SYSTEM BRUNNER PCP PICTURE CONTRAST PROFILE
Image contrasts determine the acceptance of color tolerances

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INTRODUCTION

During the past years, remote control of inking units for offset printing presses has become something quite usual. Pre-adjustment and regulation systems based on solid density are used more and more frequently. They reduce makeready time and represent the first important steps towards the automatic printing press, the realization of which, however, is still hypothetic.

Today's automatic regulation systems have not yet fulfilled all expectations. Where it was once hoped that automatic regulation alone would provide higher quality, meaning narrower tolerances, the disillusioning results have shown that there is a need for further careful work in the preparation stage, optimizing the influencing parameters at the printing press, and expert control of the production run.

Years of experience with regulation systems for inking units have proved that a competent printer who regulates by means of visual reference to the picture, is often able to maintain narrower tolerances than an automated system. Why?

The reason for this is certainly not attributed to the modern printing press with an inking unit which allows zonal fine-adjustment of the ink-feed, leaving little to ask for; on the other hand, the choice of regulation tactics has been limited to one simple approach.

For the press manufacturer, the problem of inking regulation has essentially been reduced to the meticulous control of ink-feed and ink layer thickness in each zone, and to the correction of deviations from standard values. Solid density presented itself as the most obvious measuring unit.

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In practical operation, however, secondary influencing factors become apparent, among these probably the most important is dotgain, which cannot be controlled by ink layer thickness. The effect of this fact has been underestimated in the past.

In picture printing, regulation based on solid density is carried out at a point at which the densitometer indicates considerable density differences, which are, however, perceived by the eye as only minor color variations. In the screen steps of the picture, particularly in the midtones, the densitometer measures comparatively smaller differences, although they are perceived by the eye much sooner.

Solid density control would still be effective, though, if the correlation between solid densities and screen densities were consistent throughout the production run. Unfortunately, this is not the case.

With constant solid densities, screen densities are subject to variations as a result of inevitable changes in temperature, speed, absorption of damping solution by the printing ink, and other influencing factors. For this reason, offset presses, unlike gravure presses, require adjustment.

When control engineers and electronical engineers notice that a printer turns off the automatic regulation system and resumes printing intuitively, their understandable reaction is disappointment and annoyance, and they tend to regard his behavior as outdated and counterproductive. After all, doesn't the persevering effort they put into their developments deserve better?

At System Brunner, the following question came up: Could the printer who works by intuition possibly be right? Could it be that the built-in 'picture processing system' in his head is more efficient than the presently available systems for measuring and controlling densities, and could the 'software' he was born with perhaps be superior to that offered by the electronical engineer?

COLOR GRADATIONS IN THE PICTURE

Experts in the printing industry have always been aware of the fact that some pictures are more susceptible to color variations than others. They have also realized that homogenous screen tints, especially if they consist of the three process colors, are even more critical than pictures.

System Brunner was the first to conduct extensive and systematic research with specific color gradations on various types of images, and also on homogenous, screened color patches.

Pictures consist of dozens of different color shades. It is not necessary, however, to control the changes in each one of them. It is sufficient to record the characteristics of one to three suitable measuring points which will be representative of all the other color shades.

This method is based on the extensive research, carried out by System Brunner since 1975, of the distinctive features of print and other characteristic curves in the Isocontour® diagram.

A grey patch consisting of screen densities of 50% cyan, and each 41% magenta and yellow, is especially well suited as a measuring point. These values are part of the apex area of the characteristic curves, in which the changes in dot gain are most significant.

All the color gradations in the picture samples were generated through specific divergence of the characteristic curves, whereas in screens of 50% area coverage an accuracy of +/-0.002 density units was maintained, which is the standard for the production of measuring elements.

Each picture to be analyzed was produced in 4 versions: a basic version at the upper left, a divergence towards magenta at the upper right, towards yellow at the lower right, and towards cyan at the lower left.

Despite identical divergencies at the characteristic curves, the color gradations in the different types of pictures are perceived very differently: They are perceived least in pictures with strong color contrasts, more clearly with little color contrast, and most clearly in homogenous color patches. The perceivable differences far exceed the range of color variations in offset technology.

The samples show pictures with shades of grey as well as colors, and on the other hand a homogenous patch of grey, each in four versions consisting of color gradations generated through specific divergence of the Isocontour curves (+/-4% screen dot difference at the apex of the curves), analogous to the characteristics of production printing. In spite of identical degrees of divergence of the print characteristic curves, the color gradations in the four versions of homogenous color

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patches are perceived as much more apparent than the analogous gradations in the pictures. Why?

The sensitivity of the 'human picture processing system' to color variations varies with contrast conditions. The sensitivity of the eye is reduced with numerous and high contrasts, especially if they are produced by strong, colorful shades.

Conversely, sensitivity is increased if the eye sees colors of low contrast, mainly if the colors are muted.

Under the influence of picture contrast, gradations measured as identical are perceived very differently. These perceptible differences go beyond all prevailing speculations; they can reach dimensions of several hundred percent, and exceed the color variations inherent to offset technology.

In the evaluation of results of color printing, the considerable effect on picture contrast has in the past been underestimated, particularly as far as automatic control systems are concerned. The controversial opinions referring to control automation can, for the most part, be explained by the following facts.

THE SYSTEM BRUNNER PICTURE CONTRAST CLASSES

The surprising new knowledge gained through the investigation of picture contrast motivated System Brunner to quantify pictures according to their contrast profiles, and to classify them, with the help of the System Brunner picture contrast classes, corresponding to their degree of difficulty for reproduction and press regulation technology.

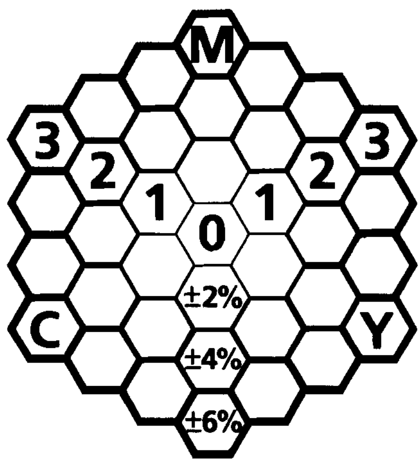
The picture contrast classes are illustrated by the System Brunner Color Balance Hexagon.

The outermost ring of hexagonal color patches is marked no.3 which stands for picture contrast class 3. The color gradations of these patches represent a screen difference of +/-6%, compared to the center patch. Color gradations in pictures of this contrast class are perceived by the viewer as slightly visible.

The ring in the middle (no.2) designates class 2, with color gradations corresponding to +/-4%. The majority of pictures pertains to this class.

The innermost ring, class 1, shows steps of +/-2%. Pictures of this class contain little or no color contrast at all. Under these conditions, the sensitivity of the viewer is increased considerably, and the color gradations in pictures are slightly to clearly visible.

The center patch of the hexagon characterizes class 0 which includes homogenous color patches without picture effect. This area is beyond the range of image reproduction technology. On the other hand, the known color gradation formulas of spectrophotometry can be applied for this area.



Color Balance Hexagon
System Brunner PCP®

The System Brunner Color Balance Hexagon serves to demonstrate picture contrast classes and provides instant information on color gradations which become perceivable in a form depending on the image grouping which raises the question of acceptance.

OBJECTIVE AND SUBJECTIVE PICTURE ANALYSIS

According to common belief, the analysis of color variations is arbitrary. On the basis of research with so-called Pixel images, System Brunner has been able to differentiate between the objective and the subjective portions. The Pixel-technique permits the content of the picture to be eliminated, and to show the unchanged contrast of pictures separately.

Tests have shown that, with a constant degree of picture contrast, identical color gradations are perceived very similarly by the majority of viewers. In the human picture processing system, the adjustment of the sensitivity to color gradations corresponding to different degrees of contrast appears to be, to a great extent, programmed consistently.

The perceptual evaluation of color gradations by the individual viewer depends, however, on subjective differences of the viewer's relation to the picture content.

An indifferent viewer will easily accept strong color variations, whereas a viewer with strong interest in the content of the picture will object to even slightly visible variations.

Manufacturers, for instance, are highly concerned with the faithful color reproduction of their products, and are consequently more discriminating.

THE INTERRELATION BETWEEN DEVIATIONS INHERENT TO THE PROCESS IN OFFSET PRINTING AND THE PICTURE CONTRAST CLASSES

Deviations of color and tone can be measured in the balance patch which is representative of all tone values, and can be demonstrated in the color balance hexagon. The necessary software was produced by System Brunner. This method allows the high accuracy of one tenth of a picture contrast class.

Deviations measured at a specific point of the sheet during the production run can range from picture contrast class 1 to 2.5. Today, a sample with a picture contrast class value of 1.8 (for 2 sigma = 95%) corresponds to a mediocre print result. Pictures of class 2, which are most common, already reach the critical tolerance limit. Pictures of class 1, or even homogenous screen patches with little color produce unsatisfactory results.

The best production results reach a tolerance frame of class 1.

What are the limits inherent to the process of today's offset technology? Three four-color sheetfed offset printing presses of the latest design (DRUPA 1986) by well-known German press manufacturers were tested for this purpose in Wurzburg, Offenbach and Heidelberg. On each press, ten consecutively printed sheets were measured and the short-term deviations characterized. The best results were in the range of 0.3 to 0.4 of a picture contrast class.

In addition to the deviations in production printing, there are the deviations within the individual sheet, particularly from the gripper edge to the opposite end of the sheet, but also from left to right, with optimal ink adjustment.

The mentioned test with the three German press manufacturers showed the best values for the so-called horizontal tolerances between 0.8 and 1.0 units of picture contrast classes, which is higher than the short-term deviations of the production run.

PICTURE GRADATION

The main cause for color variations are deviations of dot gain which is also the cause for deviations of tonal values within the picture. A differentiation can be achieved by analyzing the interaction between the three process colors: If the change in the 3 dot gain values is equally great, as well as in the same direction, the result will be a change in the brightness value of the mixed tone. If, however, the dot gain values of the three process colors diverge in different directions, the hue will be different.

The grey balance patch is not only representative of all shades in the picture, but also of all brightness values. If the three dot gain values grow equally high, the balance patch becomes darker, at the same time the tonal values in the picture are pushed together towards the solid, and stretched out in the highlights. There is a change of the inner picture gradation.

Investigations have shown that parallel changes in dot gain can be much greater than diverging changes, and still be perceived by the viewer as equally strong variation in the picture. Color variations are perceived much more clearly than variations in tonal values.

The conclusions of this observation gave access to the complex press regulation strategy.

SUMMARY

The acceptance of color variations in picture printing is to a great extent determined by picture contrast.

Neither density values nor spectrophotometrical values can directly be used for the description of perceptible color shifts in picture printing.

Therefore, pictures are classified in the System Brunner PCP -Picture Contrast Profile- to four classes according to their contrast profile.

For the presentation of color gradations in the picture, the changes are measured in a grey balance patch representative of all screened pictures, using a special densitometer, and from there area coverage and dot gain in all three process colors are determined.

The hue in the hexagon is calculated from the three difference pairs of the dot gain values of cyan-magenta, cyan-yellow and magenta-yellow.

The System Brunner Color Balance Hexagon is structurally based on the Munsell system which describes colors according to hue, chroma and value. Instead of Munsell units, differences in area coverage by screen dots are used as a measuring unit. This guarantees the direct connection to the preliminary steps of printing, the offset plate and the screen film, which are not accessible to spectrophotometry.