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IMPROVED PRINT QUALITY USING A DENSITOMETER

Having worked in the Graphic Arts for so many years I know I am biased, but I do believe that it is a very special industry and in some ways quite unique. Apart from the enormous amount of people actually involved in the industry, the output of the Graphic Arts plays a part, one way or another, in the daily lives of so many others. However, the fact that the newspaper must go out every day, rain or shine, does, I think, create a particular atmosphere that is not found in any other type of printing. It is also true, as with other types of printing, that the quality of some aspects of the final product are not always tangible. What may be considered perfectly acceptable to one person's eye, may be rejected as off standard by another's.

I remember, a number of years ago, I frequently used to visit a particular printing house where the flesh tones in the reproductions of the photographs changed each time there was a change in shift personnel. The basic reason for this was that each press supervisor had his own opinion as to what the flesh tones of the people in the photographs should be. Because of a lack of controls and coordination between one area of the production process to another, one person's idea of what the finished product would be was commonly being distorted into someone else's idea of what it should be. At that particular printing house the pressmen have since been trained to make use of colour standards press-side and they also use densitometers to control the impression. Using these methods, the flesh tones remain as close as possible to the original, constant throughout the run and indeed from one run to the next.

This illustration makes a couple of interesting points. One is that different people see the same thing in different ways. Each person's eyesight and colour recognition are different. So apart from differences in opinion as to how an image should look, we have the added ingredient of the natural variations in ability to distinguish colours from one observer to another. Even though this is the case, that brief illustration earlier does show that by training press personnel in simple quality control methods and/or the use of more sophisticated instrumentation, it is possible to establish and maintain constant colour standards.

As we know, the final printed result is the complex combination of many components; ink, paper, plates and possibly fountain solution. We should not forget the press and perhaps most important of all, the press operators. Each one of these is a variable which will have an effect on the final printed result. Having said that, I would also say that today, with the
technology available, it is possible for the modern printer to feel a certain level of confidence, even when setting out to do what might even be considered a complex print job. If the correct preparations have been made, the final result will turn out as planned.

In recent years we have seen a number of trends in the industry which have contributed to the overall improvements in quality. Some of these trends which come to mind are; Soy oil based process colours and No-Rub black inks. The use of the Reverse Osmosis process for the treatment of the water used in the fountain solution and the more widespread use of Neutral Fountain solutions. Also Subtractive Plates and Spray bars.

As an ink maker my first thoughts are of the advances made in that area. Since the initial boom of interest and almost indiscriminate use of soy oils in printing inks during the early years of development, we have now learnt how to take full advantage of their unique physical and lithographic properties. I would say that soy oil based process colours are now becoming the standard in the industry. I have included No-Rub Black inks as a trend because so much development work has been done in the area of news blacks to achieve even lower levels of rub off. However I do feel that Conventional News Blacks can also be used to obtain a very reasonable quality of impression. The secret, if you will, is in the application and to a degree the personal preference of the printer.

The other items mentioned can help to standardize the conditions with which the printer is working. Each one of these is a component of the printing process and as such has a direct effect on the final result. In reality the task of reproducing a colour photograph on a substrate as poor as newsprint, with very imperfect colours, and by the lithographic process is an impossible one. But by maintaining as constant as possible the conditions with which we are working we can gain better control over the process and come closer to achieving it.

A second group of trends which we are seeing more and more of are; Use of Densitometry, Statistical Process Control and Statistical Quality Control Charting, also Fingerprinting of Press Units and Grey Bars. In reality items two, three and four can all be derived from the first; Use of Densitometry.

The basic function of the densitometer is to control the thickness of the ink film that is being printed. It does this by emitting a beam of light down onto the surface of the print and measuring how much of that light is reflected back up on to a photocell inside the instrument. Depending on the type and model being used there may be a number of functions on the densitometer with which we can make more detailed analysis of the print but for now let's look just at the benefits which can be gained from a relatively simple operation which is the control of ink film thickness.
Less Rub-Off, Less Set-Off, Less Strike Through, Cleaner Half Tones and Smoother Solids, Little or no Smearing, Less misting, Less Second Impression Set-Off,

In the case of newspaper printing we are dealing with non drying or very slow drying inks and a relatively poor substrate with a very limited capacity for absorption. The mechanism by which we obtain what appears to be a drying of the ink film is actually the absorption of the ink into the paper. Therefore, if more ink is printed onto the surface of the paper than it can tolerate, the excess ink will create any one of the problems mentioned above.

A controlled application will result in a smoother film being printed, helping to improve the trapping of the inks over one another and giving cleaner, sharper half tones.

Lastly, to this list I would add Greater Ink Mileage. The actual density level that any particular newspaper runs will vary depending on the policies set by them. A typical density recommendation for the four colour process set might be; Black 1.00 -1.10, Blue and Red 0.90 - 1.00 and Yellow 0.85 - 0.95. It may well be the policy of an organization to look for greater contrast and specify higher ranges to their press operators. But the dangers of this are the possible appearance of any one, or a number, of the problems mentioned above and also, very importantly, higher ink consumption. Ink consumption can be a very complicated property to measure in a day to day production situation. The area of impression each day is different so fluctuation in consumption can be expected. But it has been demonstrated that a variation in density from 1.00 to 1.15, given the same area of impression and number of copies, can mean an increase in ink consumption of 50%.

So improving quality also can be very cost effective. Initial outlays, on equipment and training of personnel, can quickly pay for themselves in more efficient use of materials.

By becoming more familiar with densitometry, analysis can be made of the impression to measure such properties as; Dot Gain, Print Contrast, Hue Error and Greyness, also Trapping Efficiency.

Due to the nature of the Off-Set printing process, though we set out to reproduce a determined screen value of for example 40% the final printed result may, even under good conditions, be one of 65%. This can result in a loss of detail and or an imbalance of tones. By monitoring the Dot Gain at a particular printing operation, measures can be taken to compensate for it in the preparation of the colour separations and plates, so as to achieve in the final impression something approaching the original screen percentages planned.

Print Contrast for each of the colours can be determined by comparing the density of the solid with that of a 75% screen using the densitometer. This is a way of measuring the clarity of the shadow areas.
To give us an idea of the range of colour we are working with it is possible to develop a type of "process colour map". The densitometer can read the Hue Error and Grayness coordinates which when plotted on a graph will show clearly the colour area within which we have to work. Coordinates can also be plotted for the traps of magenta over cyan, yellow over cyan and yellow over magenta.

By making more use of densitometry, becoming more familiar and comfortable with the use of the densitometer, progress can be made in SPC and SQC. This is the type of work in which information received through the densitometer can be correlated and presented in graph form, allowing the user to determine the possibilities of control over a particular printing system. Even with the most efficient printing system, variations will occur. Variations in density, dot gain, etc. It is never possible to fix a Specification Number and expect it to be met every time. Specification Ranges must be used. A variable range of results is normal, and by using the tools of Statistical Process Control and Statistical Quality Control it is possible to determine what are the normal operating ranges and to set realistic limits of control accordingly. As more experience is gained and better control over the printing system is developed the control limits can be lowered.

Fingerprinting of press units is also a mechanism to determine the capabilities of the printing system so that the possible quality limits are known at any given time. As improvements are made, as more control is achieved, then, again, these limits can be moved.

As the use of colour becomes ever more wide spread, so we see more and more use of Grey Bars to ensure a uniform application of each of the coloured inks across the page. The printing of a test form is necessary to decide which grey bar will be used. The solid areas on the test form are controlled to the density specification decided upon, and then the grey bar that will be used is read for the density of each of the process colours. This grey bar is then reproduced in each edition of the newspaper and used to control the colour densities.

The last item I would mention here today in combination with those already touched on is, Continuous Quality Control Programmes. As we strive for better and more uniform quality it is necessary that everybody involved be committed to the quality process and take an active part in it, each supplier too. Quality is not just one more ingredient that can be added in at the end. Today, more than ever, there is climate of cooperation between suppliers and customers and often even between common suppliers to the same customer, who work together to arrive at the best conditions needed to achieve the desired result.

But these efforts must be matched by internal programmes to educate and train if they are to be effective. Fortunately it is more and more common to see this need for internal quality control and quality assurance programmes being recognized and we feel honored when we are able to participate.

And, of course, emphasis should be placed on the word Continuous. Just as quality is not something to be added in at the end of the process, nor is it something that can be turned on and off. To be truly successful it is necessary for an across the board and full time commitment.

Thank you for your attention.
Quality means system approach, system approach means training.

How to achieve those goals?

System approaches for quality and training are tremendous challenges to the management and on the one hand to the employees in newspaper production on the other hand. At the beginning a change of quality mindset is needed. Traditional quality approaches were related to technical orientation, specialised employees, control of products and production orientation. In contrast system approach environments are related to reader orientation, generalistic approaches, guaranteeing process ability potential and process orientation. Resulting from here quality developments have been changing for a long time. Quality used to be control-driven, quality in system approaches however is corporate culture driven. Whereas quality used to be applied on process, later on clients or suppliers, today however the focus is on quality behaviour and quality mindset. Additionally quality has four main aspects. Quality is environmental oriented, it is process oriented, employee oriented and input and output oriented.

These quality system approach elements have to be supported with a framework of training and education. This framework should concentrate on personnel, organisation and production. Training in personnel areas must include qualification of employees, participation competence, increasing quality motivation, change of management behaviour and reflecting on the understanding between management and employees. Likewise training support for organisational requirements in quality system approaches are related to the definition of processes, the definition of reader and supplier relations, integration of quality responsibility, quality assurance system and the organisational set-up focuses on quality circles and quality project groups. Training for quality control as well as computer support is indispensable.
Reaching system approaches for quality and training also has to do with rearranging fragmented work organisations to be substituted by group orientation. In the old days (until today) the employee may work alone on one part of a job (e.g. reel stand operator at a newspaper press), whereas in the up-to-date way the newspaper press team is working together, the reel stand operator is part of the team which also includes first and second pressman, a mechanic, an electrician etc. Whereas the fragmented group is organised by a supervisor the group oriented workforce co-ordinates itself.

Similarly basics of management behaviour must adapt to the new needs. System approaches for quality and training are not to be achieved with directives arriving at the employees work place from the top with authoritative decision making, with a dominant management behaviour connected with a demonstration of power. Decisions should be taken by group processes, management has an advisory or co-operating role, the decision processes are very much initiated by group experiences, optimised know-how is developed within the work group. In the traditional approach of newspaper manufacturing the employee's task is limited through specialisation to a narrow, limited work environment. This responsibility again is limited, he relies on his supervisor, expecting guidelines, directives, and, bureaucracy. Performance is measured by the individual. In system approach the employee experiences job enrichment through additional qualification. Over and above that the employee is integrated into responsible, entrepreneurial thinking and acting, this thinking and acting is reader oriented. The directives which employees need, must allow enough room for individual decision processes and freedom of movement in a group basis.

Finally system approach in fact is TQM approach. TQM is an entrepreneurial and managerial philosophy with a number of most important ingredients: Reader requirements, reader satisfaction, quality driven strategy by the management,
quality is integrated into the mindset of each person within the newspaper production, quality data and quality information become part of any action within the company, tools and methods of quality improvement are universal.

The very important parts of a TQM concept for system approaches are a number of tasks which have to be fulfilled. These tasks will be discussed during the conference.
ANPE1995

Automatic Register Control Systems for Improved Quality

Presented by Jeff Isherwood
ANPE1995

Automatic Register Control
Systems for Improved Quality

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Colour Register Control of Newspaper Machines

Automatic Register Control Systems for Improved Quality
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1. Introduction

The desired quality of the process colour images printed in a newspaper is determined by both the advertising and editorial requirements.

Colour advertisements are a relevant source of a newspapers revenue and advertisers are demanding a product with colour reproductions of a quality comparable to magazines printed by more sophisticated methods using the same source of artwork.

Editorial impact is dependent on a combination of both the written word and the quality of the pictures reproducing the photographs of the news photographer.

The newspaper printer is producing a product with a shelf life of sometimes less than twelve hours. The conditions under which he is printing are time critical and the substrate is inferior compared with the higher quality of heatset and rotogravure processes.

The newspaper occupies a unique position within the communications medium of the printed product and the printing quality of the product enhances the artistic design and increases the impact on the consumer.
2. The Newspaper Press

Newspaper machines are produced in a variety of configurations, each having their own characteristics and degrees of flexibility.

The choice of the machine configuration is determined by the end product to be provided and influencing factors are:

- The size of the paper which determines the number of webs
- The quantity of colour which determines the number of printing couples
- The variety of publications which determines the machines flexibility

The most common machine types are:

- 4 High Towers
- Common Impression Units
- Y Units
3. Colour to Colour Register

3.1 The Standards

Colour to colour register is correct when each image produced by the 4-colour separations are correctly superimposed on each other. The acceptable standard for newspapers is that register difference between any two colours must be less than half a screen pitch. This means that for a newspaper printing with a screen pitch of 34 - 40 lines per cm (85 - 100 lines per inch), the maximum acceptable register is 0.15mm.

This figure agrees with a standard deviation 0.05mm which corresponds to:

- 66% of copy less than 0.05mm error
- 95% of copy less than 0.10mm error
- 99% of copy less than 0.15mm error
4. Register Variations

Colour register can be considered under the following three classifications:

- Variation of length (or circumferential) register measured at a single point on the web.

- Variation of lateral (or side) register measured at a single point on the web.

- Differential variation of lateral register between two points, each on the outer edges of the web. This effect is known as fan-out and is caused by dimensional changes of the paper due to water absorption.
5. The Source of Register Variations

Printing machines are constructed so that the printing cylinders stay mechanically "in phase" relative to each other, apart from torsional changes of the drives connecting the cylinders. These variations are small and can be considered negligible for the purposes of this discussion.

Each plate cylinder is fitted with eight separate plates and these are usually fixed relative to each other to an accuracy of 0.05mm.

Provided that the machine is maintained to the manufactures specification, the source of register variation is mainly attributed to the non-homogeneous properties of the paper and the inherent characteristics of the ink transfer process.

Register changes occur during transient conditions such as reel changes and thus a new set of paper properties are introduced and speed changes which influence the ink transfer characteristics.

Other changes which have lower frequency components are paper properties variations as the reel unwinds, temperature variations and the effect of ink and paper dust on the blankets.
6. Length Register Variations

6.1 Blanket to Blanket Units

In order for the length register to remain constant between two consecutive printing cylinders, the dynamic repeat length printed by the first cylinder must remain a constant. The dynamic repeat length is defined as the length of the printed image under prevailing conditions of strain.

Some of the reasons for variations of the dynamic repeat length are:

- Variation in paper elasticity
- Variation in surface co-efficient of friction
- Variation in web tension at the input to the first print cylinder
- Variation in web tension between the two cylinders

Example:- Consider a change in dynamic repeat length of 0.1mm per metre (i.e., 0.01%), and a web length of five metres between the first and fourth printing units. This results in a change of register of 0.5mm.
6.2 Common Impression Units

Firstly, consider a four unit C.I unit without paper and allow the blanket units to print directly on the impression cylinder. Provided that the gears are to original standard, there is no reason why the printed image on the impression cylinder should not be constantly in register. If there are register variation when paper is introduced into the machine then it is concluded that the paper does not adhere perfectly to the surface of the common impression cylinder.

The magnitudes of register variations are usually less on the C.I type of unit compared with the blanket to blanket units.
7. Side Register

![Diagram of Side Register](image)

The ideal web maintains a constant longitudinal line through the machine but unfortunately any two unwound reels cannot be guaranteed to take the identical longitudinal path.

8. Fan-out

![Diagram of Fan-out](image)

In the offset printing process, water is transferred from the plate to blanket to web with the result that the web width and thus the image width, expands so that the first image width is greater than the second image width.
9. The Typical Printing Machine

Consider a printing machine configuration of six reels, of which three can be printed 4 + 4 and three printed 1 + 1. Each four colour web side has eight motors to be adjusted to maintain correct colour register and therefore 48 motors are associated with the colour register of the total product.

The machine speed is taken as 30,000 cylinder RPH and the time between reel changes is 20 minutes. The result of this is that under steady running conditions there are three reel changes per hour on each of the 4 + 4 webs and at each reel change, every 6.6 minutes, 16 out of 48 metres need adjusting to maintain the total copy in correct colour register.

In order to maintain total copy colour register quality without producing excess waste it is essential that the machine is fitted with automatic Colour Register Control equipment.
10. The Requirements of the Automatic Colour Register Control System

An automatic colour register control system must provide the following benefits for the printer:-

- Minimum waste figures
- Improved quality
- Fast make ready
- Easy to use automation

10.1 Minimum Waste Figures

Minimum waste figures are essential due to the large volume of materials consumed by a multi-web printing machine and the paper bill for one machine can be £5 million per annum and therefore each 1% saving represents £50K per annum.

10.2 Improved Quality

The improved quality of the colour register not only reduces wastage but has the added dimension of increasing both advertising and editorial impact on the consumer.

10.3 Fast Make Ready

Each edition of a newspaper is unique and therefore the pressman requires every assistance possible to reduce the time between press-start and saleable copy being produced.

10.4 Easy to use Automation

The addition of automatic colour register control to a newspaper press must provide a reduced work load for the operator and leave him free to concentrate on controlling other aspects of the print quality.
11. The System Autotron 1400

The System Autotron 1400 is an integrated automatic colour register control specifically designed for the newspaper machine.

The dominant features of the System Autotron 1400 which determine the improved quality and reduction in wastage are:-

- The flexible system architecture which allows the system to be integrated into many existing operator controls and procedures and also is structured to accommodate any future system expansion

- The unobtrusive register marks which are printed in a narrow longitudinal gutter

- The solid state scanning head (register mark detector) with patented photodiode matrix for lateral tracking of the register marks

- The control algorithms which have been developed by PressTech Controls Ltd on a proven mathematical model of the printing machine
11.1 System Architecture

The Autotron 1400 system comprises three major modules:

- Measurement and Control Module
- Operator Interface Module
- Motor Controller Module

The modules are interlinked with communication lines in such a manner that any of the individual modules may be replaced by another that performs the identical function but may be of a different form.

The advantages of a system with the flexibility is that the end user (i.e., the printer) has some choice concerning the configuration of his individual system.

Examples:
The operator Interface function may be embodied into an integrated press control console.

The motor controller function may be integrated into the pre-setting system of the machine.
11.2 Register Marks

There is no known system that can automatically measure register directly from the printed image and in order to measure and control register automatically it is necessary to print a purpose set of register marks.

The area available for the marks is determined by the publication being produced and depends on whether it is broadsheet, tabloid or in panorama broadsheet format.

On a typical eight page cylinder, independent of the publication, the only area available for register marks is the printable area outside the publishers boundary. This free printable area is limited by the method of plate making.

In order for the register marks to be acceptable by the publisher they must be substantially indiscernible.
The register marks shown are those required for use with Autotron 1400.

This mark pattern and associated photo-electric detector are used to measure and therefore control, colour-colour register and a brief explanation of the system is as follows.
Light, from a remotely mounted high power white light source, is piped via a fibre optic light guide to give a patch of evenly illuminated light on the web.

This area of web is imaged onto a two dimensional photo-diode matrix and as the web passes under diode matrix, a digital picture is accumulated representing one repeat of the printing cylinder circumference.

The image thus accumulated is analysed and the pattern of the register marks is recognised, all other print apart from the register marks is rejected.

Register marks may move laterally relative to the fixed diode matrix and therefore it is necessary to track the lateral position of the marks. This is accomplished by electronic means rather than mechanically moving the detector assembly with a motor or similar mechanical device. There are no moving parts required in order to track the position of the marks by the detector assembly over a range of 8mm.

Once the pattern of the register marks is recognised, further calculations are performed to determine the centre of area of each register mark relative to each other in both the longitudinal and lateral dimensions and thus register error measurements are made.
11.3 The Operator Interface

The Operator Interface comprises two elements:

- A VDU presenting information to the operator
- A membrane key pad receiving information from the operator

11.4 The VDU

The VDU presents three types of display:

- A running screen
- A setup screen
- An Oscilloscope display

11.5 The Key Pad

The Key Pad provides the operator with various facilities, dependent on the mode selected.

11.6 The Motor Drive

The Motor Drive module contains various options of driving the register control motors.

11.7 System Configuration

The various elements described are linked together to provide customised system configurations to suit individual customer requirements.
11.8 Summary

The main features and benefits of the system described are:-

- Small register marks requiring minimum unprinted web
- Automatic mark pattern detection requiring no operator intervention
- Register error measurement from centre of area of marks providing high accuracy
- Electronic tracking of register marks without moving parts from maximum reliability
- Modular construction