INTELLIGENT PLATE SCANNER FOR OFFSET PRESSES

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Abstract: A new intelligent plate scanner has been developed and constructed at the Technical Research Centre of Finland. The scanner is capable of measuring both presensitized Al-plates and multi-metal offset plates. To obtain this feature, the optical sensor operates in three modes. A densitometer type assembly is used, if the diffuse contrast of the plate is high, and a specular measuring method is used to determine the image distribution of glossy plate types. In some cases, a polarization filter is used to enhance the optical clarity of a fuzzy plate. The plate scanner functions are controlled by a microcomputer which chooses the measurement mode after reading the signal levels at the calibration spots near to the gripping end of a plate. The scanning sensor consists of 16 elementary detection spots, each 6 millimeters wide. The readings of adjacent elements are combined to conform with the width of inking zones in the printing press used.

The microcomputer program is provided with intelligent features which are capable of determining whether an inking zone contains any image or not. The use of detection logics and local calibration values has significantly increased the measurement accuracy at the inking zones with only minor ink consumption. The computation of the presetting values is done using a press-specific set of parameters. When matching the offset plate scanner with a printing press, these parameters are determined using test printings. When on-line

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connected to a press, the plate scanner is able to fit the parameter set using an adaption program developed. The computer updates the parameter values, whenever an authorized correction of the inking amount is asked by the printer.

1. INTRODUCTION

Presetting systems based on film scanners have been used with newspaper presses since the early seventies. Today presetting based on measuring is making rapid progress with highquality heatset offset presses and sheet-fed presses, where presetting is based on plate measurements instead of film measurements, because plates are more practical to handle. (Simomaa e.a. 1983).

Commercial printing sets higher requirements for the presetting system. In order to be economical the presetting accuracy of high-quality printing must be much better than in newspaper presses. The plate is also more difficult to measure than the film. Difficulties are caused by the darkness variations of the offset plate surface (Kaivosoja e.a. 1983), appearing specially in the inking zones that contain only a little printing image. Because of the higher quality requirement the characteristics of the inker also cause more problems than in newspaper printing. On the other hand, a satisfactory presetting accuracy will bring big savings, too.

Quite a number of heatset offset presses were bought in Finland in the late seventies. Most of the presses have analog remote control for the inking but the presetting concept was not actual in those days. Today, many of the offset plate scanners on the market are suited for one manufacturer's sheet-fed and rotary presses. It would be waste of money to buy a plate scanner for each press, because the plate scanner is needed only for a short time at the beginning of printing. And, quite frequently plate scanners that are compatible with the existing presses are not available.

experimental printing carried out with the press. Today the installation is complemented and we have one month's experience in the commercial operation.

The development of the OPS plate scanner is a part of our studies aimed at producing an integrated control system for the offset press. The results obtained with a single-unit press in the VTT laboratory are reported by Dr. Simomaa. (Simomaa e.a. 1984). The next step will be the application to production by using the feedback control with the computer-controlled heatset press in our customer's plant.

Subject Outline

The construction of the OPS plate scanner is presented in Paragraph 2. Paragraph 3 contains the results obtained when studying the offset plates used by Finnish printing houses. The measuring and presetting computation methods are described in Paragraphs 4 and 5. Paragraph 6 contains the results received with the computer-controlled heatset press. The results are discussed in Paragraph 7 and the conclusions reached in Paragraph 8.

2. CONSTRUCTION

Fig. 1 shows the outline of the OPS plate scanner. The plate to be measured is fastened on to the board by using air suction. The sensor is placed inside the vertical balk, which is moved horizontally, whereas the sensor inside the balk is moved vertically. A solenoid-controlled marking pen in the sensor is used for plotting. An external printer is used to record the output.

The scanner in Fig. 1 is equipped for use with three different printing presses. The operating panel consists of three press selecting switches, twelve unit selecting switches and starting switches for plotting and recording. All the data describing the printing presses is stored in a nonvolatile parameter memory. The parameter values are changed by means of the programming panel. The programming panel is located behind the apparatus inaccessible to the pressmen. The

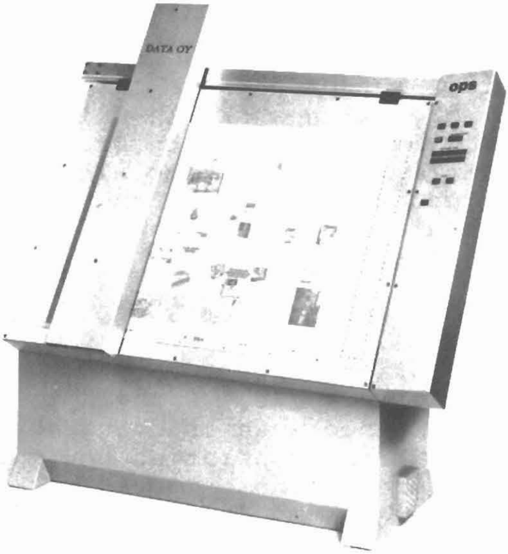

Figure 1. The offset plate scanner OPS.

data describing the presses include the plate sizes, the numbers of the inking zones, the sizes and positions of the graphic output plot and the sizes and locations of the calibration areas. The parameter memory contains the data to compute the settings of the inking screws.

Sensor Features

The optical sensor of the OPS plate scanner is shown schematically in Fig. 2. The shielded enclosure contains sixteen light emitting diodes which are nearly monochromatic red light sources. Each of these solid state lamps illuminates a 6-mm-wide spot which measures 3 mm in the direction of the sensor movement. Reflected light rays are detected by corresponding diffuse and specular detectors which are of the silicon photodiode type.

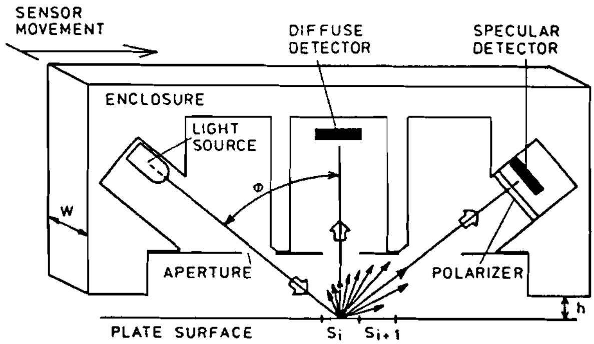

Figure 2. The sensor construction of the plate scanner.

Using this measuring geometry, an offset plate can be evaluated by three different measuring modes, i.e. diffuse, specular and polarized specular. Bluish and greenish presensitized plates are conveniently measured by using the densitometer type diffuse mode, while clossy bimetal plates require the use of a specular mode. An example of the difference between the two plate types is shown in Fig. 3, giving the diffuse contrast

$$C_P = I_{light} / I_{dark} \qquad (1)$$

as a function of the light wavelength. I stands for the light intensity reflected from the light and dark spots. Even at the red end the area elements of the Cu/Cr plate are barely distinguishable, while the Al/diazo plate is measured easily. Using the polarized specular mode a comparison of these plate types is made in Fig. 4, which shows the plate contrast as a function of the light's angle of incidence. A polarization filter is used to reject the linearly polarized light component from the dielectric reflection. The linear polarization does not occur when light is reflected from a better-conducting copper surface. For certain plate types the nonpolarized gloss measurement may provide better results. 15 source - detector pairs are used for the actual scannings and one pair is used to chose the most suitable of the two specular modes.

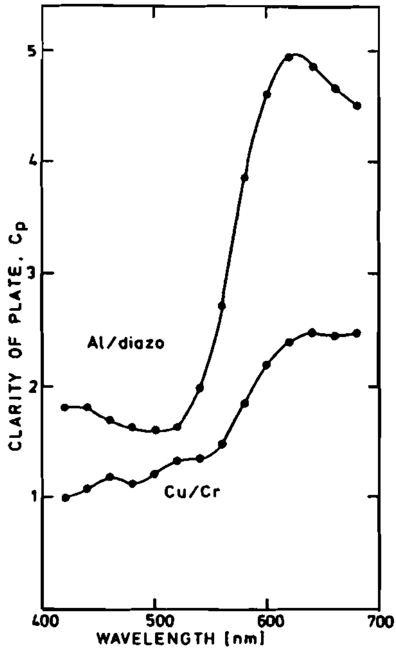

Figure 3. The contrast (clarity) of the offset plates in the diffuse measuring mode. Plate types were Kalle P7S (Al/diazo) and Quadrimetal (Cu/Cr).

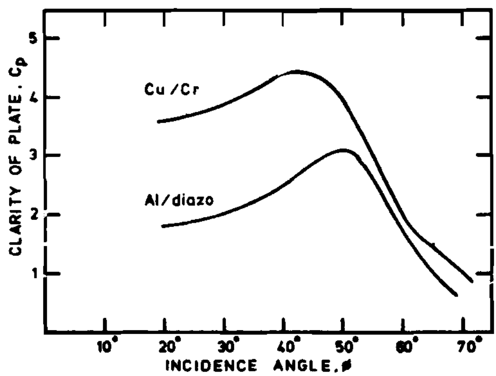

Figure 4. The contrast (clarity) of the offset plates in the polarized specular mode. The plates were Quadrimetal (Cu/Cr) and Kalle P7S (Al/diazo).

Operation of the Offset Plate Scanner

The offset plate scanner has a memory for storing the measuring results of all the plates of a particular printing press. The measuring of a plate set is initiated by selecting the press with a pushbutton switch. The plates can be measured in any order. After a plate is placed on the board the measuring is initiated by pushing the corresponding switch. The offset plate scanner keeps the pushbutton switches illuminated to help the user remember which plates have been measured.

The actual measuring consists of calibration, scanning and computations. The calibration is made by scanning the 0 percent and 100 percent calibration areas. The scans are made simultaneosly by using all the sensor channels and both measuring modes. The feasibility of the calibration results is verified and the measuring mode for the final scan is chosen. The choice is based on two computation results: the contrast between the two calibration areas and the variation in the calibration areas. The measuring mode that gives the better contrast to the variation ratio is chosen.

During the final scan the plate is divided in 6-mm-wide zones corresponding to the sensor channels. The zones are scanned 15 at a time by taking measurements at intervals of 3 mm. The printing image percentages of the inking zones are computed according to the scan results of the 6-mm-wide zones. The duct roller's speed selection and the computation of the inking screw profile are based on these computation results.

After measuring all the plates of a printing press the user initiates the output. There are three alternative methods for different printing presses: printer, graphic plotter or online connection. Recording on a cassette is also available as an option. The output to an online connection or printer is initiated by pushing a switch. The printing image percentages and the inking screw settings of all the printing units are transmitted or printed consecutively. In order to use the plotter output the user has to place a plastic foil on the measuring board. Like the printing plates, the foil is fastened by using air suction. The inking screw settings of the upper side and lower side units are plotted on different foils. After the initiation the offset plate scanner automatically plots the inking screw setting profiles of the selected press side on the plastic foil. The foil, part of which is shown in Fig. 5 is placed over the display of the remote control console of inking screws.

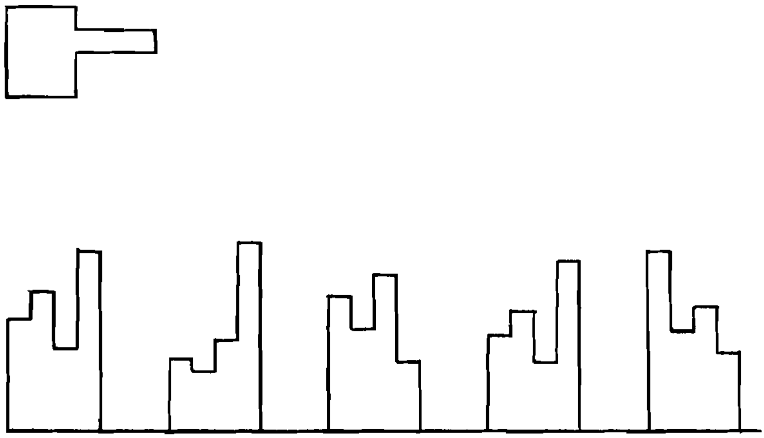

Figure 5. Part of the graphic output plot of the offset plate scanner. Each bar group represents to the inking screws with the same number. Each bar inside a group corresponds to the inking screw of that number in a particular printing unit. The horizontal bars describe the selected duct roller speeds of different printing units.

Using the online control the inking screws and duct roller speed are preset automatically. During the make-ready printing the printer makes the necessary corrections by the inking screws. Changing the duct roller speed is avoided whenever possible. When the print quality is approved the printer presses the OK switch. The presetting computation parameters are updated according to the differences between the precomputed profile and the accepted profile.

3. PRINTING PLATES

Finnish offset presses most commonly use presensitized aluminium printing plates. Both negative and positive plates made by several manufacturers are used. Some presses also use two types of bimetal plates, the etchign type and the presentisized type, for long runs. The etching type is gradually disappearing from the market as printing houses now prefer using aluminium plates or presensitized type bimetal plates.

The printing area of the aluminium plates is covered with a coating. The colour of the coating varies from blue or green to grey. In some cases the coating may be red. The nonprinting area is made of anodized aluminium and it is always grey. The darkness of the nonprinting area varies. The nonprinting area of the bimetal plates is made of chrome oxide. Chrome oxide is also grey but it is a much darker colour than the nonprinting areas of the aluminium plates. The printing area is of glossy copper in the etching type and it has a coloured coating in the presensitized type.

In some printing houses the aluminium plates are burnt after the development, but today this procedure is no longer generally used. The plates are always gummed manually or by machine. Burning and gumming cause changes in the darkness of the plate surface. According to our observations the coating of the nonburnt printing plates is very sensitive to the ambient light. For instance the colour of the coating changes from green to blue when held in the light. Thus, the earlier the plates are measured the better results obtained. Usually measuring is not possible before gumming because the plates without the gum coating are sensitive to handling. The best results are obtained when the plates are measured in the plate copy immediately after they have been made.

Study of the Printing Plates

The darkness variation of the plate surface has a strong influence on the measuring accuracy of the plate scanner (Kaivosoja e.a. 1983). In order to develop measuring methods that are less sensitive to the darkness variation we have studied the amount and type of these variations. We had printing plates made in some printing houses. The plates were made according to our test film and developed in the same way as the plates used in production. They were also gummed manually or by machine.

The plates were measured with the OPS plate scanner using a test program. The test program scanned a line recording the measuring results at intervals of 3 mm. The measurements were taken by one sensor channel in the densitometer mode or the specular mode depending on the plate type. The measuring results were calibrated so that the lightest nonprinting area got the value 0 and the darkest printing area the value 100. Fig. 6 shows an example of the scaled scanning results.

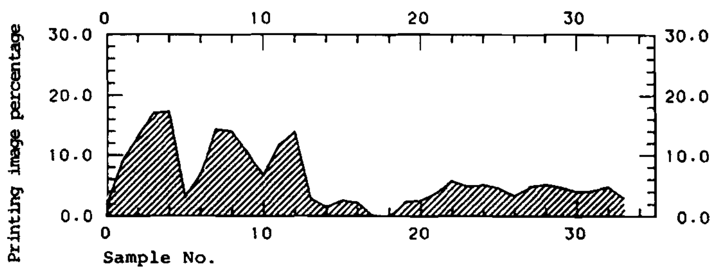

Figure 6. Scaled results of a scan with the test program. The left half of the plot corresponds to an area containing the text, the right side corresponds to the nonprinting area.

The darkness variation was divided into two categories: local variation and gradual variation. The variation in the mean values of eight successive measuring samples was used as a measure for the gradual variation. The local variation was computed as a difference between a single sample and the mean value of eight successive samples in the surrounding of the sample. These computations were chosen because they are easy to perform and thus applicable also in the actual plate scanning. The results computed in the nonprinting and printing areas of the printing plates are presented in Tables 1 and 2. The same measuring procedure was applied to some common printing images, too. These results are in Table 3.

Table 1. Gradual and local variations in the measuring results scanned in the nonprinting areas of different printing plates. Where no measuring mode is mentioned the diffuse mode was used.

Plate type	Pos/ Neg	Gum	Maximum gradual variation in %	Maximum local variation in %
Aluminium 1	Pos	Manual	14.4	2.2
Aluminium 2	Pos	Machine	10.9	3.2
Aluminium 3	Pos	Machine	6.4	1.2
Aluminium 4	Pos	Machine	6.9	2.3
Aluminium 5	Pos	Machine	2.0	1.1
Aluminium 6	Neg	Machine	4.0	1.7
Aluminium 7	Neg	Machine	3.5	1.1
Aluminium 8	Neg	Machine	9.4	2.4
Aluminium 9	Neg	Manual	3.9	1.1
Bimetal presensitized	Neg	Manual	11.7	15.0
Bimetal etching	Neg	Manual	2.2	1.0
Bimetal etching, specular mode	Neg	Manual	2.1	0.3

When observing the measuring results, it is seen that on presensitized plates the variation is larger in the nonprinting area than in the printing area. Combined with the fact that printing plates usually contain more nonprinting area than printing area the conclusion is reached that the main cause for the measuring inaccuracies is the darkness variation in the nonprinting areas.

Table 2. Gradual variation in the measuring results scanned in the printing areas of different printing plates. Where no measuring mode is mentioned the diffuse mode was used.

Plate type	Pos/ Neg	Gum	Maximum gradual variation in %
Aluminium 1	Pos	Manual	7
Aluminium 2	Pos	Machine	4
Aluminium 3	Pos	Machine	2
Aluminium 4	Pos	Machine	6
Aluminium 5	Pos	Machine	4
Aluminium 6	Neg	Machine	2
Aluminium 7	Neg	Machine	3
Aluminium 8	Neg	Machine	4
Aluminium 9	Neg	Manual	3
Bimetal presen-sitized	Neg	Manual	7
Bimetal etching	Neg	Manual	24
Bimetal etching, specular mode	Neg	Manual	13

Table 3. The darkness level and local variation in the measuring results scanned on some common printing images.

Image	Darkness level range in %	Local variation range in %
Ordinary tone picture	20-60	10-20
Some small light pictures	5-10	4-17
Very light sky	6	2
0.2-mm-broad line	1	3-6
0.3-mm-broad line	1	7-10
Ordinary text	12-16	6-10
Very small text without empty lines between	10-12	3-7
Very small text with empty lines between	5-9	5-10

With aluminium plates the gumming does not cause great problems because the colour of the gum is about the same as the colour of the nonprinting plate surface. On bimetal plates the nonprinting area is much darker than the gum. Thus manual gumming results in large darkness variations. According to our previous studies machine-gummed bimetal plates are not much more difficult to measure than aluminium plates are.

With the best aluminium plates it is possible to achieve a measuring inaccuracy of about 2 to 4 percent simply by computing the mean value of the scanned samples. With other aluminium plates the measuring inaccuracy varies from 4 to 14 percent in the worst case.

When comparing the local darkness variations in Table 1 with the darkness variations caused by printing images in Table 3 it is seen that, with the best plate types the local darkness variation is always smaller than the variation caused by any of the printing images. Also with the other plates either the local darkness variation or the average darkness level is above the maximum values caused by the plate darkness variation. Thus, excluding the manually gummed bimetal plates it is possible to develop an algorithm that separates the measuring samples measured in the nonprinting areas from those measured in areas containing some printing image.

4. ADVANCED COMPUTATION METHODS FOR PRINTING IMAGE PERCENTAGES

The measuring inaccuracy of 2 to 4 percent obtainable with the best aluminium printing plates is tolerable in the inking zones containing a lot of printing image. But in the inking zones where the printing image is less than 4 percent it is impossible to know whether or not the inking zones contain any printing image at all. With some other plate types the measuring inaccuracy is much larger. Even if there is enough printing image to prove its existence, the measuring inaccuracy is quite poor in the inking zones in which the printing image is less than 10 to 20 percent.

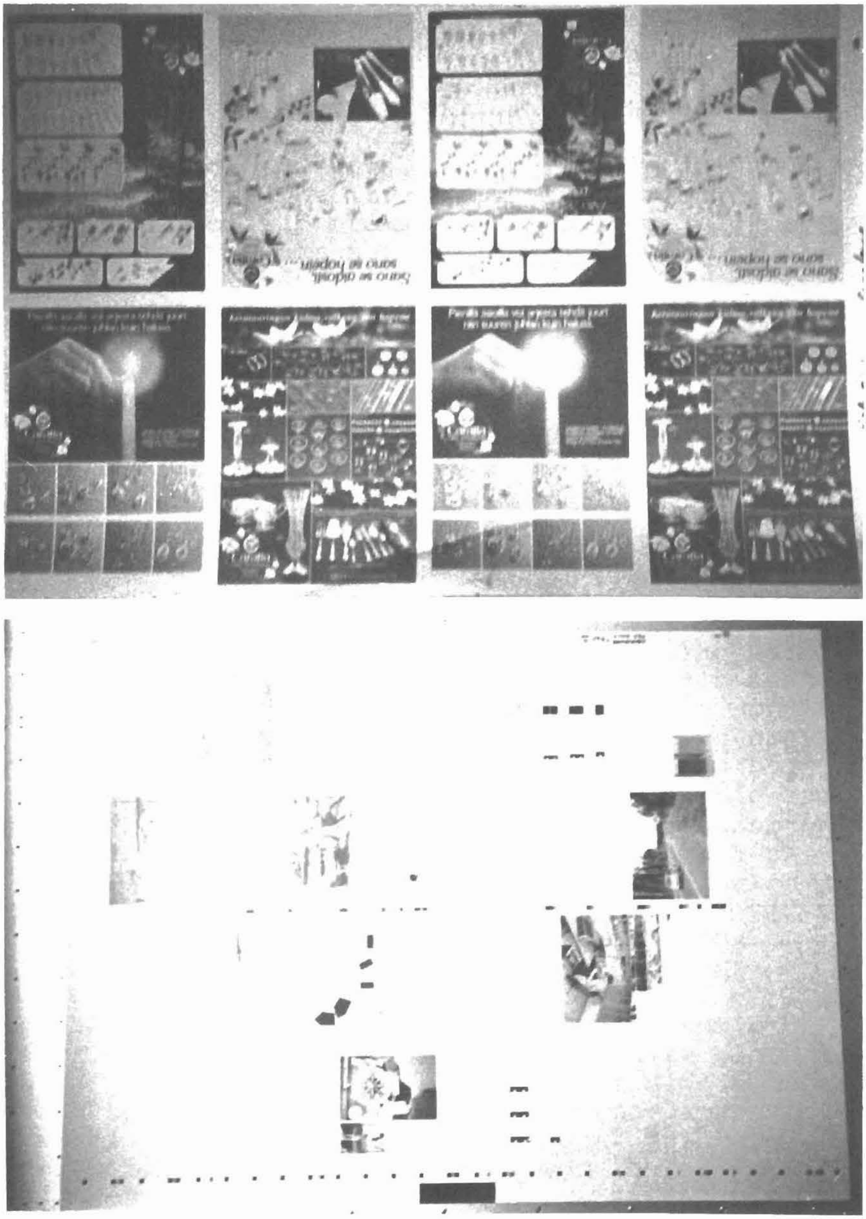

Figure 7 A and 7 B: Two typical printing plates for a process colour. In case A printing image percentage varies from 40 to 60 and in case B from 0 to 20.

Such inking zones are not rare at all. An ordinary text plate without any pictures contains some 10 to 15 percent printing image. The printing image percentage of the plates for process colours depends on the size and amount of the pictures, and the two cases in Fig. 7 are quite common. In case A the printing image percentage varies from 40 to 60 and there are no problems with the measuring inaccuracy. If the amount of the printing image is small, it is very probably distributed like in case B. This distribution availed when developing the advanced computation methods.

Elimination of Samples Measured on Nonprinting Area

The samples measured in the printing area are separated from those measured in the nonprinting area. The samples measured in the nonprinting area carry no information, about the plate, only pure distortion. These samples are omitted from the computations. The printing image percentage is computed:

$$P = \frac{S_p}{N_t}, \quad \text{where} \tag{2}$$

P = the computed printing image percentage,

N_t = the total number of samples during the scan

S_p = the sum of the samples measured in the printing area.

Excluding the text plates the measuring inaccuracy is improved significantly in the inking zones containing only a little printing image. The measuring inaccuracy of 4 to 14 percent obtainable with conventional methods is multiplied by the proportion of the inking zone area coated with pictures or text. In the plate of Fig. 7 B, for example, the measuring inaccuracy is 1 to 3 percent when omitting the samples measured in the nonprinting area.

The separation of the measuring samples is done by means of a printing image detection algorithm. Excluding the samples at both ends of the scan the following mean and difference values are computed for each measuring sample i:

$$M_i = \left(\sum_{k=i-3}^{i+4} R_k \right)/8, \quad \text{and} \tag{3}$$

$$D_i = \left| M_i - R_i \right|, \quad \text{where}$$

R_i = measuring sample i during the scan

The printing image is detected on sample i (and on its surroundings), if one of the following comparisons is true:

$M_i > L_m$, or

$D_i > L_d$, where

L_m = the detection limit for the mean value, and

L_d = the detection limit for the difference.

The selection of the detection limits depends on the plate type. The detection limit for the mean value is chosen according to the gradual darkness variations and the detection limit for the difference according to the local darkness variations. For example manual gumming requires a higher detection limit for the difference than machine gumming does.

Two aspects have to be taken into account when selecting the detection limits. First, in the inking zones with no printing image the computation result should always be zero, because removing ink from the inker is a slow process if there is no printing image to consume the ink. Secondly, all the samples measured in the areas containing printing image should be detected.

The contradiction between these two aspects is solved by using two sets of detection limits: one giving safe detections and the other giving probably correct detections. The printing image percentages are computed only for those inking zones in which at least one safe detection has been made. The actual computation is based on the use of the second detection limits.

Today the safe detection limits are implemented in the OPS plate scanner. The implementation of the second set of detection limits is retarded because of the involved computations requiring a lot of time.

Local Calibration

The calibration areas for the plate scanning are always located on the edges of the plate. According to our studies the edges of the plate surface are in some cases darker than the other parts of the plate (Kaivosoja e.a. 1983). The implication is that the calibration values are at a wrong level. This applies specially to the calibration value of the nonprinting area.

The fact that the printing plates contain large nonprinting areas is important for calibration, too. The detection of the nonprinting areas is in principle a reverse operation to the detection of the printing areas. The selection of the detection limits may be quite complicated. With the poorest plates, in which the local calibration is really needed, the darkness variation of the plate surface is greater than the darkness variation caused by the smallest printing images.

The problem is solved by dividing the offset plate into calibration regions large enough to contain nonprinting areas. This means that each region contains nonprinting areas between the pages of the magazine that is printed. The number of local calibration regions can be selected by parameter. During the scan each region is divided into 6-mm-wide zones corresponding to the sensor channels. Each zone is searched for the smallest mean value M_i computed for the printing image detection according to Eq.3. The feasibility of these smallest mean values is verified by comparing them with the acceptance limits. The local 0 percent calibration values are computed as the mean value of the accepted smallest mean values in the local calibration regions.

5. COMPUTATION METHOD FOR INKING SCREW SETTINGS

The Mathematical Model

According to our previous studies (Kaivosoja e.a. 1983) the major difficulty in predicting the inking screw settings in an old press is the dissimilarity of the inking screws in different printing units and even in the same printing unit. In the OPS plate scanner the difficulty is overcome by using for each inking screw specific parameter values in the presetting computations.

The computation of the inking screw profile is based on a mathematical model. The model is applicable to all printing presses by selecting the printing press related, the printing unit related and the inking screw related parameter values. We have chosen to use the following second order polynome for the presetting computations:

$$Y = A + K\,(P + BP\,(100\,\% - P)) \quad \text{IF } P > 0 \qquad (5)$$

$$Y = 0 \quad \text{IF } P = 0,$$

where

Y = the computed inking screw setting,
P = the printing image percentage of the zone,
A = offset, the setting where the screw starts giving ink,
K = amplification,
B = nonlinearity.

The polynome can represent the concave and convex dependences of the inking screw setting on the printing image percentage on the inking zone as shown in Fig. 8. The inking screw setting is cleared if there is no printing image, this is the procedure in the printing houses. The decision can be made accurately, because printing image detection is used for measuring. The offset and amplification of the polynome are composed of two parts:

$$A = A_u + A_s \quad , \quad \text{and} \qquad (6)$$

$$K = K_u K_s \quad , \quad \text{where}$$

A_u and K_u are the printing unit related parts and

A_s and K_s are the inking screw related parts.

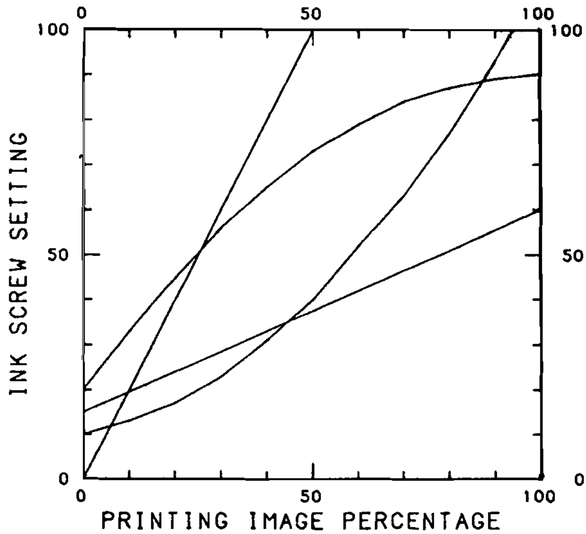

Figure 8. Some plot examples with different parameter values from the polynome used for the presetting computations.

The printing unit related parts represent the mean values of these parameter values in the printing unit. The inking screw related parts are used to represent the differences between the different inking screws.

The final setting of an inking screw depends on many more factors than the printing image percentage: the speed of the duct roller, the paper type, the ink type, the bending ability of the ductor blade and the speed of the printing press. The first four are taken into account in the presetting computations. The last one is left out on the assumption that the same make-ready printing speed is used at all times.

The duct roller speed is used as a master control for the inking. Since the final control of the colours is made by using the inking screws, it is not necessary to use all the possible duct roller speeds. The OPS offset plate scanner uses 1 to 5 different parameter selected duct roller speeds, the socalled duct roller speed steps. One of the duct roller speed steps is chosen for the most typical production and it is called the base duct roller speed. The duct roller speed step is selected to fit the maximum ink consumption on the measured plate. The minimum sufficient duct roller speed is selected in order to bring the inking screws up to a good working level.

The printing unit related parameter values are different for different duct roller speeds. The inking screw related parameter values are determined for the base duct roller speed but they are also used with the other speeds.

Paper and ink type affect on the amount of ink needed to produce the optimum density level. The OPS plate scanner has distinct ink consumption factors for each ink type - paper type pair. The measuring results of the offset plate scanner, representing the ink consumptions of the inking zones, are multiplied by the ink consumption factor of the ink type - paper type pair used. The parameter values of the presetting computations are determined for the most commonly used ink type - paper type pair; its ink consumption factor is 1.

Bending the ductor blade too much typically decreases the total ink feed. In the OPS offset plate scanner this is prevented by using a smoothing algorithm that makes the inking screw profile fit the bending ability of the ductor blade without changing the total ink feed. The maximum permissible difference between adjacent inking screws is parameter selected. With presses having segmented ductor blades it is possible to skip the smoothing by using the parameter value 100 percent.

Parameter Value Adaption

The parameter values are initially determined by performing an experimental printing. When the press gets old and used the parameter values have to be adapted. This applies above all to the inking screw related offsets. When using the OPS offset plate scanner connected online to a printing press, the plate scanner adapts to the changes occurring in the press by changing the parameter values of the presetting conputations.

The adaption is based on the inking screw profile at the end of the make-ready printing. When the quality is acceptable the printer pushes the accepting switch. Depending on the construction used the parameter adaption algorithm is performed in the press control computer or the inking screw profiles are transmitted to the OPS plate scanner and the adaption algorithm is performed there.

Various conditions control the adaption. In many cases the adaption is totally omitted, in other cases some of the inking zones are excluded from the adaption algorithm. When the adaption is applied to a parameter, the accepted inking screw setting is compared with the precomputed setting. According to the parameter-selected filtration factor an intermediate inking screw setting is computed from the precomputed and final inking screw settings. The parameter value is changed so that the presetting computation will next produce the intermediate inking screw setting.

There are two conditions that must be met before the parameter adaption is performed. The first condition is that the printed solid densities must be equal to the optimum densities of the press. This means that the reason for the changes in the inking screw settings really is found in the press and not in the poor reproduction. It is now up to the printer to decide how to proceed; initiate the parameter adaption only if the printed solid densities are optimum. The second condition is that the duct roller speed must be equal to the speed precomputed by the offset plate scanner.

The parameter adaption is not performed in all the inking zones. It is not performed in areas, where there is a strong transversel ink flow in the inker, i.e. there are great differences in the printing image proportions of adjacent inking zones. And, the parameter adaption is not performed in inking zones where there is no printing image.

The adaption is applied to different parameters in different situations. In the most common case, i.e. when using the base duct roller speed, the adaption is applied to the inking screw related parameters. In zones with only a little printing image the adaption is applied to the offsets, and in zones with a lot of printing image it is applied to amplifications. In some intermediate cases the adaption is not performed at all.

When using the other duct roller speed steps the adaption is applied to the printing unit related parameters instead of the inking screw related parameters. In that case the inking zones are divided into three categories: those with only a little printing image, those with a lot of printing image and the intermediate cases. The offsets are adapted according to the mean values of the first group and the amplifications according to the mean values of the second group.

6. OBSERVATIONS MADE AT THE PRESS

The tests described here were made with a OPS plate scanner installed with computer based press control system in a customer's press. The system controls the operation of a commercial heatset offset press. The rotary press has four blanket-to-blanket double-length printing units. The inkers are of the film type and the ductor blades are continuous. The press was bought in 1980 and it was originally equipped with analog remote control consols for inking screws.

The interface to the remote control consols was made using PRINTA press control system manufactured by ALTIM CONTROL, Finland (Altim Control 1984). The OPS offset plate scanner is connected online to the press control system. Since the installation is the first one with parameter adaption algorithms, the presetting computation programs were placed in the control system and not in the offset plate scanner. This arrangement reduces the work required to make the program changes.

Experimental Printing

The parameter values of the presetting computations were determined by performing an experimental printing. Before the printing, observations were made at the press to determine the duct roller speeds for the presetting. It seemed to be possible to print nearly all the products at the same duct roller speed. We determined also one slower and one faster duct roller speed for different products.

The test runs were made using three different printing image percentages. During each run the inking screw profiles producing the optimum densities were determined at the three predetermined duct roller speeds. Step changes were made in the inking screw settings to get the dependence of the printed density on the inking screw setting. The printed sheets were measured and the inking screw profiles producing the optimum densities were corrected according to the measuring results.

The inking screw settings producing the optimum density levels proved to be a linear function of the printing image proportions. Fig. 9 shows these functions in one printing unit.

Table 4 shows the results of the step changes made in the inking screws. Two observations are made. First the same change in the inking screw setting causes a greater change in the density values if the printing image proportion is small, i.e. a better measuring accuracy is required in the inking zones that have only a little printing image. Secondly, the same change in the inking screw setting causes a larger change in the density values if the duct roller speed is high, i.e. the inking screw setting is small. We came to the conclusion that presetting produces a better print quality at small duct roller speeds.

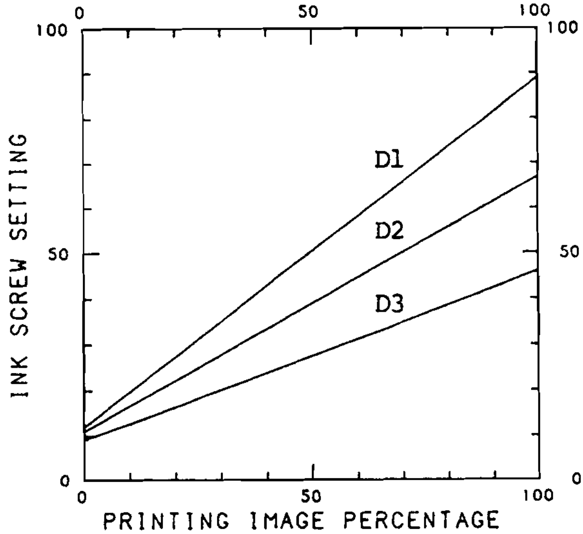

Figure 9. The dependence of the mean value of the inking screw settings producing the optimum density level at three different duct roller speeds (D1, D2 and D3).

Table 4. The change in the density caused by a one percent change in the inking screw setting using different printing image proportions and different duct roller speeds.

PRINTING IMAGE PERCENTAGE	DUCT ROLLER SPEED D1	D2	D3
5 %	0.06 D	0.09 D	0.20 D
10 %	0.05 D	0.07 D	0.14 D
30 %	0.03 D	0.04 D	0.08 D

The experimental printings confirmed our previous observation that the inking screws are quite different in different printing units and even in the same printing unit. The mean value of the inking screw settings producing the correct density level varied from 11 to 32 percent in different printing units. Fig. 10 shows one typical inking screw profile producing even density profile.

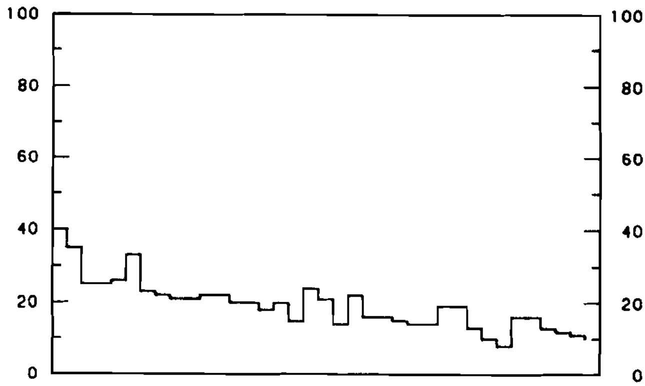

Figure 10. An example of the inking screw profile producing an even density profile.

Presetting Accuracy

The test printing was made in February 1984, two months before the installation of the OPS plate scanner and the press control system. Fig. 11 shows the precomputed inking screw profile and the accepted inking screw profile in the very first printing in which the presetting system was used. During the two months' time some changes have occurred in the press, but still the precomputed inking screw profile has the correct form and level.

Today, presetting is used in all production printings and we record the precomputed inking screw profiles and the accepted inking screw profiles. We have made a few changes in the parameter values in order to compensate for the changes occured in the press after the test printing. The presetting inaccuracy seems to be 3 to 5 percent when computed as the mean of the changes made in the inking screws from presetting to approval. With larger changes there is always a reason for the inaccuracy, for example poor reproduction.

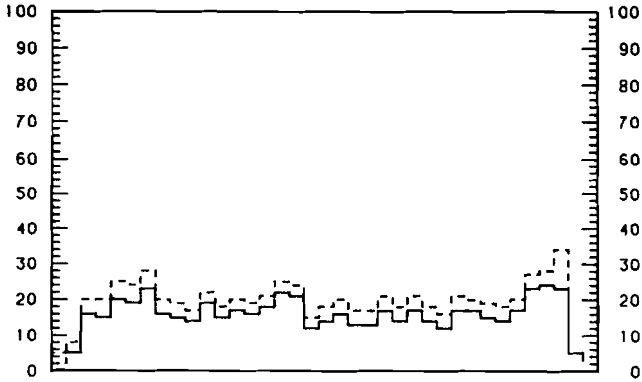

Figure 11. The precomputed inking screw profile (dotted line) and the accepted inking screw profile (continuous line) in the very first printing with presetting. The unit was selected to represent the typical presetting accuracy.

We have also made observations of the differences between the accepted inking screw profile and the inking screw profile at the end of the printing. The difference seems to be a bit smaller than the presetting inaccuracy obtained. Differences exceeding 5 percent were also observed, when repairs were made on the inker or when the ink mark was changed during the printing.

Thus the presetting accuracy obtained is quite close to the maximum obtainable with this press. The purpose of the parameter adaption algorithm will be to maintain this accuracy. The parameter adaption algorithm will be taken into use after we have gained more experience with the changes occurring in the printing press. The parameter values for the adaption will be selected to fit these changes.

7. DISCUSSION

The prototype of the OPS plate scanner was introduced in 1982 (Juhola e.a. 1982). This was the first time that an offset plate scanner was introduced in a TAGA conference. The DRUPA exhibition in 1982, TPG exhibition in 1983 and the TAGA conference in 1983 proved, that the idea of presetting the inking on the basis of the plate measurement is now commonly accepted. This is also seen in printing houses. When new printing presses are bought, the purchase often includes a plate scanner. And, the printing houses are also interested in buying plate scanners that are compatible with their older presses.

High-quality commercial printing requires a high presetting accuracy; otherwise the effect on the amount of start up waste is not significant. High presetting accuracy is possible to achieve only with accurate measuring and good knowledge of the printing press.

The poor measurability of offset printing plates has also been reported by other plate scanner developers (Imamoto 1983). The measuring accuracy obtainable with conventional methods i.e. with mean value computation and calibration, is insufficient in the inking zones with only a little printing image. The measuring method based on the printing image detection and local calibration improves the measuring accuracy significantly. Plate manufacturers will probably improve the measurability of the plates (Imamoto 1983), which today is not taken into account when the plates are chosen for production use. In our opinion the measuring methods introduced here will be, at least to some extent indispensable in high accuracy presetting.

The difficulties with presetting computations are caused by the inker mechanics. The characteristics of the inkers change when the press gets older and the inkers of the older presses were not designed to work with presetting systems. Today, the press manufacturers take count of these aspects and make more accurate inkers with segmented ductor blades (Imamoto 1983, Uhrig 1983). Some manufacturers also produce new ductor boxes for old presses (Quilliam 1983). And, we have come up with more economic solution: development of precomputation algorithms with inking screw related, automatically adaptable parameter values. By selecting the parameter values the OPS plate scanner can be used with all offset presses. When the presetting computation algorithms are used the plate scanner knows the characteristics of each inking screw and is also able to follow the changes occurring in the press.

There seems to be different views of what should be done to the inking screws of the non-printing zones. Tobias (1983) prefers having a thin ink film in the inker, i.e. never totally closing the screws. In our experience pressmen usually close the inking screws of the nonprinting zones. Since the setting where an inking screw starts giving ink is more or less indefinite, we prefer this practice for reasons of security. In the inking zones with a little or no printing image it is always faster to increase the ink feed than to decrease it.

The sensor construction of the OPS plate scanner is quite different from those of other plate scanners. We do not agree that a sensor with a large measurement opening is needed because of the darkness variations on the plate surface (Imamoto 1983). On the contrary the sensor with small measurement openings has made it possible to develop the printing image detection logic presented here. The OPS plate scanner has a unique method for measuring glossy bimetal plates. Instead of having a different light source for those plates (Rettberg 1983), a different measuring geometry is used which makes it possible to measure the gloss of the plates, too.

8. CONCLUSIONS

Using a plate scanner with a printing press requires measuring and the presetting computations. Today, offset plates are often rather difficult to measure. It appears to be especially difficult to determine whether or not there is some printing image in the zone to be measured.

The measuring methods based on the use of a sensor with a small measurement opening make it possible to measure plates that would otherwise be impossible. And, the measuring accuracy is better in the most critical instances i.e. in the inking zones with only a little printing image. The measuring methods also help to decide which inking zones contain the printing image.

The difficulties in presetting computations are caused by the inker mechanics. The difficulties with the inkers can be devided into three categories. First, different inking screws give different amounts of ink with the same setting. Secondly, the amount of ink given with an inking screw setting changes when the press grows older. Thirdly, the inkers with a continuous ductor blade are not able to produce very sudden changes in the ink feed profile.

The use of inking screw related parameter values for the presetting computations and the automatic parameter value adaption help overcome the first two difficulties. The third difficulty is in fact not a presetting problem but rather a printing problem. The only thing that the presetting system can do is to bend the ductor blade as much as possible by using a smoothing algorithm.

The new features of the OPS plate scanner reported here are: the sensor with small measurement openings, the measuring method with the printing image detection and local calibration, the presetting computation method with inking screw related, automatically adaptable parameter values. The use of these features makes it possible to satisfy the demand for high presetting accuracy in commercial offset printing.

9. ACKNOWLEDGEMENTS

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