Tolerance Levels for Standards in Premedia Colour Workflows

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Abstract: Development of colour management systems, level of agreement and standardisation in the graphic arts industry, as well as the embedding of the facilities for colour management into computer operating systems and software, enables successful future interoperability of colour reproduction. Yet colour reproduction from one medium, to another still give rise to inconsistencies.

This paper investigates the utilisation of standards in colour management systems of premedia and press manufacturers and the achievement of colour fidelity from original to print. Questions of interest are: how carefully has a standard adjustment, e.g. ambient light, display temperature and measurement tools, to be complied, especially when visual perception is used for control of colour fidelity, and, how significant is the lack of colour control in certain places in the reproduction flow for the final printed colour? There is a special interest in the usage of colour control methods, such as hard and soft copy proofing. Swedish premedia and press colour workflows were investigated to get the necessary information. The companies all use cold-set web offset printing to reproduce their final product, but lay different emphasis on premedia or press, or handles both workflows.

The result shows that the compliance with standard adjustments varies, and principally all workflows neglect some adjustment, caused of shortage in routines or knowledge. This does not affect the final result too much, since complaints from customers are few, yet the automation throughout the workflow. The investigation also shows that soft proofing in prepress and in press workflow would increase colour stability and would reduce the consumption of time and money.

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INTRODUCTION

Colour management is required to provide predictable and consistent colour results throughout the printing flow with maximum throughput and minimum interference of operating skill. The premedia process consists of systems being able to integrate different imaging peripherals, delivered from different suppliers, and to reproduce coloured media on printing manufacturers located over a large area.

At present, colour fidelity diminishes, among other things, due to lack of routines and efficient use of high-end equipment and standard tools, in graphic arts workflows. These inadequacies reduce the reliability of the colour reproduction flow and result in inquiries, non-remoteness, non-automation and inflexibility of the colour media production.

An essential procedure in the colour reproduction process lays in the calibration and characterisation of the hard and software of the system, in the quality of these devices, and in their optimal utilisation. A large share of colour complaints is related to issues that could be solved by equipment calibration [McCarthy, 02]. Although calibration for each device is a local proprietary function, any device in a workflow that is not controlled can adversely impact colour results on the other devices in the workflow. Calibration accuracy and stability in each device involve control capability, such that the device can be maintained within its optimal operating range. Devices must reproduce the same colour in different places on an output device, across multiple output devices and from one day to the next. Stable hardware devices, easy to use built-in colour controls, and re-calibration procedures can result in controllable devices. However, imaging systems are built with tolerances, based on specification, and these tolerances differ across markets, and between imaging component vendors. When colour is not fully specified in a document file, imaging components receiving the document must make certain assumptions. For these reasons, improved open system colour fidelity requires improved consistency between colour measurement tools. Still, the same image file sent to several consistent reproduction media yields different results, leading to inconsistencies in the impact of the presentation.

The aim of this paper is to discuss how inconsistence in standard variables (e.g. calibration set-up, ambient light, transforming algorithms) affects a digital reproduction workflow and the effect these variables on the impact of colour management during the reproduction process, especially on the visual perception. A particularly strong requirement is focused on reduction of the dependence on the often colour-divergent hard copy proofs, instead visualising printed colour by soft proofing on display monitors, focusing on flat panel displays [Leckner et al., 02].

To achieve the necessary information, the workflows of colour management systems of several premedia and printing companies have been studied; the

managers of prepress companies have been interviewed. The companies investigated were chosen because they are all keeping themselves in the frontline concerning quality (colour) management (one case was chosen because of the product), and they all produce prints on uncoated paper using cold-set web offset press.

OBJECTIVES

In order to expound earlier investigations of colour management systems in premedia and press workflows, described in [Leckner et al., 02], extensive work has been done by additional interviews of managers of colour management systems; at six large and middle sized newspaper, journal and advertisement companies in Sweden. Further, investigation of newspaper colour management systems' routines and utilisation of standard configurations have been obtained from 14 newspaper companies by questionnaires.

PREMEDIA AND PRESS WORKFLOWS

Swedish premedia and press colour workflows have been investigated. In order to cover a conventional print production workflow, three cases have been focused on: manufacturers working with advertisement premedia, production of premedia for weekly journals, and newspaper premedia and press production. Specific media parameters and design of each workflow are presented in Figure 1, 2 and 3.

Besides internal control of the colour reproduction tolerances mentioned in *How colour is controlled and secured*, the external input of colour material is often provided by persons who are not skilled in media production, or in printing methods and paper qualities. This makes the colour reproduction of the final product a crucial task.

Case 1: Premedia Advertisement

In this case, focus of colour reproduction is basically for one great customer, who in turn has advertising customers. This premedia workflow works for these customers, mostly with composing of advertisement. Each customer usually provides logotypes and/or various image media for the ads, though complete photo-ready material is seldom supplied. When the company makes the ads, they get a script of a varying quality from the main customer, demonstrating expected ad layout. There is no feedback directly to the final customers.

Colour management started in 1995-96 with a modest progress in later years, although colour management has become more stable since started with hardcopy proofing. The hard proof is not used during printing, but by prepress operators as colour proof and by customers as a receipt of colour agreement. Otherwise security of colour management consists in allowing a restricted number of formats in the database system and in using the same printing manufacturer. The colour fidelity, all the way to the final product is considered to be very satisfying despite being printed in a great number of editions on law quality paper.

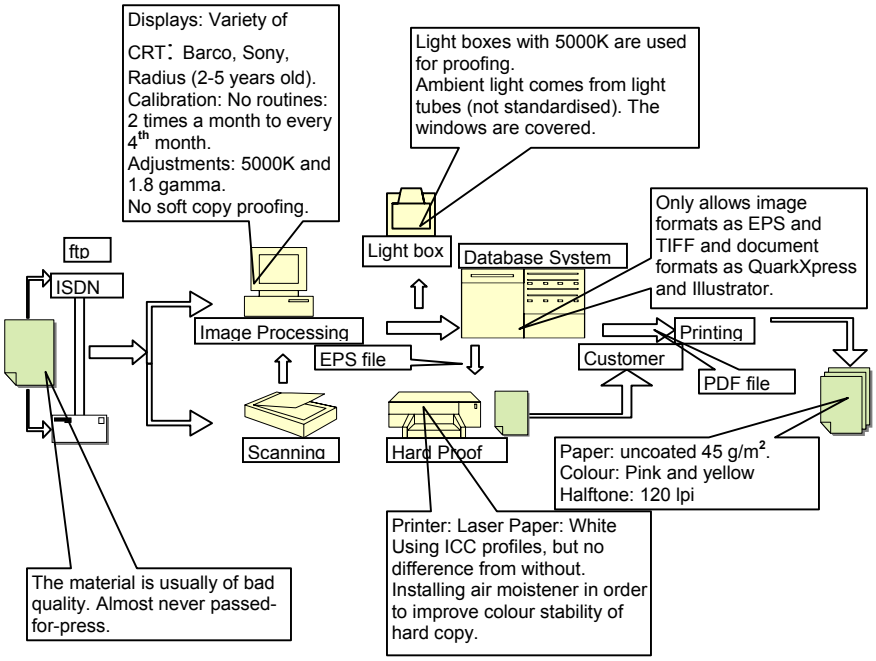


Figure 1. Description of premedia for an advertisement workflow.

Case 2: Premedia Weekly Journal

This workflow produces nine weekly journals and papers. The journals are printed in heat-set on uncoated paper, unlike the other products of concern for the present paper. They are of interest for comparison, since the print quality is higher and the colour tolerance levels are lower. This demands better agreement between original and print. The workflow is interesting here, since this is one of the few premedia workflows, which uses only soft proofing as proofing method. Accurate image processing is considered more important for good colour reproduction than proofing. To offer colour fidelity, the workflow demands very precise colour transforming ICC profiles from their printing manufacturer. The premedia production is mostly in-house; the main customers are the editorial staff of the journals, located in the same building. The company has a separate advertisement department. The passed-for-press files are sent to the printing manufacturer digitally as PDF or TIFF files. The company is very satisfied with the colour fidelity of the printed journals. The edition printed on newsprint has less severe colour tolerances levels, since the colour variation is greater, caused by the paper quality and print method, which makes correctly displayed soft proof harder to achieve.

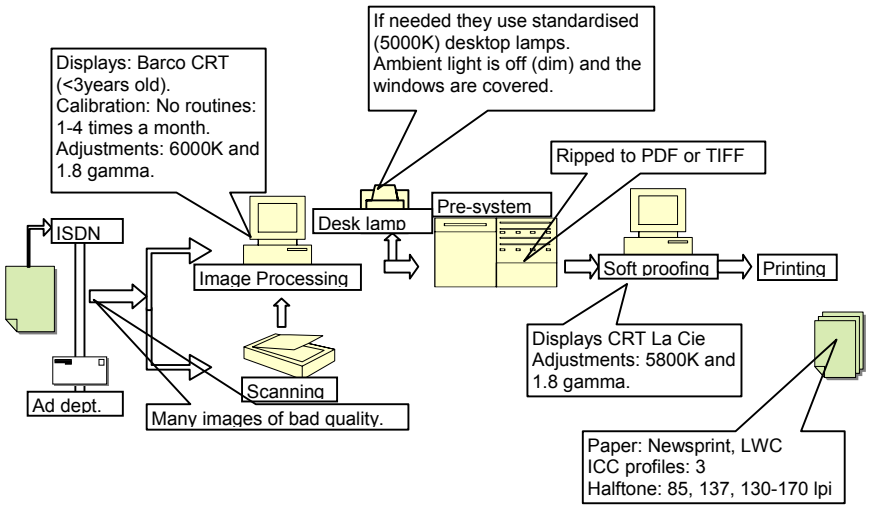


Figure 2. Description of a premedia workflow for production of weekly journals.

Case 3: Premedia Newspaper

Newspaper workflows usually consist of either premedia and editorial workflows or premedia and press workflows. The first type of workflow produces, besides a newspaper, supplement papers printed by different printing methods, usually on a weekly basis. The second type of workflow, most likely focusing on press, produces besides a newspaper, a number of other printed matters, such as other newspapers, papers, journals, folders and advertisements.

The advertisements are the most important colour reproduction in a newspaper, since they are a great income for the newspapers and misprints could be costly. In Sweden most newspaper companies use TU's standard, [TU, 03], for handling advertisement materials. Usually the advertiser sends a digital file with the passed-for-press ad. Unfortunately many advertisers are not skilled in graphic arts, and this results in time-consuming restructure of ads. To avoid this, some newspaper companies offer technical support to their customers as well as the possibility to look at a low-resolution composite file through the Internet, soft proofing, but without colour management. Most press workflows use Computer-to-Plate (CtP) and the final print is usually controlled by grey balance bars and hard copy proofs. Generally the "human factor" is considered to be the greatest cause for mistakes in the workflows. Many newspaper companies are committed to present and future developments of their graphic arts production.

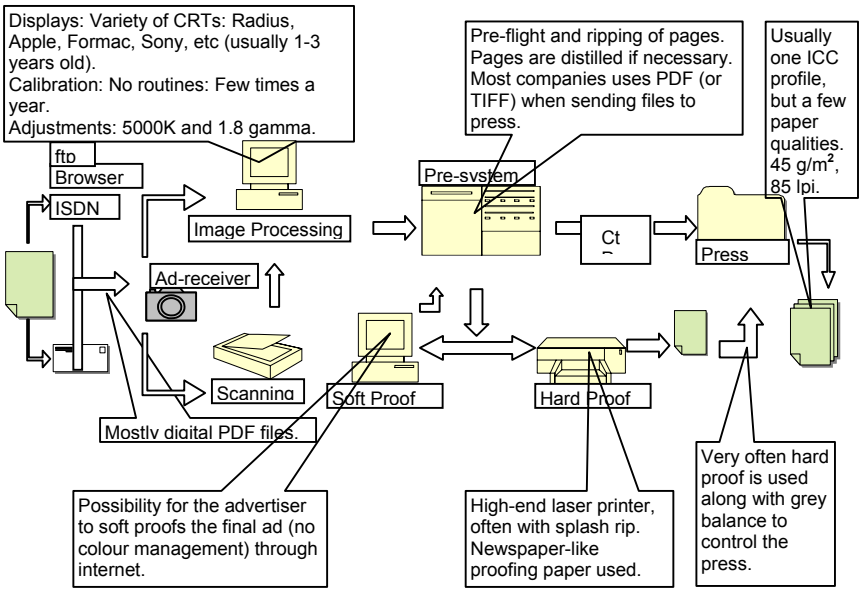


Figure 3. Description of a premedia workflow of newspapers.

General overview of presented workflows

Customer complaints of printed matters in workflows

All investigated workflows claim to have had very few complaints from customers, according to the answers received from the questionnaire, presented in Figure 4, generally not related to colour issues according to the printers, but to miss-register, smear, tinting and false spreads. A few complaints are related to the advertiser's unawareness of the actual quality of a cold-set print.

Bottlenecks in the workflows

The greatest bottleneck is found in the quality of the material sent by the advertisers. The material is often incorrect and may contain erroneous formats, images of too low a resolution, missing parts (images, fonts), insufficient image quality or non-separated images, just to mention some common problems. Often the premedia division or company, offers a service of correcting or making ads for the customer and/or supports the customer in other ways, e.g. to buy and handle display and software.

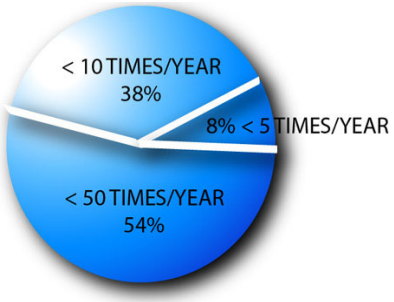


Figure 4.

How often the companies get complaints related to colour.

Inertia in correction and updating of the print ICC profiles is inherent in the workflow, according to the prepress companies. They think it would be to the interest of the printing manufacturer to provide an ICC profile that is as correct as possible. However, there is a variation of keen ears of the printing manufacturers, in meeting the wishes from their prepress customers.

Strength in the workflows

Flexibility is an important part in colour workflows. By this means for example the ability to print new editions with short notice and still get the edition distributed in time. In the prepress workflow, the flexibility lays in the ability to deliver low quality material passed-for-press. Also their employees that have the task to support the advertisers and to develop the prepress and colour management systems, is a basic part of stable colour management according to the workflow operators.

Ongoing/Future developments in workflows

Many premedia and press managers are satisfied with their reproduction workflow, Figure 5, thus, automation and increased efficiency of workflow configurations and control routines, as well as increased knowledge of colour management, need to be developed. Another important part in future developments of colour management workflows is to integrate of the advertising customer further to the premedia production, e.g. by developing existing web-based advertiser systems, principally resulting in increased automation.

Sublima halftoning is yet not much used for newsprint, but it is of increasing interest for the printing manufacturers. Still it is expensive and gives problem with sharpness and more.

Another part of the future development of the traditional printing workflow is the increased convergence with other media [Ifra, 02].

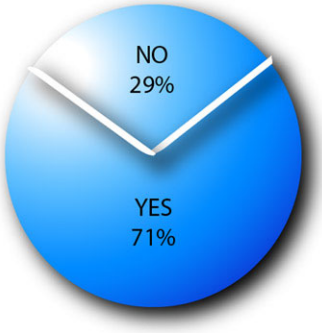


Figure 5.

The satisfaction with existing reproduction workflow according to newspaper companies.

HOW COLOUR ARE CONTROLLED AND SECURED

The traditional graphic arts workflow consists of two major production areas: prepress and print manufacturing (press and postpress). Major premedia functions include design, image, editing, and proofing. From this point of view, prepress could be defined as premedia. The reason for this term is that, to a large extent, the creation, design and layout processes in media production are, initially, independent of the medium reproducing the final product. For printed media production, this means some additional prepress preparations, depending on the equipment used for production, the required quality etc [Kipphan, 97].

At present the production of the publishing industry is driven primarily by requirements for high-quality advertisements (ads).

Efficient attainment of desired colour in prepress depends on accurate capture followed by aesthetic adjustments that are sometimes guided by a proof simulating the final output. Print operators mainly control the colour by grey balance bars, visually judged and/or measured density, in many cases together with a hard copy proof. In many markets, such as publication of advertisements,

the requirement of reproducing an ad identically across a multitude of output devices implies a need for well functioning and well-managed standard colour methods. In many colour workflows, opinions concerning colour system are that; prepress responsibility is fulfilled if the proof accurately simulates the intended characterisation. The responsibility of print manufacturing is fulfilled when the final print product matches a valid proof [Kohler et al., 99].

Colour fidelity in premedia workflows

In order to get an idea of the impact of calibration tools and routines used in colour workflows, a questionnaire was sent to 96 of the newspaper companies in Sweden. The number of questionnaires retrieved (14) did not allow statistically based conclusions, but the results were used to support earlier assumptions, based on numerous interviews. Thus, they were regarded as well suited for qualitative judgments.

The questions asked were based on standard issues used in the workflows. The answers can be summarised as follows:

LCD displays are yet less used than CRT displays, Figure 6, and almost never in case colour control is used for image processing. The only premedia using LCD displays are newspapers.

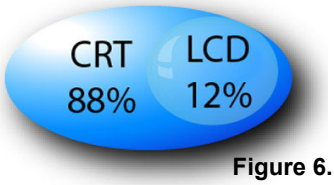
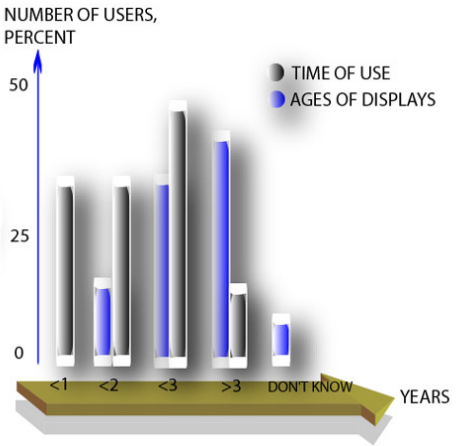


Figure 6.
Display types used in workflows.



Many workflows use new (one to two years old) display devices, but the frequency of exchanging the displays varies, as seen in Figure 7. Replacements are made when a display seems unstable, rather than after a certain period of time.

Figure 7.
Time of use of displays in colour workflows and age of these displays.

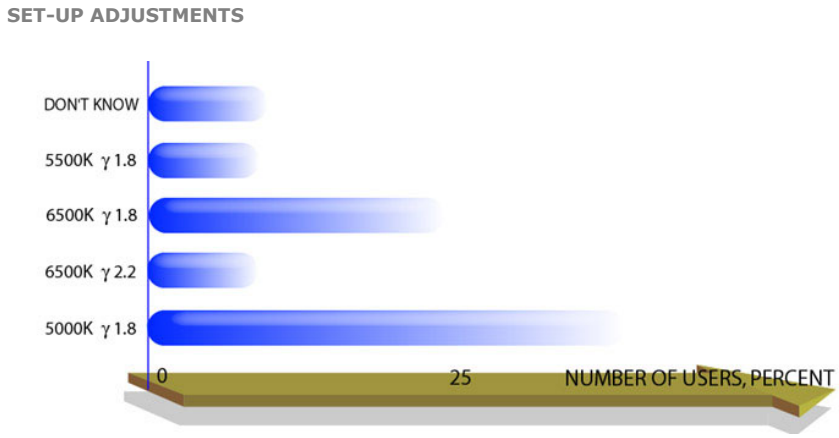
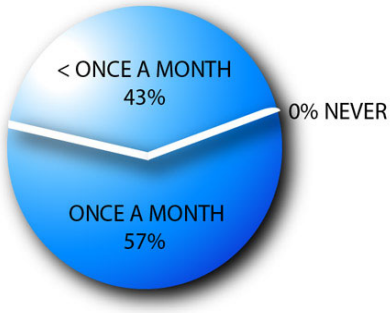


Figure 8. Display set-up used in workflows.

Less than 40% of the workflows use the graphic arts standards as set up for their displays Figure 8, the rest chose another set up because it fits them better, they do not consider calibration of their display as important or they lack the knowledge. Surprisingly enough, they all calibrate their displays, or state they do so, Figure 9. The importance of display calibration is considered to be very important or quite important, Figure 10.

Figure 9.

Frequency of display calibration for displays used in workflows.



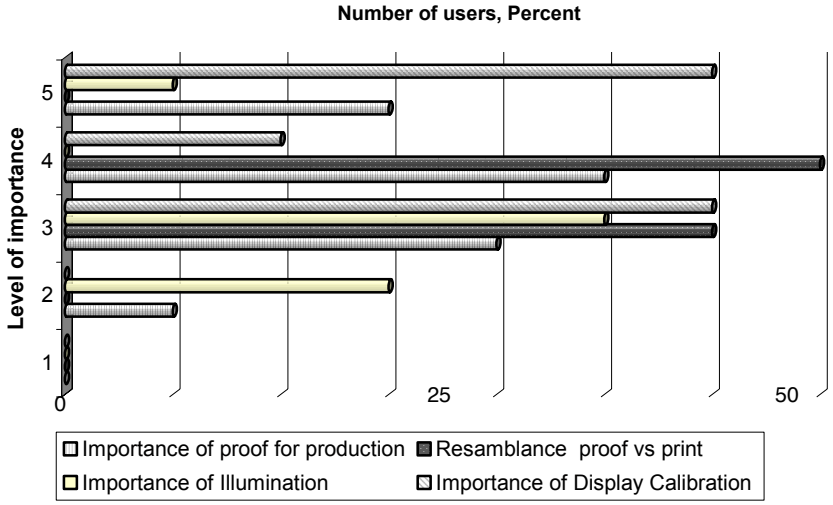


Figure 10. Importance for the production workflow of using proofs, standard illumination and display calibration and resemblance of proofs.

Many newspaper companies, Figure 11, commonly use proofs as a control method in the printing production workflow. When soft proofing is used, usually no colour management is (yet) involved. The use of proofs for control in the colour production is considered quite important and the resemblance between the proofs and final print are considered slightly divergent, Figure 10.

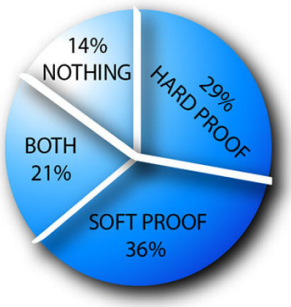
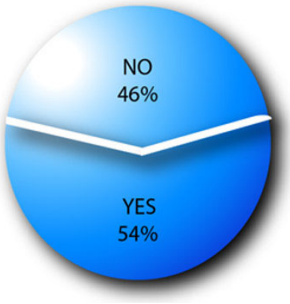


Figure 11.

Proof types used in workflows.

As for standard illumination, about half of the companies claim that they use standard illuminants, Figure 12.

Most of them use neon tubes with no interference of daylight, Figure 13, even though about 40% do not know the temperature of the illumination used, Figure 14.



If standard illumination(s) is used in workflows. **Figure 12.**

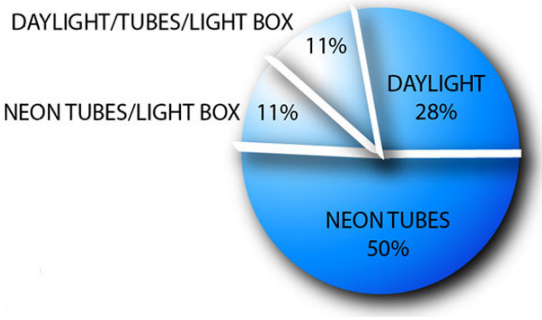


Figure 13. Types of Illumination(s) used in workflows.

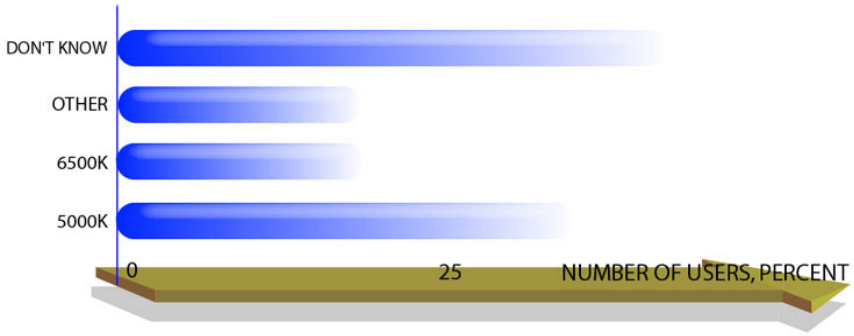


Figure 14. Illumination set-up used in workflows.

It is not often controlled if the standard illuminants produce the right spectral and intensity values, Figure 15.

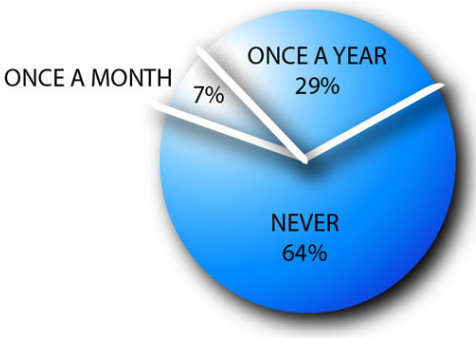


Figure 15.
How often the illuminants are controlled in keeping standard values.

Surrounding characteristics and configurations of devices, Table 1, play an essential part in the appearance of colour. Two of the same colour patches presented on an identical medium and with identical viewing geometry will usually not match visually if the surroundings are different, even though they are measured to have identical XYZ values [MacDonald, 96].

Parameter	Real scene	CRT display	LCD display	Print in office
Type of medium	Mixed	Self-luminous	Lamp	Reflective
Dimensions	Dynamic 3-D	Dynamic 2-D	Dynamic 2-D	Static 2-D
Illuminant type	Sun+light	Self+ambient	Self+(ambient)	Lamps-Daylight
Luminance (cd/m2)	1000-5000	50-120	200-500	150-500
White point (K)	2000-10000	5000-9300	5000-9300	2700-4500
Surround	Light	Dark-light	Dark-Light	Light
Dynamic range	1000:1	100:1	400:1	50:1
Spatial resolution	Ideal	Low	Low	Very low
Colorants	Mixed	Phosphorous	Filters	Ink pigments
Colour gamut	Very large	Large	Large	Medium

Table 1. Characteristics of different media [MacDonald, 96].

Unfortunately, typical real-world viewing conditions cannot achieve all conditions and colours that have identical XYZ values look different in practise and vice versa.

Colour fidelity control in press workflows

Almost all of the 172 newspaper companies in Sweden, [TU, 03], use the same printing method; cold-set web offset printing; they have mostly the same paper quality and use European Standard ink, and print at the 61, [TU, 02], newspaper printing manufactures.

There are cost advantages of using cold-set above heat-set. Cold set makes it possible to print on lightweight newsprint qualities, which reduces the cost for the paper and distribution, which is 29%, [TU, 02] of the cost of producing newspapers. Since the heater, using as much energy as the press, is left out, the energy cost is reduced. The disadvantage using cold-set printing is the difficulty to get correct colour reproduction because of the low-quality surface of the paper and the fact that the ink never dries, which causes unwanted effects like smear.

The colour control made by grey balance is mainly used for newspaper printing. A grey balance strip usually consists of a number of bars placed at the border of the page across the printing direction. The standard, advertised by the Swedish Newspaper Publishers Association (TU), recommends a grey balance mix consistent with 30% of Cyan colorant and 22% of Magenta and Yellow, which should agree with the amount of black colorant [TU, 03]. The TU recommendation advocates colour control without any proof, and the grey balance bars are supposed to mostly be controlled visually. When the colour impression of the page visually gives an impression of a deviation, density measurements are made. Grey balance has many advantages in time strained press workflows, such as newspaper printing. However, the colour fidelity in this workflow is affected because the number of grey balance bars is often a compromise between layout and the number of colour keys on the press, thus there are usually too few grey balance bars to cover the page evenly. Another problem could be the ambient light in which the colour prints are being viewed. The light in the press control room usually originates from non-standardised light tubes. This means that the spectral and intensity level varies, and this results in colour infidelity.

When the colour is controlled by density, full tone surfaces are measured. The Swedish recommendation for newsprint specifies density means for the chromatic colorants (C, M, Y) by tolerances between 0.80 and 1.00, and for black colorants, between 1.00 and 1.20 in full tone surfaces [TU, 03]. High values in the full tone density, without smear, yield high contrast. The problem when considering colour fidelity is that significant colour variations result from the approved tolerances between 0.80 and 1.00 units. Research of colour variations of the Ifra [Ifra, 03] density-standard, has shown that for CMYK-colours printed by three and four colorants, large variation of reproduced colour are implied, as well as when low area coverage or area coverage in the midtone range is reproduced [Wintzell, 02]. This implies that a colour printed within the standard, might become a variation of 16 different colours. This can definitely

be a problem when an advertising customer is not satisfied with the printed ad. The colorants in the ads are within the tolerance recommendation, proving that the newspaper company has printed a correct ad, but the customer visually gets a quite different ad compared to the original.

PROBLEMS AND POSSIBILITIES

Colour management is not new in the graphic arts industry, however, the tools are developed constantly, although implemented a little slower. There is still an opinion that the ICC standard leads to an automatic increase of image quality, resulting in disappointment when this is not the case. The ICC standard is a powerful tool to attain an optimal quality, but the judgement of competent operators, skilled and experienced in a workflow that is consistent with high quality equipment and qualitative routines, is still of great importance. Essential for obtaining colour fidelity is also the preparatory work; evaluation of the ICC profile(s) to be used, i.e. if the profile accurately refines paper quality and white point, as well as employment of stable and consistent hardware.

Due to the complexities involved, manufacturers of print media often provide specific guidelines to advertising customers, enabling them to set their document colour control attributes as required for the print workflow. These guidelines are usually provided on the Internet. In many cases the prepress-operators are not satisfied with the information given on the company web site; incorrect information and too little information is given and/or it is too hard to find.

If the printed matter has met the requirements of prepress, a correct ICC profile is used, and correct measurement is made of density and/or grey balance, a proof should not be necessary, during printing. The press-operator should be able to just apply the measurement parameters. In case of an already existing hard proof, it is difficult for the press-operator to know if this hard proof is correctly done. If the customer is present during printing, the adjustments usually differ to a higher extent, as do the waste of copies, unlike when only grey balance or density control methods are used. Some newspaper companies believe that incorrectness concerning advertise printing has decreased by reintroduced (hard copy) proofs.

Especially when display reproduction is essential, e.g. during image processing and soft proofing, even in well calibrated, well managed ICC workflows, problems with colour fidelity may occur because of software based on different specification may differ across markets, and between imaging component vendors. Deviation in software may even occur between programs distributed from the same vendor, as older program versions might not support colour management or free ware and full version might have different colour engines, resulting divergent reproduced colour impact. The latter is shown in PDF files reproduced in Adobe Acrobat compared to Acrobat Reader, where the Reader-

version will appear to be of higher contrast and of more saturated colours. Similarly, exchange of characterisation data is limited by restrictions in document and image formats. For example, common document and image formats do not support embedding of ICC profiles [McCarthy, 02].

For newsprint qualities, colorants printed with three or four colours are more likely to vary in density when printed. Especially when magenta is present these variations are prominent. Red and blue hues are consequently more sensitive to density changes than green and yellow colours [Wintzell, 02].

Soft proof and Hard Proof

When considering colour fidelity, workflow and management of a stable and consistent system, the aim of the final product must be considered, especially for proofing method(s) and for the control of the printing procedure.

Prepress workflow that uses only soft proof claims to have an agreement between proof and print of about 90-95%, though some colours are harder than others to reproduce correctly. It is easier to get similarity between proof and print for journal paper (and better) qualities than for newsprint qualities naturally. At present the poor properties of newsprint appearance cannot be reconstructed completely on any proof media. The colour quality of hard copies used to resemble newsprint would never be accepted in sheet fed printing production, but is considered as satisfactory proofs in web offset cold-set printing.

Arguments against merely soft proofing have been that print problems related to halftoning, such as overprint and moiré, cannot be discovered. This might be possible to discover in the ripped version of the document, but not for sure. These are mistakes belonging to the starting phase, and they will disappear by knowledge of the workflow. In workflows with repetitive production process it is easier to get a successful dividend of soft proof as well as proofing media, as in workflows with higher colour tolerance level. Investigated workflows fit in both these contexts, i.e. newspaper, journal and catalogue production, and medium to low quality advertisement prints.

In many cases hard proof is considered necessary, and one of the pronounced reasons is the customers' claim for it. Such a case is mainly psychological, since the environment (at the customer's) where the proof is judged is unlikely to be standardised, and it is a source of income for the producer, because a high quality hard proof is costly. The use of soft proof in a prepress workflow instead of hard proof saves money by reduction of time consumed as well as of equipment and materials.

Displays are not made much use of for proofing during printing by today's printer manufacturers. This is surprising, especially for cold-set offset. If proofs are used as a complement to grey balance control, the proof is a hard copy of

varying colour divergence from the actual print. With visual control methods (common in press workflows) problems with colour fidelity will occur, if the ambient light is not standardised. In such a case an accurate display would probably deliver higher colour approval, and even more so with standardised surrounding illumination, along with software supporting colour management and routine calibration. The cost for high-end displays will soon be paid off by the reduced cost for hard copy materials

Today, hard copies still serve as a control issue, sent by an uncertain non-skilled advertiser as a complement to the digital ad. Then the premedia operator receiving the ad can form an opinion about the correctness of the digital file. This has one main drawback; automation is prevented, i.e. the procedure becomes time consuming. By using soft proof through web browsers a hard proof would not be necessary. Many newspapers already use this possibility. Their customers log in by a browser on the newspaper web site to check a composite version of their passed-for-press file. This serves as an acceptance that the passed-for-press file is correct and as a receipt for the customer that the ad looks like it is supposed to do. Existing soft proof workflows do not (yet) utilise the possibility of correct colour reproduction for their software, but with accurate colour management, it could lead to reliable automation of the advertising workflow, and would reduce the need for any "just in case" hard copy ad.

Hard copies are also accompanying digital proof by very concerned advertisers; an advertisement for, for example, the cloths manufacturing company Grant, a very concerned advertiser, is to be printed in 70 different newspapers or magazines. The company might bring even a contract hard proof, which is often considered to be the most accurate proofing method, but it would not be of any use if not 70 different ones are sent, since all newspapers or magazines have their own printing parameters.

CONCLUSION

In a given workflow, the desired colour depends on the calibration of the devices and can only be as good as the measurement process employed in the calibration and characterisation to maintain consistent colour appearance in the colour production over time. Neglect of correct standard parameters such as well adjusted ambient light and ICC profiles, has no severe influence on the colour output in a workflow using cold-set printing, but the possibility for maximum throughput and minimum interference of operating skill is reduced, including time and material expenses. Improved efficiency and automation would also include reorganisation of existing methodology, to make more use of technically advanced facilities, (reliable equipment and routines), for colour management, such as displays and remote features. Use of soft proof instead of hard proof throughout the printing workflow is fully possible, in-house, and as remote

proofing; for customers, premedia operators and printers. Workflows producing higher colour tolerance levels as, cold-set printing products and repeatable printing production, like newspaper and journals, would gain assurance of a consistent and reliable colour reproduction flow and result in automation and flexibility of the colour media production.

Within premedia and print workflows, colour aims are based on experience with prepress and press capabilities. Reorganisation of methods and routines includes preparation. Before optimised results can be delivered, time and knowledge have to be allocated.

FUTURE INVESIGATIONS

In future investigations perceptual experiments will be carried out to specify the actual variance of importance of different calibration and standard parameters for the visual perception of colour.

In further investigations it is of interest to know how well (how close to the specified standards) surrounding, characteristics and configurations of parameter tolerances need to be determined, e.g. ambient light, display temperature, as well as devices techniques used, in the affection of tolerable colour reproduction environment.

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