System Brunner PCP Picture Contrast Profile

Image contrasts determine the acceptance of colour tolerances

With this edition of the M.A.N.-ROLAND News "Extra Nr. 1" we start a new series of publications which will treat topics of general interest from the areas of printing and reproduction and bring them up for discussion. In this series we invite personalities of the Graphic Arts Industry to speak.

The first extra-edition being at your disposal will treat the "System Brunner PCP picture contrast profile".

With this method it becomes possible, to make the reasons more transparent, which may lead to variations in the printed picture, and to provide – even before printing – adequate remedy.

Besides, the image analysis as per "System Brunner" shows possibilities to stabilize the printing quality.

M.A.N.-ROLAND
Druckmaschinen AG
Offenbach am Main

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 dissillusioning 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 in the production run 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.

In practical operation, however, secondary influencing factors become apparent, among these probably the most important is dot gain 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 minor colour variations. In the screen steps of the picture, particularly in the mid-tones, 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 behaviour as out-dated and counterproductive. After all, does not 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 system for measuring and controlling densities, and could the "software" he was born with perhaps be superior to that offered by the electronical engineer?

In the beginning thoughts like these were concentrated on the investigations which ultimately led to the development of System Brunner® Picture Contrast Profile (PCP). Using the system, pictures are examined with reference to their different contrasts, and based on the obtained contrast profile, quality requirements can be derived in the form of tolerance frames.

In addition to PICTURE ANALYSIS, System Brunner® PCP offers – as a logical consequence – a REGULATION STRATEGY.

This article presents PCP picture analysis; in a coming issue of "Roland News", we may focus on PCP regulation strategy.

PCP picture analysis gives the answers to fundamental questions of quality assessment in reproduction and printing, also with reference to the performance and limits of ink regulation systems. This article deals with the following questions:

- Are the standards for homogenous colour patches equally valid for the evaluation of colour variations in picture printing?
- What are the criteria that affect the perceptual assessment of colour gradations?
- How large are the differences in the subjective assessment of identical colour gradations by different viewers?
- Which measuring units are suitable for the characterization of colour gradations?
- How do the variations inherent to the process of offset printing affect the different picture contrast classes?

Colour Gradations in the Picture

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

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

Each of the pages 6 and 7 show a picture with shades of grey as well as colours, and on the other hand a homogenous patch of grey, each in four versions consisting of colour gradations generated through specific divergence of the Isocontour curves (± 4% sceen 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 colour gradations in the four versions of homogenous colour patches on page 7 are perceived as much more apparent than the analogous gradations on page 6. Why?

The sensitivity of the "human picture processing system" to colour variation varies with contrast conditions. The sensitivity of the eye is reduced with numerous and high contrasts, especially if they are produced by strong, colourful shades.

Conversely, sensitivity is increased if the eye sees colours of low contrast, mainly if the colours 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 colour variations inherent to offset technology.

In the evaluation of results of colour 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.

Two further picture samples with different contrast profiles appear on pages 10 and 11. The colour gradations in each of the four versions were also produced through specific divergence of ± 4% at the apex of the print characteristic curves in the Isocontour diagram.

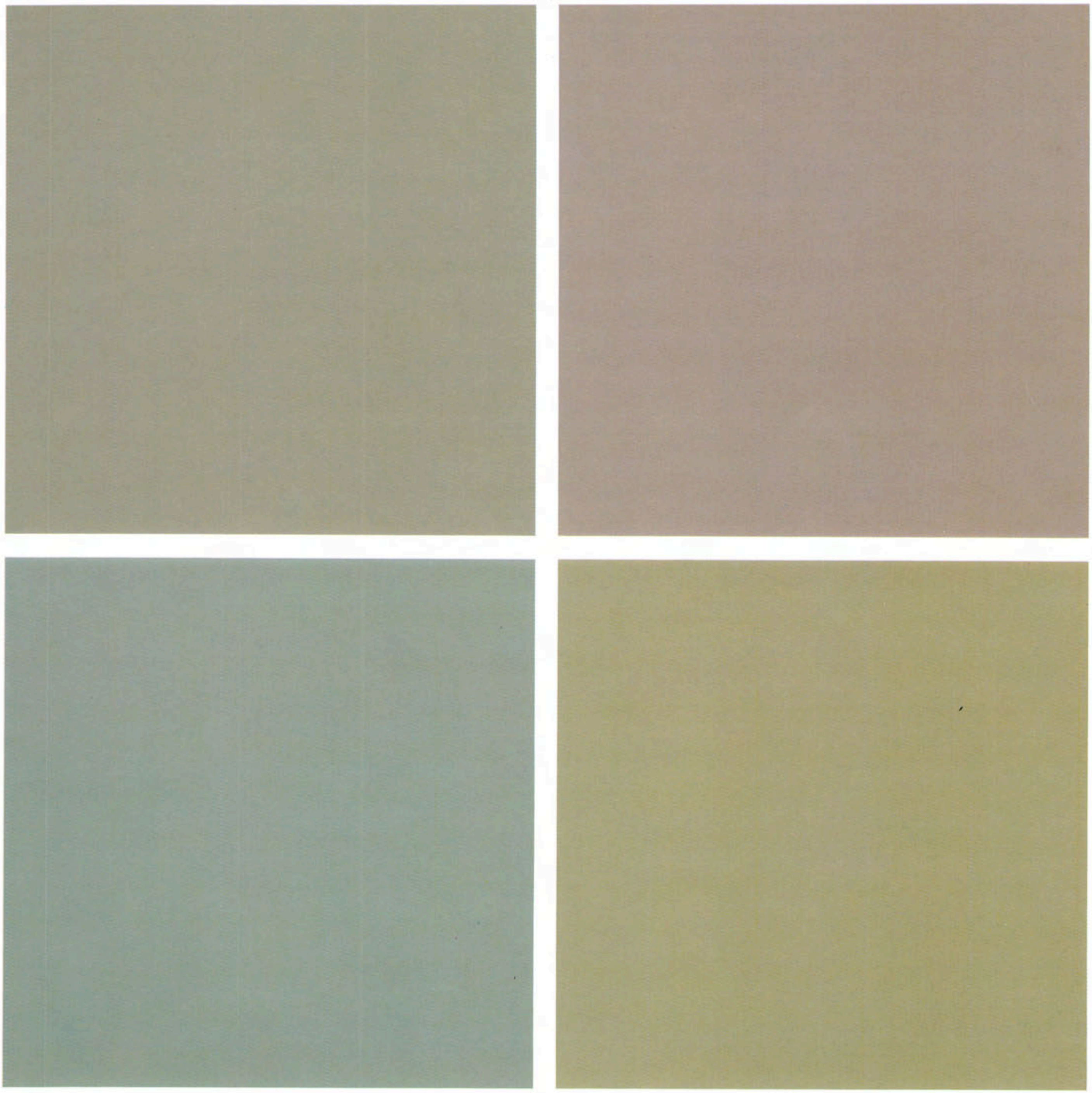
The detail of the picture with the flock of sheep is characterized by a lack of strong, colourful shades, and hence of colour contrast. The sensitivity of the viewer is increased and as a result, these colour gradations are perceived as "strongly visible" – the colourful sheep appear unnatural, because they do not correspond with our conception.

In comparison with the previous example, the detail of the picture with the green Roman vase is made up of strong colours and strong contrasts of brightness which reduces the sensitivity of the viewer to approx. one third. These colour gradations are perceived as "slightly visible".

The picture has a considerable grey content but also strong colours. These colour hues reduce the sensibility of the picture in relation to colour differences.

Homogenous grey areas present a viewing situation which is extreme in the paucity of representation. The sensibility of the viewer is increased.

Under the influence of image contrasts colourimetrically uniform distances are perceived very differently.
The four variants of the two pictures above have the same colour divergencies seen from a measuring point of view.



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 regulation technology.

The picture contrast classes are illustrated by the System Brunner® Colour Balance Hexagon on page 9.

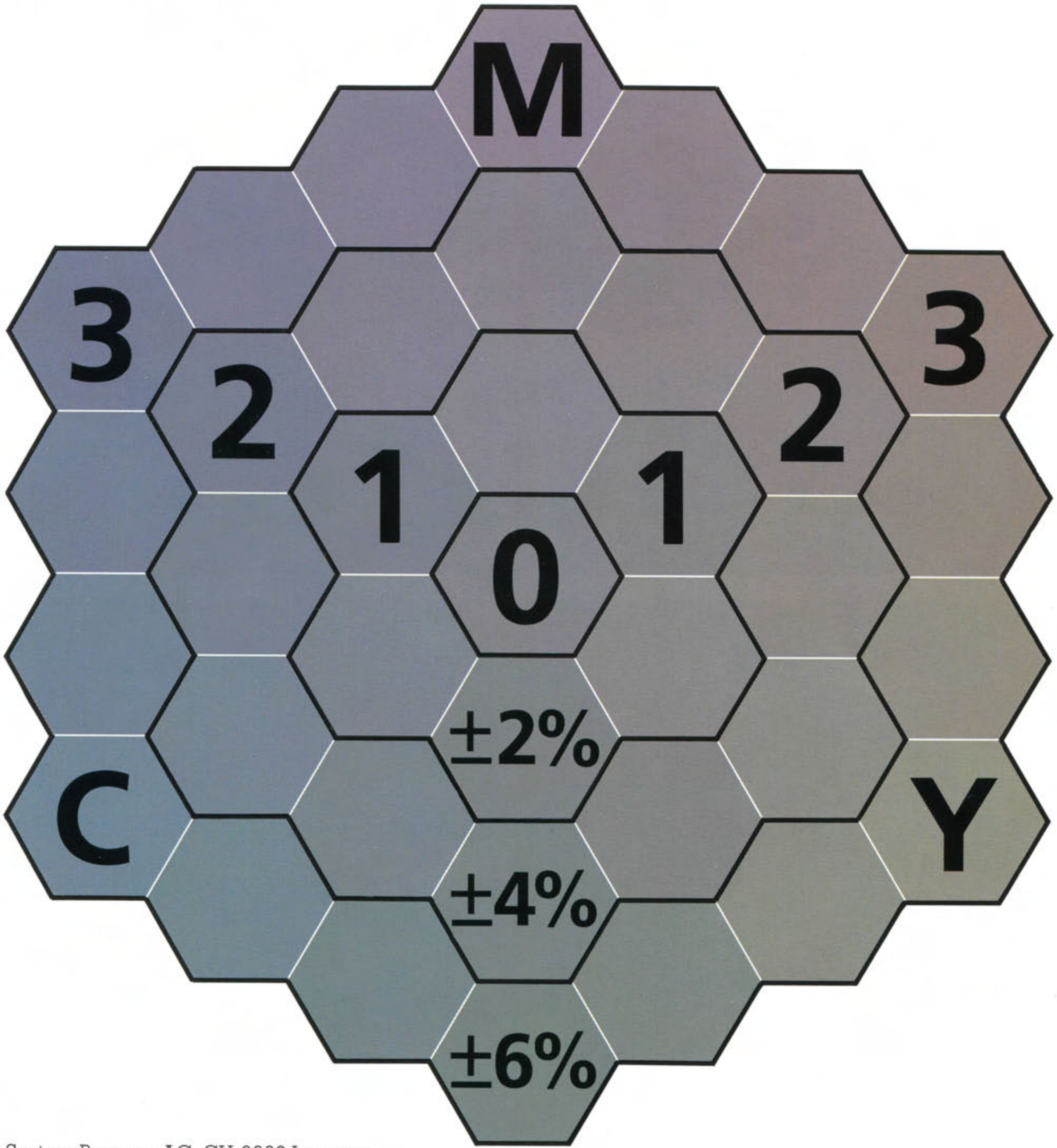
The outermost ring of hexagonal colour patches is marked no. 3 which stands for picture contrast class 3. The colour gradations of these patches represent a screen difference of ± 6%, compared to the centre patch. Colour gradations in pictures of this contrast class are perceived by the viewer as slightly visible. The scale used for the distinction of perceived colour gradations is made up of the following five steps: not or barely visible – slightly visible – clearly visible – strongly visible – extremely visible.

The ring in the middle (no. 2) designates class 2, with colour 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 colour contrast at all. Under these conditions, the sensitivity of the viewer is increased considerably, and the colour gradations in pictures are slightly to clearly visible.

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

The System Brunner® Color Balance Hexagon serves to demonstrate image contrast groups and provides instant information on colour distances which become precciveable in a form depending on the image grouping which raises the question of acceptance.



The image detail has light/dark contrasts but because of the absence of colour contrasts the colour distances are strongly perceived.
The subject image is seen more critically because the coloured sheep do not meet accepted image notions.
System Brunner® Image Contrast Group 1.

This image is characterized by strong colour accents and light/dark contrasts. These reduce the viewer's sensibility.
System Brunner® Image Contrast Group 3.

Under the influence of image contrasts colourimetrically uniform distances are perceived very differently.
The four variants of the towo pictures above have indentical measured colour divergencies. The average viewer perceives the colour distances of the sheep as strong, while the vases are considered only faintly visible.

Objective and Subjective Picture Analysis

According to common belief, the analysis of colour 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.

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

The perceptual evaluation of colour 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 colour variations, whereas a viewer with strong interest in the content of the picture will object to even slightly visible variations.

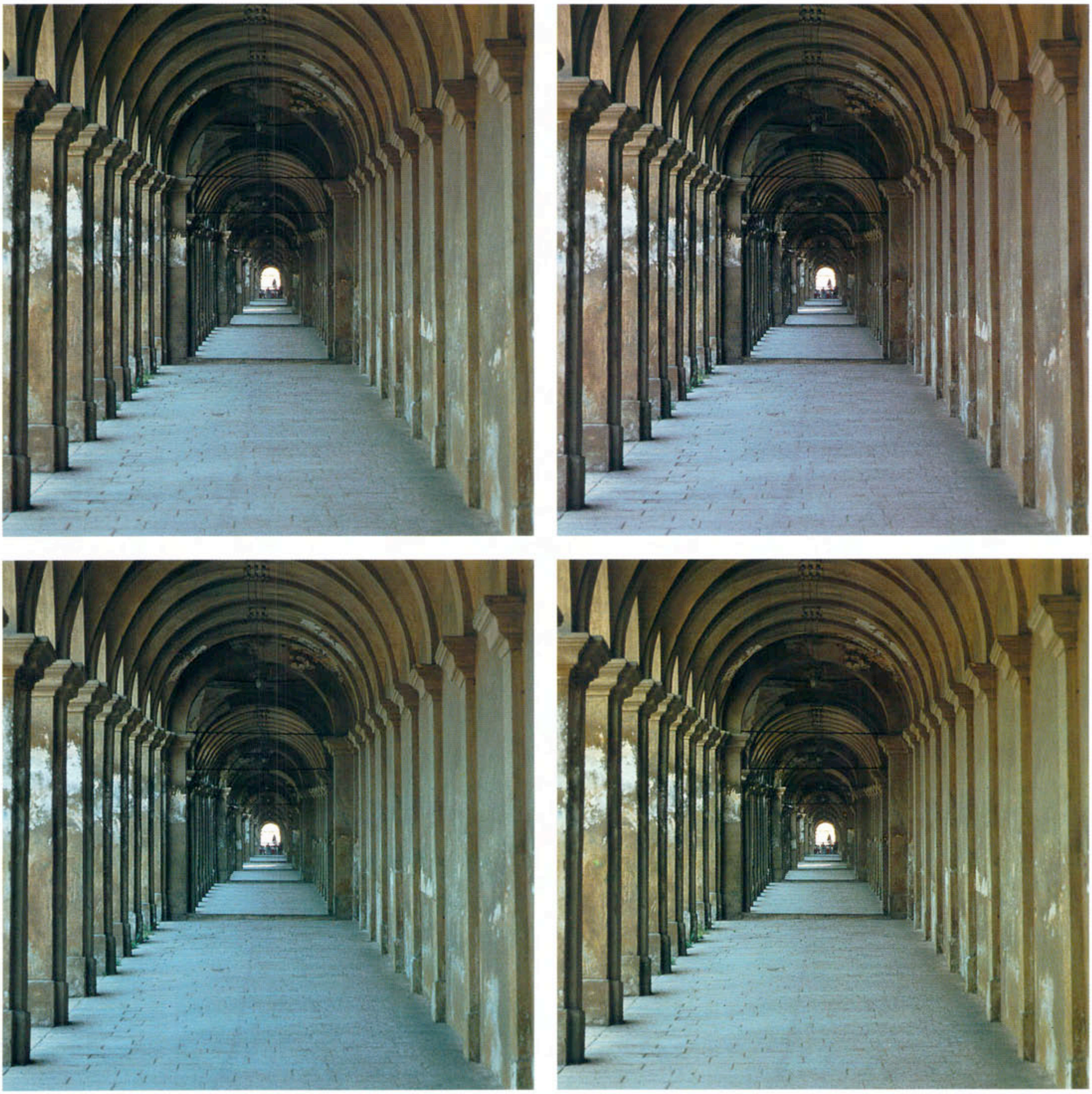
Manufactures, for instance are highly concerned with the faithful colour reproduction of their products, and are consequently more discriminating.

Subjects which the viewer associates with certain colour shades are assessed more critically. The picture with the sheep on page 10 is an example of this: Lacking in colour contrast, it falls into class 1, but furthermore, it is evaluated more precisely because sheep with a colour shift look unnatural.

The Pixel-technique permits the content to be eliminated, and to show the unchanged contrast of pictures separately. On pages 13 and 14 a realistic photograph is put apposite its Pixel-version. Without any particular relation to the picture content (courtyard of a monastery in Italy), colour variations are not perceived by the viewer.

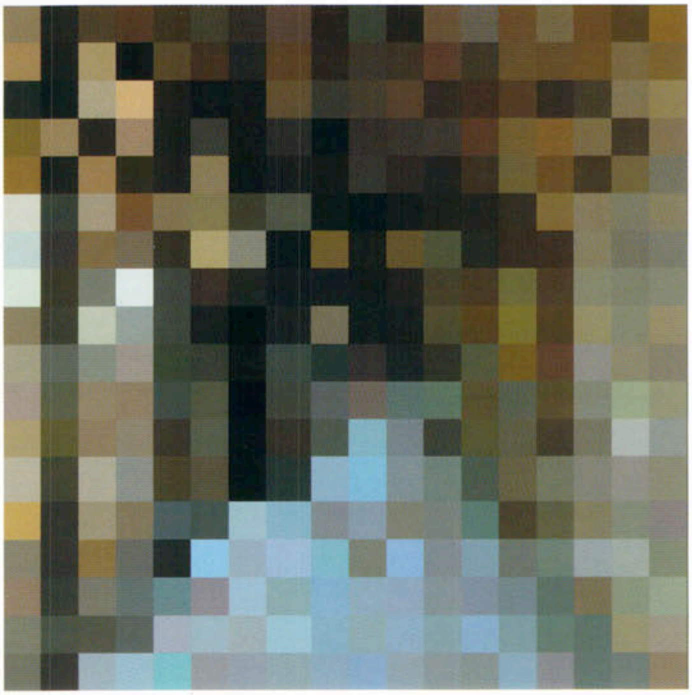
This comparison proves that is more efficent to classify the degrees of difficulty of pictures by contrast class, rather than by subject. This way, the number of classes is cut from dozens down to a few.

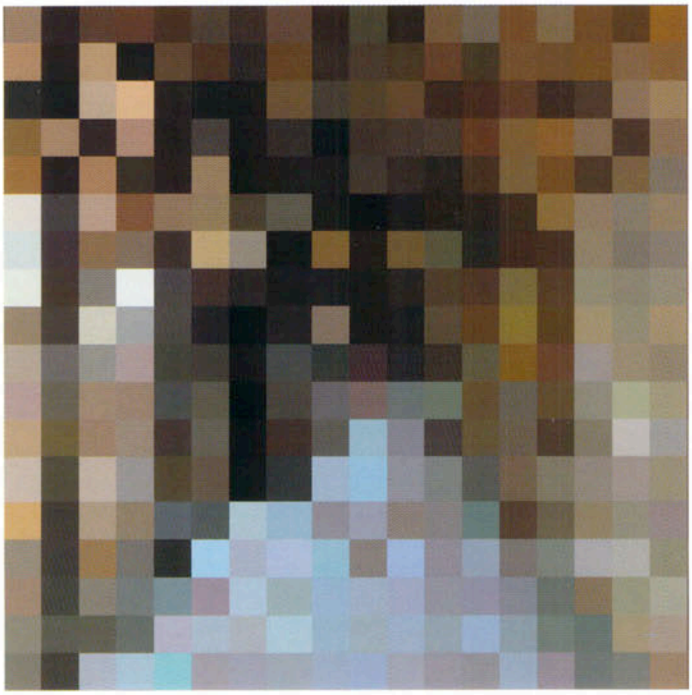
Cloisters realistic

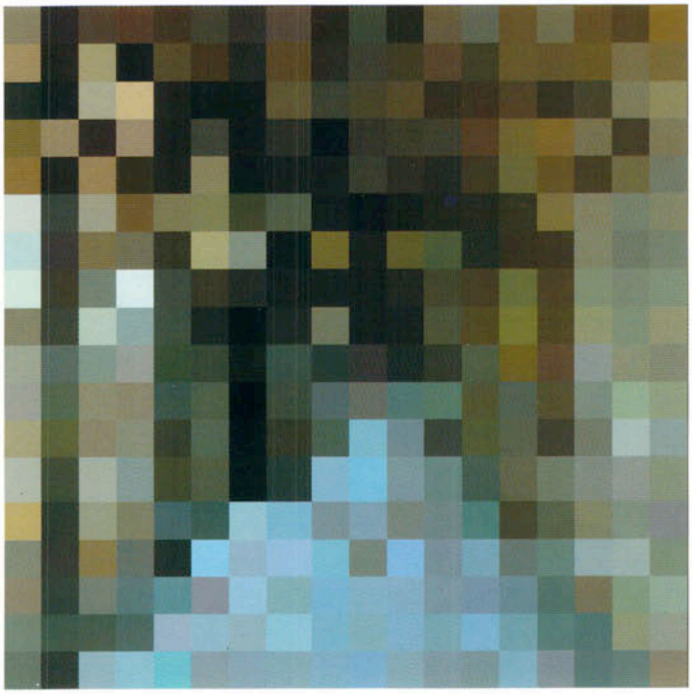


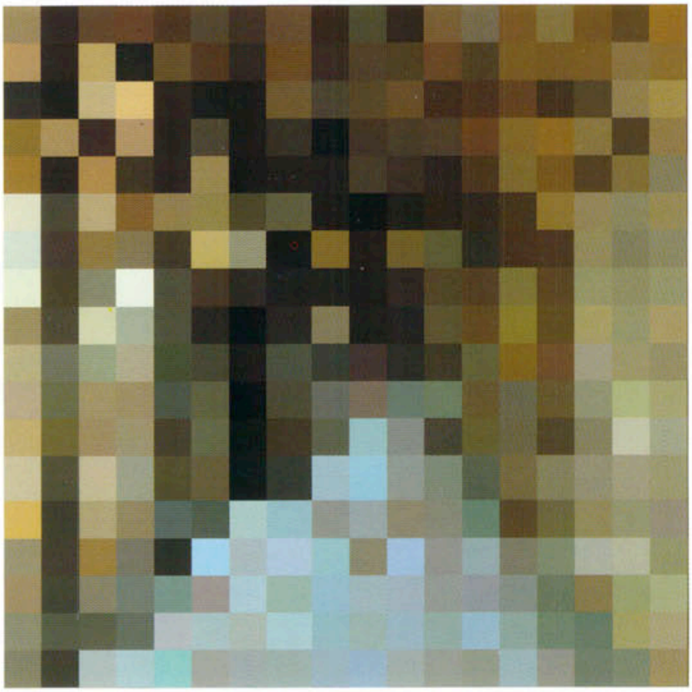
Without any special relationship of the viewer to the picture content the perception is governed largely by the image contrast.
The juxtaposition of a real picture to the abstracted Pixel version shows that uniform colour distances under the same strenght of image contrasts is received rather in the same way by the viewer even when the image expression is relinquished in Pixel version.

Cloisters in Pixel version (abstract)









Grey Stabilization (Grey Compound Replacement)

In the preceding chapters it was pointed out that colour variantions inherent in the process of offset printing do not allow the printing of homogenous colour patches consisting of screen combinations of class 0, or pictures of contrast class 1, without any visible colour variations, as long as they are produced in the usual way with the three process colour plus structural black. To the printing industry, this fact poses a serious problem which cannot be solved by control automation.

As early as 1971, System Brunner® published a completely new solution, under the name "grey stabilization", and suggested the composition of the grey portion in muted colours predominantly of screened black, rather than of cyan + magenta + yellow. In the neutral shadow part of the image, the concept of undercolour removal (UCR) had alreay proven successful. However, the visible colour variations appear initially in the midtones of grey and brown, and that is where they have to be stabilized first, because they are most susceptible to variations due to dot gain.

Through intensive grey stabilization, by which the grey compound of all colour shades is replaced by 80% and 90% black, the sensitive pictures of the System Brunner® picture contrast class 1 can, so to speak, be placed into class 2, in which variations twice as strong (± 4%) still produce results with acceptable colour. A stabilization of 50% and 60% already relieves the printer considerably.

Pages 16,17 and 18 illustrate the effect of two different degrees of grey stabilization – 50% and 90% – in comparison with a non-stabilized reproduction. In all versions the print characteristic curves have been equally diverted by ± 4% at the apex. The differences with reference to perceptual colour variations are considerable.

Colour buildup ±4%

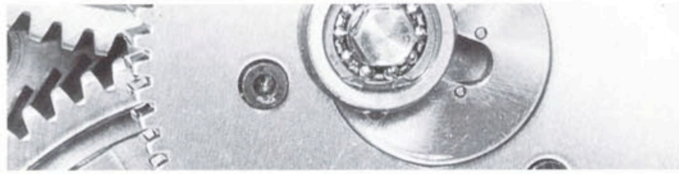
Black separation

Colour buildup: the colour distances of the four variants of the picture according to the System Brunner® Image Contrast Group 1 are evaluated as strong to very strongly visible.

Grey stability 50% ±4%

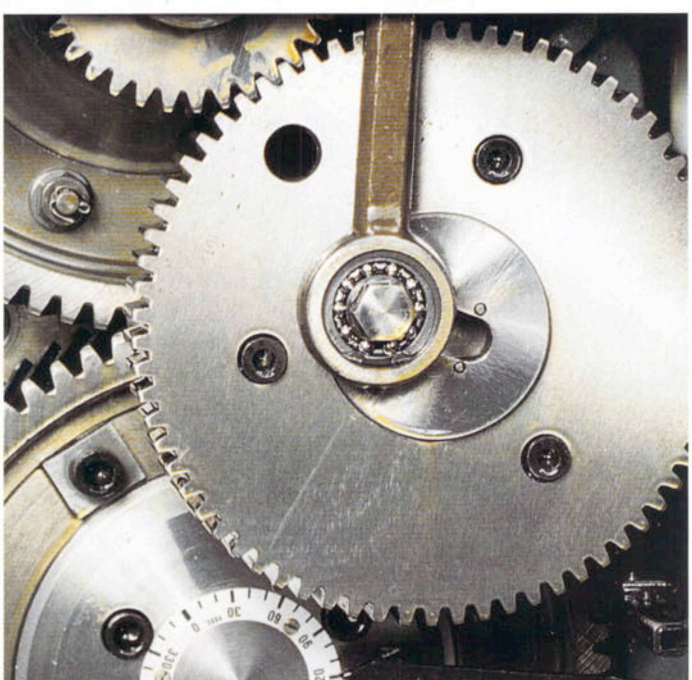
Gray stability 50 per cent: At a stabilisation grade of 50 per cent the same changes in the identification line may still be evaluated as clearly visible.

Black separation

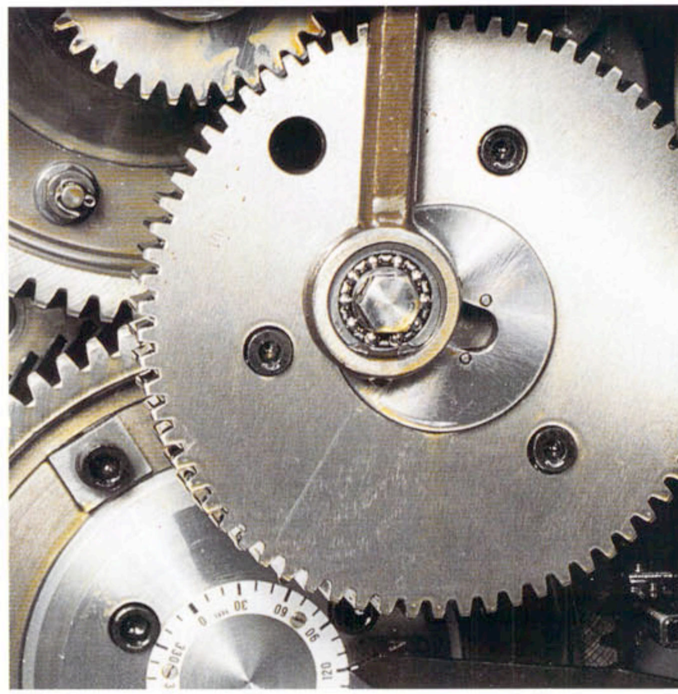


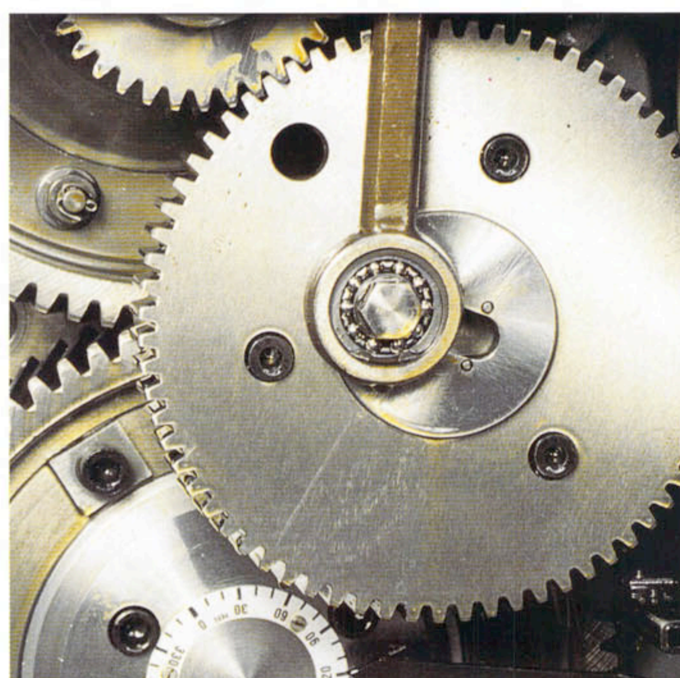
Grey stability 90% ±4%

Gray stability 90 per cent: At this high rate of stabilisation the average viewer will evaluate colour distances as hardly to poorly visible.



Black separation





Colour buildup ±4%

Black separation

Grey stability 90% ±4%

The juxtaposition of the two colour separation methods shows that in a picture with strong colour contrast the aimed for colour distances in the variants are hardly or poorly perceived both in colour buildup and in grey stability.

Black separation

During its first ten years, the concept of grey stabilization could not fully break through, because the additional time required for producing stabilized separations encountered the resistance of colour separators.

The pressure towards the realization of grey stabilization, recently also called "grey compound replacement", did not become significant until 1983, when the Japanese manufacturer Dai-Nippon-Screen placed a scanner on the market which allows the production of grey stabilized separations in the same amount of time as colour separations.

Having resisted grey stabilization for a long time, companies now tend to favour the other extreme – to stabilize basically all separations. This has little effect on picture originals with strong colour contrasts, as illustrated by the comparison pages 19 and 20. Because the photograph of the peppers contains no greys, especially in the highlights and midtones, the specific colour gradations of the different versions are barely visible.

Based on the System Brunner® picture contrast classes, the recommendations for stabilizing originals are the following: 80% to 90% for class 1, 40% to 60% for class 2, whereas class 3 can do without stabilizing.

Automatic Regulation and Colour Variations Inherent to the Process of Offset Printing

A computer can never be more intelligent than its programmer, and one thing neither of them can accomplish is to step beyond the limits inherent to the process. Regulation instructions are only efficient if the conditions to be affected remain constant, at least until a control action has become fully effective, which is equivalent to the space of time in which several hundred sheets run through a press. Any variations appearing in shorter intervals cannot be influenced by regulation of the inking unit. This includes slurring, doubling, undetectable irregularities of material, temporary changes of the ink-water balance, etc.

Investigations have revealed that, under ideal printing conditions, variations through dot gain amount to approx. ± 2% at the 50%-step within a limited zone, and ± 3% to ± 4% over the full format. This means that even with optimal zonal control of the production run, the colour variations within the individual pictures correspond to the innermost ring in the System Brunner® Colour Balance Hexagon (page 9). These colour variations are visible if the pictures pertain to picture contrast class 1. Under equally good conditions, the variations in pictures of the classes 2 and 3 are perceived as barely or slightly visible.

At the beginning of a run, the exact dot gain in each colour at pre-selected solid densities is hard to anticipate. This depends on the temperature of the press, the rheology of inks, tack under the influence of the damping solution, as well as a number of other influencing factors. The uncertainty with respect to dot gain that can expected is easily as high as ± 5%, or even higher.

Attempting to control only solid densities, by entering fixed values obtained from, e.g. the proof, one has to put up with deviations of colour balance corresponding to the outermost ring of the hexagon. Deviations of this extent are acceptable only in pictures which are very colourful and high in contrast. This concludes the outline of the limits of automatic ink regulation based on solid densities.

Photographies:

Front page: Mrs. Sherry Smoot,
Exclusively for system Brunner AG;
Photographer: Marcel Kuenzi,
Kilchberg – Zurich

Page 6: "Merry-go-round"
Photographer: Maurizio de-Marchi,
Tenero – Locarno

Page 10: "Sheeps"
Photographer: Felix Brunner, Corippo TI

Page 13: "Portici in vincenza"
Photographer: Maurizio de-Marchi,
Tenero – Locarno

Page 14: "Roman Vases"
Photographer: Maurizio de-Marchi,
Tenero – Locarno

Page 16-18: "Gears"
Photograph by M.A.N.-ROLAND
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Page 19/20: „Peperoni"
Photographer: Max Buchmann,
Gordevio – Locarno

Text and illustrations:

System Brunner AG
Via Ciseri 17, CH-6600 Locarno
Phone 093/316489

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