Using colorimetry for ink regulation?

System Brunner replies to Heidelberg

In the magazine "Deutscher Drucker" no. 13 from April 25, 2003, Jürgen Mittmann, head of Product Management Prinect at Heidelberg, promoted colorimetry for inking unit regulation and positioned it as the superior technology. The populistic assertion that colorimetry perceives color like the human eye is bound to lead many printers astray.

Which influencing variables determine the "color" in illustration printing?

In the color matching phase the printer corrects the inking until he has achieved good conformity with his color original. Therefore the obvious thing for the printer to do is regulate the solid ink density, which has for years been proven as a gauge for ink film thickness, in order to keep the result constant.
In reality however, changes to the **screen dots** (size, shape, etc.) in the printing process have a much greater influence on the color appearance of the picture than solid ink densities. Some 80% of color deviations in printing are caused by many different types of changes to the screen dots. Screen dots can lie alongside one another, or over one another, and partially overlap. Color-relevant changes to the screen dots occur in all stages of the work process.
There are at least nine important groups of influencing variables, namely screen ruling, screen dot shape, screen dot border zone, printing plate, blanket, paper, ink, ink/damping solution and printing pressure, within which color-relevant changes to screen dots can take place.

Variations in the solid ink densities have an effect on the overall contrast of the printed result and could contribute around 10-15% to color deviations in a printed picture.

And so more than 90 % of all color deviations in four-color printing are process-inherent, can be detected and regulated most precisely with process-oriented measuring methods, and have absolutely nothing to do with colorimetry.

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The ink supplier is responsible for providing standard-compliant process inks (ISO 2846-1) and will also certify this at the request of any customer. This is in accordance with the fundamental idea behind the ISO 9001 standard. The inks are spectrophotometrically checked for compliance to the standard in a laboratory under defined test conditions which can hardly be duplicated during a print run.

Therefore one doesn't need colorimetrical measuring instruments to achieve the highest level of color security, but instead measuring methods that optimally analyze and precisely control the process. And these measuring methods are based on the process-oriented densitometry.

Densitometry: optimal for process control and color regulation

There are various technologies for acquiring densitometric measurement values. Apart from reflection densitometers that are equipped with filters for the so-called complementary colors to the process colors, spectral measuring instruments are also used these days which calculate these filter characteristics from spectral values. One can also obtain very precise, standard-compliant densitometric measurement values using video technology and corresponding software.

These technologies can be used to measure solid tone areas as well as selected halftone areas. With the aid of the Murray-Davies equation, these measurements can be used to calculate halftone area coverages.

The **area coverage of halftone dots**, which is generally expressed in percentage values, is the **most important control variable** of the entire printing process. This can be used to numerically record all color-relevant changes. Every workflow stage can be precisely linked with any other one. The characteristic curves of films, plates and all recordable influencing variables can be added up and the resulting print characteristic curves displayed. This makes the printing process transparent and controllable.
But densitometry can do even more: it can also check the color correctness of the process inks CMYK, which are standardized as well in accordance with DIN ISO 2846-1. Modern densitometers measure simultaneously in all filter channels. Through simultaneous use of these densities in the Instrument Flight* software, System Brunner can for instance check the correctness of the process colors and indicate all deviations with simple messages. Instrument Flight* also precisely measures the gray balance and makes any corrections needed with the patented regulation algorithm. It doesn't need colorimetry to do this.

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Colorimetry is process blind!

With colorimetry it’s the other way round. Since it has no access to screen dot parameters, the printing process remains for colorimetry a black box it can’t see into and because of this irrefutable fact can be classified as **“process blind”.**

Seen from this aspect, the slogan ”colorimetrical regulation” is nonsense. There is no mathematical association between colorimetric measurement values and the process variables ink film thickness and halftone area coverage used for color control. With empirical methods (e.g. look-up-tables), classification must be done first whereby accuracy is always strongly affected.

Colorimetry is not picture-pertinent!

Colorimetry has never been a suitable method for assessing visually noticeable color deviations in illustration printing. Already in the mid-eighties as System Brunner was carrying out tests to develop the Picture Contrast Theory, it was demonstrated that colorimetrically identical color differences can be perceived by the observer as being very different depending on picture contrast. See the examples of a low-contrast and high-contrast picture, both of which show the same metrological color deviation. Nevertheless, the observer perceives the differences in the ”egg” pictures as being several times more important.
For this reason Delta E*ab is totally unsuitable as a gauge for perceived color differences in illustration printing. Depending on picture contrast, distortion could be as high as factor 4. Delta E* can only be used as a perception value for evaluating individual, homogenous color areas in a contrast-free environment. (An example that every car owner is familiar with: repairs to the paintwork on a damaged part of a car body).

Colorimetry and its applications

Colorimetry is a discipline that seeks to understand, describe, measure and classify the human perception of color. The defined CIELAB color space, which is based on the coordinates hue, chroma and value first described by Munsell, has gained worldwide acceptance.
Colorimetry tries to be universally applicable and is not fixed to any specific technology; it describes color as it is perceived by the so-called normal observer. This is its strength but also its weakness. Colorimetry can objectively describe with numerical values the difference between two individual color shades, but it cannot indicate how it is technically possible to get from one hue to another.
Colorimetry provides no clue how to do this.

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Applications for colorimetry include for example logging runs with spot colors in accordance with L*ab which can certainly be interesting for packaging printers. Solving metamerism problems between color originals like paint or fabric samples and printing inks are also typical colorimetry applications but this is done off-press with hand-held measuring instruments.
Colorimetry is also used for profiling various output media e.g. for approximating display screens, cameras, or digital proofs to print results. In this application colorimetry serves as a mediator and presumes that each of the output media always shows the same result which in reality is not the case.

In most industries, color changes are made by changing the color mixture. In the printing industry two different types of color mixtures are used: *pigment mixture* and *autotypical mixture*. The pigment mixture, which has more to do with colorimetry, will be dealt with first.
With pigment mixtures for ink formulation, one starts with a number of defined basic pigments. One knows from experience which proportions of basic pigments results in a certain new hue. Colorimetry helps here to numerically record the components and results of the mixture. The empirically gained mixing rules are categorized with colorimetrical values. With the aid of colorimetry, this categorization enables technical directions for color mixing to be deduced. In printing, pigment mixing has proven itself for spot colors.

Pigment mixing takes place before the ink is placed in the ink fountain of the printing press. From this moment on, the ink can no longer be changed; the color can only be regulated by changing the ink film thickness.

With *autotypical color mixing,* i.e. color mixing through the cyan, magenta, yellow and black halftones, the proportions are different. The components of the mixture are not weighted pigments but halftone areas that are subject to other inherent laws. In all phases of halftone printing these halftones undergo numerous changes which colorimetry cannot identify because there is no connection between halftone values and colorimetrical values.

The basic question raised in the headline for this article **"Using colorimetry for inking unit regulation?"** can be answered by the following summary:
Offset printing, with its standardized process colors CMYK, densitometry, and halftone area measurement, has created its own color space and an independent diagnostic and process technology that permits every phase of the printing process to be completely explainable and controllable. Which is why densitometry is infinitely more important than colorimetry for offset printing, although colorimetry is indeed suitable for ink formulation, or logging runs with spot colors, or generating color profiles in prepress.

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Colorimetry is absolutely unsuitable for controlling the printing process and detecting process faults in illustration printing.
This also explains why undefined spectral measurement "in the picture" and ink regulation deduced from this does not work. One can also see why individual profiles are painstakingly produced in order to realize so-called Color Management with a great deal of "luck and coincidence".

Summary
System Brunner is not a manufacturer of measuring instruments or printing presses. System Brunner concerns itself with standardization and process control in printing and prepress which represents the basis for successful and comprehensive Color Management. System Brunner utilizes the technologies necessary for standardized, industrial-scale production at a high level of quality. The ultimate goal is maximum process security, productivity and economy.
The use of System Brunner technologies on every printing press in every printing plant is not a technical question but instead a matter of policy. Both press manufacturers and printers must themselves decide to what extent they wish to master the offset process, and this decision therefore belongs in company philosophy and not only in budget and investment planning.

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Colorimetry is not picture-pertinent! Both versions of the two pictures have the same metrological color divergence. Due to the minimal picture contrast, the observer perceives the color difference in the "egg" pictures as being many times more extreme. For this reason colorimetry with Delta E*ab is obsolete as a gauge for perceived color differences in illustration printing.

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Typical color variations in production run, even with consistent solid ink densities

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