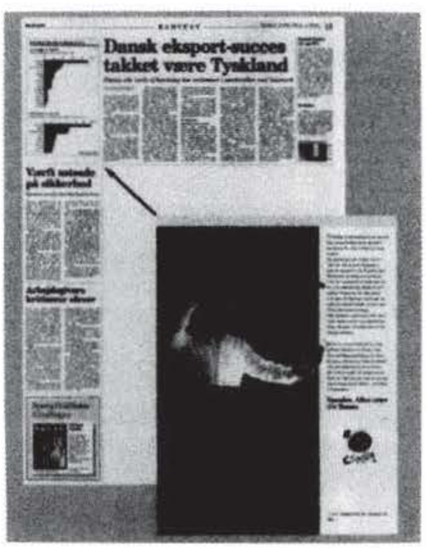

Figure 8. Open a page in the electronic pagination program, open the preview file of the scanned ad, position the ad on the page, send the page to output.

During the output of the page, each of the scanned separations is automatically inserted by the RIP in correct register on the corresponding full-page plate or film.

Once again, let us repeat the steps necessary to digitize a four-colour ad and integrate it into an electronic page:

- mount all films in register
- define the scan parameters
- scan all films, one-by-one
- position ad on electronic page, using colour preview
- output all four complete pages

The same procedure in principle applies to one-, two- and three-colour ads. It could even apply to editorial four-colour images, which at many newspapers today are stripped into position manually.

Why digitize films?

The need for digitization of films started with electronic pagination a few years ago when output was still complete pages on film. You may ask: Why digitize, when it is still possible to strip the ad into the complete page. The answer is, that for partial-page ads there seems to be a substantial productivity gain, by scanning each ad separately and then using electronic pagination to assemble the complete page. Obviously, the productivity gain is even bigger when ads are used several times, as it is often the case. Scanning takes place only once, whereas manual stripping must be done every time. With computer-to-plate the situation is completely different: Now stripping is no more possible. All incoming films MUST be converted to digital data before the plate is exposed.

Potential problems when digitizing films

Line art scanning is normally considered trivial. However, digitization of films with screened images is not quite simple. There are some potential problem areas, and some basic rules must be observed in order to reach a satisfactory result.

The ideal scanner for digitization of screened films must be able to scan at least one full broadsheet page on film: 360 x 580 mm (14" x 23") at a resolution of 400 - 500 lines/cm (1016 - 1270 DPI) over the full scanning area.

Let us have a closer look at some of the potential problems areas:

- CopyDot or Descreening
- Scanning resolution
- Dot reproduction range
- Moiré suppression
- File formats
- Data compression
- Automatic register
- Colour proofing

I shall now add a few comments to each of these potential problem areas.

CopyDot or Descreening

We are often approached by people who want to discuss descreening, because they have heard from other vendors that descreening is the road to electronic pagination. We always try to convince these people that there is another and better way if the purpose is just electronic pagination of existing ads on film. We have named this other procedure CopyDot, a term which is now gaining acceptance in the whole pre-press industry.

By CopyDot we understand a reproduction dot-by-dot of the original screen. This exact reproduction of each dot is only possible if the original is scanned as line art at a resolution which is at least 10 to 12 times the original screen ruling. This means that for a normal newspaper screen of 34 lines/cm (85 lines/inch), the minimum scanning resolution is 400 lines/cm (1016 DPI).

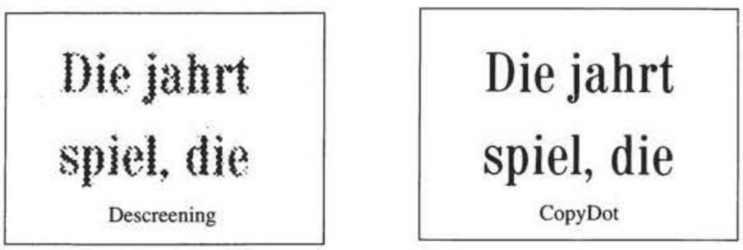

Figure 8. The obvious difference between descreening and CopyDot regarding line quality.

The advantages of CopyDot are:

- screen ruling, screen angle, and dot sizes are identical to the original, a requirement from most advertisers
- line details and fine text have the same quality as the original

A limitation of CopyDot:

- the original must have correct size and screen ruling

A disadvantage of CopyDot:

- the files generated from scanning screened images as bitmaps used to be very large. As we shall see later, there is now a solution to that problem.

Sometimes, however, the ad does have the wrong size or the wrong screen ruling. Descreening is then necessary in order to be able to change size, without changing screen ruling, or change screen ruling without changing size. The workflow for digital descreening is the same as for CopyDot, but the resulting high-resolution files are now continuous tone, NOT bitmaps. We call it digital descreening, because we use a powerful computer to eliminate the screen by a mathematical process. Digital descreening maintains all the details of the original image.

The advantages of descreening for some applications are obvious:

- descreening gives complete freedom regarding sizing screen ruling, gradation changes and retouching

Descreening, however, also has a serious disadvantage:

- line details and text are screened as part of the image when the ad is output as part of the complete page

The resulting line quality is normally not acceptable for offset printing.
Our conclusion is therefore very clear: Whenever it is possible, use CopyDot for digitization of ads!

Scanning Resolution

When screened ads are scanned as bitmaps (CopyDot) the most important of all settings is the scanning resolution. The resulting data file must have exactly the resolution of the intended output device. Otherwise the RIP will attempt to change the image resolution to fit the output device, and the only way to change the resolution of a bitmap is to remove or add bits at certain intervals. This will usually lead to unacceptable moiré.

For existing film output devices for newspapers there is a number of frequently used output resolutions, from 1000 DPI up to 1270 DPI. A scanner for digitization of films must be able to generate all of these resolutions. Horizontal, and vertical scanning resolution may even be different if distortion is required. These are the typical newspaper resolution of some of the popular image setters on the market:

- Monotype	394 lines/cm 1000 lines/inch
- Autologic APS6	400 lines/cm 1016 lines/inch
- AGFA SelectSet	472 lines/cm 1200 lines/inch
- Linotronic 300	500 lines/cm 1270 lines/inch

Dot Reproduction Range

In order to maintain the colours of the original film it is necessary that the digitization process is able to accurately reproduce the full dot range of the original, i.e. from 1% to 99%, when scanning from film originals.

If screened originals are scanned as line art with a fixed threshold, there is a tendency to lose the smallest dots - in highlight as well as shadow. The solution is known as Area Adapted Threshold, or AAT. This means that the threshold is automatically adapted to the average local density of the area actually being scanned: the threshold is low in highlight areas and high in shadow areas. AAT makes it possible to reproduce dots from 1% to 99% with deviations of less than +/- 1% over the full dot range.

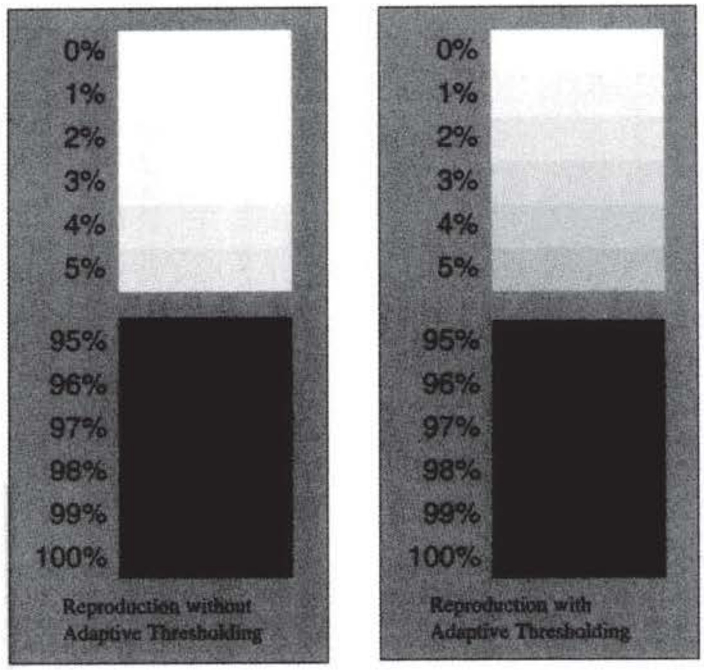

Figure 9. Dot reproduction range when scanning without and with Area Adapted Threshold

Moiré Suppression

It is generally known that there is always a risk of generating moiré when scanning screened originals on a digital scanner. Moiré is caused by interference between the scanning resolution, screen ruling, and the resolution of the output device used to create the original. The traditional solution to this problem is to change scanning resolution slightly or to rotate the original.

However, as we have just seen, the scanning resolution is already fixed, and rotating the original is not allowed when scanning into electronic pagination.

Figure 10. Scanning moiré can be eliminated by using a suitable moiré filter

A scanner which is used for digitization of screened originals must therefore be able to suppress scanning moiré by digital filtering. Unsharp scanning or blurring is not acceptable, because it causes loss of image details.

File Formats

In order to make it easy to handle digitized four-colour ads in electronic pagination it is necessary that all four separations can be treated as one image, not four independent images. Firstly, because it would be too time consuming to work with four independent files, secondly because the low resolution of preview images would not be sufficient to visually guarantee accurate register.

Therefore the scanning procedure must guarantee that all four separation are scanned in accurate register. There is one well-known standard format which submits itself to this application. This is the DCS-format - or five-file EPS, which is normally used to represent a continuous tone CMYK-image.

The DCS-format can also be used to represent a set of four-colour separations scanned as line art. Each of the four high-resolution files contains one bitmap file representing one colour separation, and the fifth file - the master file - contains a low-res continuous tone colour image - for positioning only - and the links to the four high-res files.

This format can be used in pagination programs like Quark XPress and Aldus PageMaker, and in several other pagination programs. The colour preview image is simply brought into the required position on the page, and during output the high-res bitmaps are inserted in the corresponding positions of the completed page.

Data Compression

One of the problems related to bitmap files has previously been the resulting file size. A DIN A4-size four-colour ad scanned at 1270 DPI is 20 Megabyte per colour or 80 Megabyte in total. Transport of such file sizes on an Ethernet could take from 3 to 15 minutes, depending on the type of file server.

However, CCITT Group 4 data compression and the widespread use of PostScript Level 2 RIPs, which can decompress CCITT Group 4, have largely eliminated the file size problem. CCITT Gr.4 is a two-dimensional data compression, which was developed for facsimile applications. It is totally loss-less and very efficient for text and drawings. Even screened images scanned as bitmaps, which are normally difficult to compress, are compressed three to five times depending on screen and scanning resolution.

The CCITT Group 4 compression performed by software running on a PC/486 or Pentium is able to compress half a Megabyte of data per second. This means that an A4-separation is compressed in about 40 seconds, which corresponds to the typical scanning time. Decompression speed of the RIP is similar. The typical compression ratios for CCITT Group 4 are:

- line drawing	50:1
- small text	20:1
- screened image	5:1 - 3:1
- typical newspaper page	15:1

Altogether this means that the high-resolution files are compressed during scanning, remain compressed during pagination, and they are only decompressed by the RIP, when the page is output to film or plate.

Automatic Register

One of the frequent questions related to scanning of partial-page ads into electronic pagination has been: What is the benefit of electronic stripping if it requires the same skill and accuracy as manual stripping. Now there is a convincing answer to that question: Electronic stripping does not require the skill and accuracy of manual stripping, because it is possible to let the computer perform the accurate alignment. The condition is only that all separations contain a well-defined pair of register marks, which can be recognized and electronically aligned by the computer.

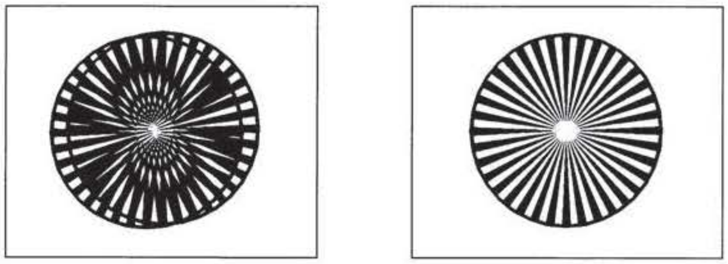

Figure 11. Close-up of a register mark, scanned as mounted and with automatic regitration.

The separations only need to be mounted approximately in register, which does not require special skill and takes much less time than conventional stripping. This new feature, demonstrated by Eskofot at DRUPA, compensates for displacement errors as well as rotational errors. A close-up of a register mark demonstrates the effect of automatic register.

Colour Proofing

Very often there is a need for generating a colour proof of a complete page containing digitized film. Digital colour proofers, however, are expensive, much more expensive than CT proofers. Therefore there is an economic advantage in converting digitized films to CT before proofing. As we have seen earlier, descreening has problems regarding retention of line quality. However, the purpose of the colour proof in this case is only to check colours and to help the printer to adjust the ink settings. Details are not important for this application, and this can be used to optimize the descreening for speed and colour balance, rather than image details. The output will still be based on the original bitmaps, which maintain the line quality of the original.

Conclusion

I hope that this presentation has given you the correct impression that digitization of films for electronic pagination is a mature and available technology, whether it is for computer-to-plate or computer-to-film.

I have also provided you with a check list which is absolutely essential when selecting a scanner for this application. Most scanners were designed for entirely different applications, and many are not suited for digitization of large films.

We all know that digitization of films is only needed during a transition from the film-based to the film-less work flow. But we are convinced that this transition will take several years. I believe that you will all agree that the ability to digitize films is an interesting alternative to manual stripping for everybody, who enter full electronic pagination. It is simply a **must** for everybody who wants to start on computer-to-plate production now.