VALIDITY AND LIMITS OF COLOUR PREPROOFING IN CONVERSION GRAVURE

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Abstract: Colour preproofing systems are discussed as a method of standardization on gravure printing in order to obtain higher quality levels and lower costs cutting down cylinders retouching times. Tonal and colour rendition characteristics of colour preproofing systems are analyzed and discussed. A working method utilized for matching preproofs and printed paper in a gravure plant is described and results given.

INTRODUCTION

Checking colour separations to assess their capability of bringing to an acceptable colour image in the pressroom has been, and still is, a mental process based on experience and sensitivity. Both experience and sensitivity are always necessary in quality control, but cannot be regarded as industrial tools, being so much linked to human (subjective) factors. In conventional gravure, the situation is worsened by the use of carbon tissue which became one of the least predictable media when used on continuous tone mode. Gravure has always envied offset´s facility of previewing printing results with great accuracy straight from separations and tried very long to find a preproofing system capable of cutting down cylinder´s preparation cost. At the beginning of the seventies Cibachrome Graphic showed a great potential, at least in Europe. Only in more recent times, the use of photographic methods derived and using lytographic technologies (normally referred to as gravure-conversion), has allowed gravure to consider as part of its working procedure already established preproofing techniques.

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Preproofing System Classification

Color proofing is probably as old as colour printing. Some fifty years ago, systems like the Belcolor and Koloroid were already available even though working instructions stated that both were not suitable for quality work. Today the range of possibilities is very widely spreading from electronics to direct positive colour materials.

Let us begin with a definition: a colour preproofing system is a method of checking tonal and chromatic rendition achievable on prints for a defined printing system, directly from separations either on film or electronically stored. All available methods can be grouped in three categories:

proof presses
electronic previewing devices
photographic methods

Proof presses are so well established and known as a preproofing system that no further descriptions are needed.

Photographic methods can be split in two subcategories: working on overimposition (like 3M Color Key and Enco Color Proofing System) and working on consecutive exposures (like 3M PMP, Cromalin and all direct positive colour materials).

Electronic previewing devices are using video systems coupled to buffer memories and analogic calculators capable of relating colours obtainable on printed paper to colour obtainable on a colour TV screen. Electronic devices are also capable of giving direct informations on set-up modifications needed to obtain a particular tonal or chromatic effect.

A main point to be considered during the evaluation of any preproofing system is its capability of bringing results within close tolerancies when making proofs from the same positives or negatives at different times.

Tonal Rendition

To verify the capability of reproducing tonal values with preproofing systems, we must start from a more general consideration: In offset and conversion gravure, tonal values are rendered in a physically very similar manner. In both printing systems the ratio between white light relected from paper and coloured light reflected from inks is modulated via variable amplitude media, the screen. Very similar is also the chemical link between inks and papers; in fact, offset and gravure inks have the same general formulation: pigment + ligand + solvent. Whereas pigments and ligands are very similar, solvent and ratio within three components are specifically related to the printing system.

E. Joyce and G. L. Fuchs (Sun Printer 1966) showed that the transfer of ink from a gravure form is closely related to the transfer in letterpress/offset printing.

From a general point of view, it can be said that any pre-proofing system suitable for offset is also suitable for gravure application. For a closer examination, we must take into account the influence of paper and inks. Gravure paper is more absorbent than offset paper, and solvents in gravure inks are very volatile; combination of those two facts is modifying, to some extent, the relation between optical densities obtainable on paper and cell size.

In conventional gravure all cells have the same area; at small cell volumes, the quantity of ink transferred to the paper is normally larger than the quantity of ink transferred from conversion gravure, cells having a much smaller area. In this region, ink viscosity can be adjusted to obtain an higher or lower printing density.

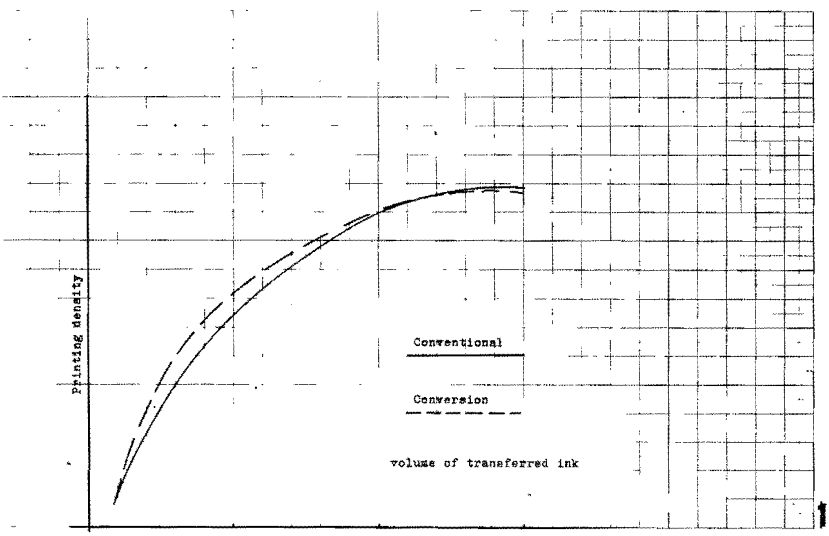

Figure 1. Relation between cells´ characteristics and printing densities.

At higher volumes (larger cells), obtainable optical densities becomes very similar for both gravure systems increasing up to a limit in the region of cell sizes varying between 80 and 90 percent as a function of ink viscosity.

What has been precised does not mean that earlier statement is no longer valid. In fact, in practice ink dilution must be determined in order to obtain the desired density range on each type of paper used, or a compromise found within different conditions. As a second step, dot range and tone gradation of separation positives must be modified accordingly or gradation curves on Helioclischograf properly set.

Ink spread on paper (dot gain) must be considered, but, if the preproofing system is being set from printing results, it will be automatically taken in account and its value easily determined.

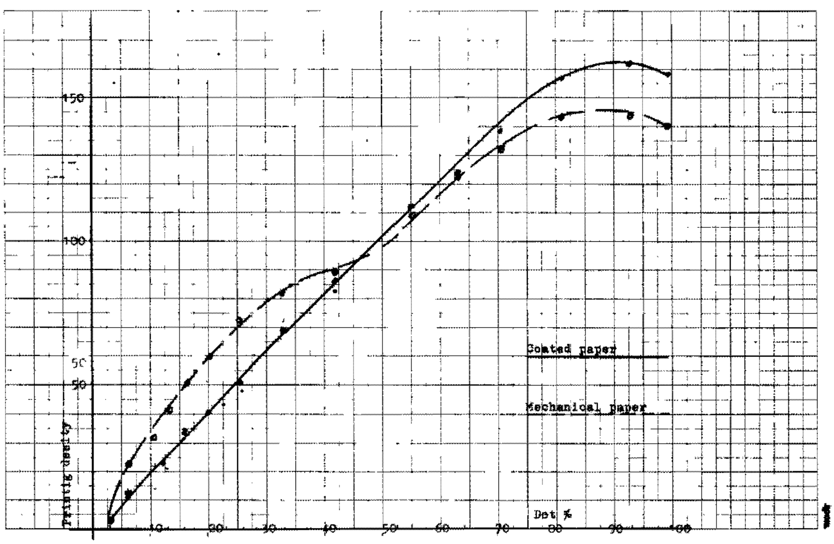

Figure 2. Relation between cells' sizes and printing densities for two different papers.

From the point of view of tonal rendition, we can conclude that offset preproofing systems are more than adequate for gravure application.

Considering colour reproduction or the preproofing systems' capability of reproducing the chromatic characteristics of printed paper, we enter the most complex and more difficult part of the problem.

To start we must say that two colour reproduction systems cannot give identical reproduction unless they are identical. In a more crude way the only method of knowing very exactly what happens on printing paper is printing the paper. To avoid any illusion about "perfect reproduction" and about the possibility of reducing system's tolerancies to zero a simple statement can be made: In any colour reproduction system, colour sensation is produced by modulation of white light components to which receptors on human eye are sensitive (roughly red, green, and blue). Every system is structured in such a way that each component is playing a well-defined role in order to obtain a certain range of results in well-defined conditions. Therefore, on a different paper, and in most of the cases with pigments overimposed in layers and not anchored to the paper's surface, we cannot expect to achieve perfect matching; we can only have a very close similarity in strictly defined conditions.

If our needs are slightly different from identity, we can find a solution, and the further we go from identity, larger is the number of solutions offered.

Since we are speaking about visual colour sensations, we can use tristimulus values notation and try to find out which is the best achievable solution, in practical terms, how close we can get to our printed paper. We already said that identical reproduction is inpossible; the same can be said of an exact reproduction, i.e. we cannot expect two different colour reproduction systems being able to reflect all wavelengths in exactly the same way.

Using some mathematical notation: $X_p = X_{ppr}$; $Y_p = Y_{ppr}$; $Z_p = Z_{ppr}$; identical reproduction impossible.

$$R(\lambda)_p = R(\lambda)_{ppr} \quad \text{Exact reproduction}$$

The aim of preproofing could be an equivalent colour reproduction; in this colour spatial coordinates (x,y) are the same for both printing and preproofing whereas the Y value is only corresponding: $(x,y)_p = (x,y)_{ppr}$; $Y_p = Y_{ppr}$.

In practice we can only obtain a correspondent colour reproduction: viewing printed paper and preproof on standard conditions we receive the same visual impression.

Electronic preproofing devices claim to give generally "better" results. This claim is endorsed by the ever-spreading use of colour TV monitors on integrated systems. Due to facilities offered from a combination of electronics and imaging technologies, colour TV monitors can give excellent quality images. Screen phosphors are normally matching colour transmission close to that of colour transparencies, so typical defects of those materials can be expected, namely small hue deviations on greens and some desaturation on more saturated colours. On the other hand, the widest colour experience in graphic arts derives from colour slides more than from reality which could account for a good percentage of the "better" quality.

A Practical Approach

A working method has been decided and applied to match a preproofing system to printed paper in a gravure plant. Main components of this method are:

Control stripes based on Brunner system.
A Gretag reflection densitometer serially linked to a Sharp PC 1500A pocket computer.
A program based on Murray and Davies equations elaborated by Prof. P. Chasseur of CSG Verona.

Screen separations were made on Hell C399 ER scanners using built-in gravure programs and cylinders engraved on Helioclischograf using a straight line gradation. Colour preproofing has been set in order to obtain maximum densities close to average printing densities obtainable on paper.

A set of cylinders has been engraved with images, mechanical stripes and Brunner stripes and a first proof made on a Bouzard gravure proof press. Close examination of printed paper showed that results were totally unreliable due to different transfer of inks from engraved cells to paper; so a second run on a production printing press has been organized with same cylinders.

For the proof all ink fountains on the press have been cleaned and filled with pure inks (not diluted). During short runs at 75 percent of production speed and in standard printing conditions, ink dilution has been set monitoring monachrome printing densities of cells corresponding to positive values with 85 and 95 percent. The ink dilution setting point has been fixed when average printing density of the highest volume cells was matching "conventional" printing characteristic curve values. With all inks properly diluted, a last run has been made printing in four colours (Y,M,C,K).

Results from densitometric measurement and computer alaboration have been compared, all figures being close to experience´s forecast but one: dot gain.

Dot gain showed two tendancies: to increase in the same direction of ink viscosity and moving its maximum from dot sizes around 50 percent to dot sizes around 30 percent as ink viscosity increased. Printing speed had also some influence on dot gain with slightly higher values for mechanical than for coated paper; dot gain figures were higher than expected being around 20 to 25 percent at low speed low viscosity and reaching 30 to 35 percent at low speed high viscosity. Average dot gain at high speed and set ink viscosity is around 25 percent for dot sizes of 30 percent.

The engraving gradation curve on Helioclischograf has been modified taking into account parameters derived from previous printed results. A second set of cylinders is being made for a press run scheduled on May 8th.

The following graphs are derived from the computer printout which show similarities and differences between preproof and printed paper on in-plant test conditions.

Although our experiments are still lacking production support, a conclusion has been achieved: for editorial printing, a close similarity between preproof and print can be accepted without searching for identity. Repeatability and stability seem to be more important than colour fidelity even though large hue deviation must be avoided.

We can conclude that gravure now has an industrial tool, repeatable and measurable, which can be used as a back up to experience and the sensitivity of quality control people.

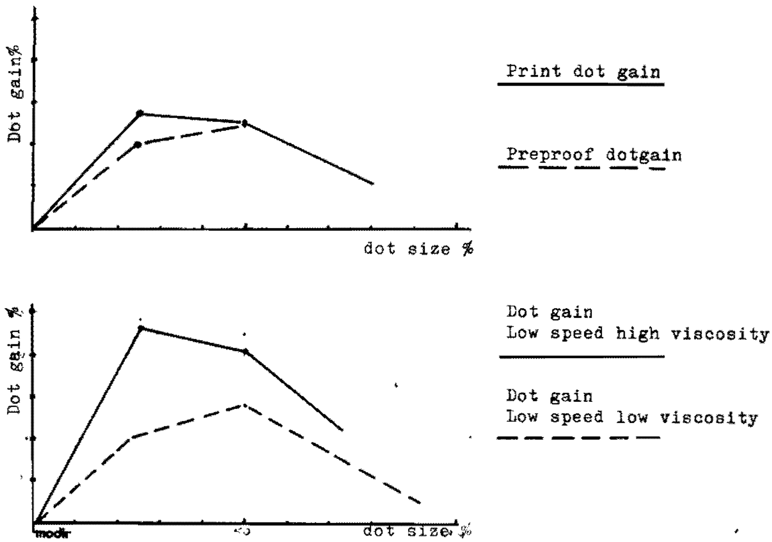

Figure 3. Comparison between dot gains in different printing speeds and ink viscosities.

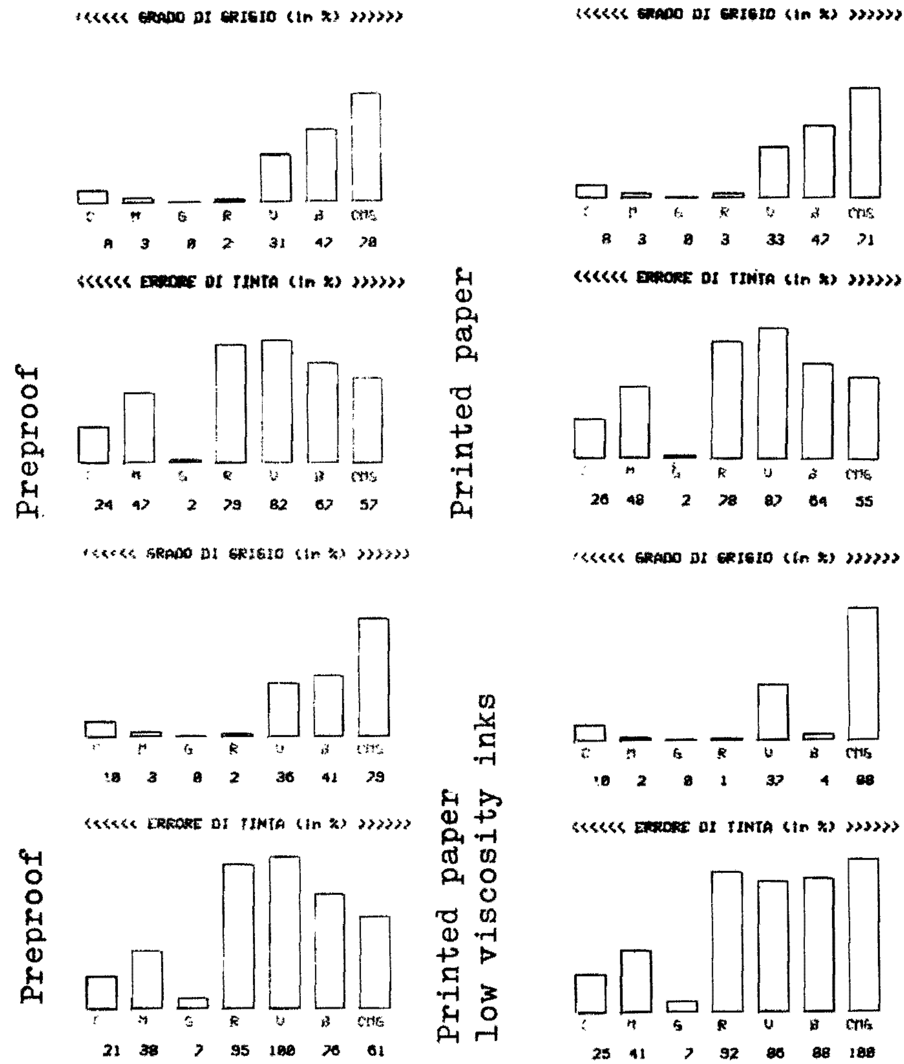

Figure 4. Samples of computer printouts comparing some printing characteristics (grayness & hue error).