

High quality printing – Hi-Fi printing

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ABSTRACT

This paper explains the techniques of Hi-Fi printing, as well as their advantages and disadvantages. Hi-Fi printing, as a group of printing techniques, emerged somewhat recently, at the beginning of this century. It represents a step forward in producing realistic reproductions of the original. Therefore, it enables increased printing quality and entrance into the new era in printing. In addition to the standard C (cyan), M (magenta), Y (yellow) and K (black) colouring agents, the Hi-Fi printing features include the use of additional colorants which provide gamut extensions. This paper is a review paper, based on information available from public sources. The paper also presents several examples of these Hi-Fi printing procedures practical application.

Keywords: High-Fidelity (Hi-Fi) printing, reproduction, gamut.

Introduction

The fundamental purpose of Hi-Fi printing is to achieve the best possible reproduction accuracy. The idea of a Hi-Fi colour reproduction started in 1972 by publishing Harald Kupper's theory described in the "Die Farbenlehre der Fernseh - Foto - und Drucktechnik". It defines the application of basic printing dyes with the addition of red, green and purple-blue. Based on this system, German colour manufacturers soon developed the so-called "Kupper colorant set" (CMYK + RGB), i.e. a set of seven basic colours for colour printing. However, the Hi-Fi printing came to be used as late as the early nineties of the twentieth century, and has not achieved wide commercial use yet. High Fidelity or Hi-Fi printing is defined as the technology of reproduction which increases print quality above the acceptable limits of the classic four-colour printing. This includes some changes in comparison with the standard four-colour process that will allow printing in a wider range of colours. Nowadays, the customers expect more from the traditional media. Printing technology must try to catch up with the expectations of its clients. In order to achieve a faithful reproduction, the printing seeks to expand the range of colours that can be reproduced, i.e. an increase in the colour gamut. It is for this reason that the technique called Hi-Fi printing was developed in the first place. Its application increases print quality by spreading the gamut of the output device and thus increasing the authenticity. Hi-Fi

printing aims to approach the colour range found in nature. Reproduction of colour tones such as: some orange, violet, specific red, blue, purple and green tones; is not possible with the conventional CMYK printing. It is these tones that represent the focus in Hi-Fi printing reproduction.

Hi-Fi printing

In response to the desire to increase the gamut, i.e. the range of colours that can be reproduced in printing, the Hi-Fi (High-Fidelity) printing was developed. It represents printing with additional dyes, namely, CMYK + additional colorants. Because of the desire to achieve as genuine and as realistic reproduction as possible, this printing was named high-fidelity printing. Additional dyes provide a more realistic representation of the colour spectrum in the print. The term Hi-Fi printing dates from 1972 when it was first described by Harald Kupper in his theory. The Kupper theory represents the extension of gamut usage in printing by applying pigments of greater purity and adding orange, green and blue dyes. The application of Hi-Fi printing begins at the end of the 1990's. The development of High – Fidelity printing in colour began with technological research conducted by experts in labs, in the production (manufacturing) programs. Hi-Fi colour printing is successfully used in creation of new theories and methods and seeks to correct major deficiencies in conventional printing with four basic colours, i.e. to bring the visual effects

of colours closer to the actual scene. A vivid, richer, and more realistic imprint with a stronger three-dimensional effect is obtained.



Figure 1: On the left: standard CMYK printing reproduction, On the right: Hi-Fi printing method reproduction

The advantages of Hi-Fi printing were quickly accepted by graphic designers, as the expanded Hi-Fi colour gamut enables creation of more realistic and vibrant tones. It is most commonly used in package printing (especially luxury ones), security printing and printing of high quality and luxury graphic merchandise.

Hi-Fi printing techniques

Five to eight colours are used in Hi-Fi printing techniques. It is possible to use several different methods of printing. These are the most commonly used techniques:

- Hexachrome
- Opaltone
- MaxCYM
- Printing with additional lighter dyes
- HP IndiChrome
- Printing with increased concentration of pigment and richness of dyes
- Printing with additional mixed dyes (one or more)

Hexachrome printing

Hexachrome printing represents printing developed by Pantone in 1994. It is printing with six colours, i.e. CMYK + OG, which means four basic colours plus the addition of partially fluorescent orange (O) and green (G). Pantone developed this technique because, at that

time, many printing shops had had printing presses with six printing units. Hexachrome is the oldest and one of the most used Hi-Fi printing techniques. The reason originates in the fact that its usage increases orange, green and partly blue parts of gamut, causing significant increase of the print quality for the human eye. Additionally, this technique does not require having more than six printing units and thus belongs to the cheaper versions of Hi-Fi printing, because some of them do require up to 8 printing units.

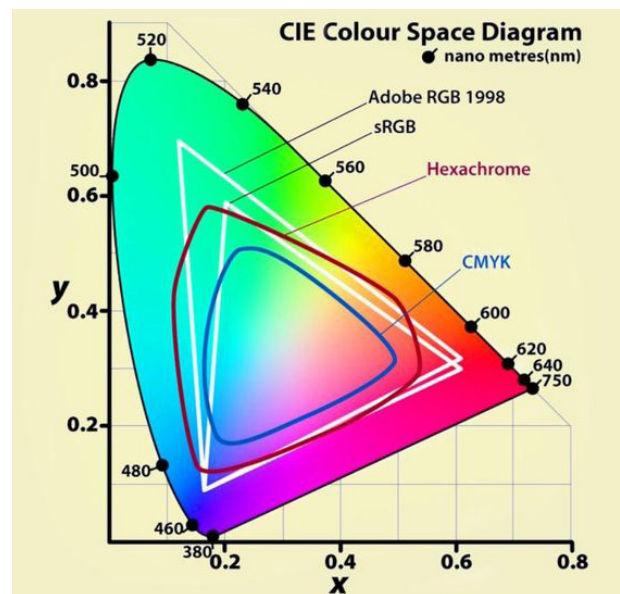


Figure 2: The diagram shows the chromaticity of colours visible to the human eye in which the red line represents the Hexachrome gamut, blue colour represents the CMYK and white represents sRGB (lower) and Adobe RGB (higher)

However, the Hexachrome printing can neither use the standard CMYK dyes, nor the standard or mixed orange or green colours, but more distinguished specially designed Hexachrome colours. CMYK colours for Hexachrome printing are somewhat lighter due to the characteristics of the ICC profile, i.e. the settings, so that fidelity deviations from the original would not occur. Hexachrome printing is used when we want to improve the quality of prints containing green, orange or blue tones, as it does not increase the quality of the prints which do not contain these tones. The application of this technique enables the printing presses to reproduce gamut larger than the gamut of the monitor which penetrates even into fluorescent and pastel areas. In addition, Hexachrome can reproduce 90% of the Pantone Matching System tones, while the standard CMYK printing can reproduce 55% of these tones. To eliminate the

Moiré effect, orange is printed at the same halftone angle as the cyan, while green is printed as magenta. The Hexachrome printing deals with the problem of controlling dye application, because it is impossible to apply 600% of coating due to possible problems in drying, besmearing and fingerprint deformation. This can be controlled via HexWrench software that has three options: normal coating, thin coating and a thick coating.

Opaltone printing

Opaltone printing was developed in 1998 and represents 7 colours printing or CMYK + RGB, four primary colours plus red, green and purple-blue. Less than seven colours can be used as well, if the motif permits so. It is not necessary to use special CMYK colours in this type of Hi-Fi printing, as the printing is possible with the standard CMYK as well. This method is based on Harald Kupper's method in the following manner: we place the colour, resulting from the two CMYK colours overlapping, in the area, where the CMYK colour overlapping occurs. For example, we put green colour in the area where blue and yellow overlap. This is why there are no problems with regulating the coating application of dyes when using this technique. The coating is even thinner than the one used in the four colour printing.

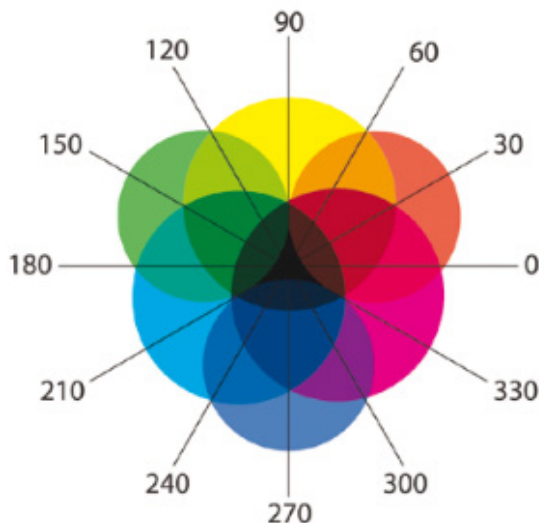


Figure 3: The additional RGB Opaltone dyes perfectly fit into the spaces between the CMYK dyes

This technique allows much easier colour balancing. For example, when using the standard four-color print, even the slightest variance in the percentage of colour, which contains 50% magenta and 50% cyan, results in a tone deviation. In Opaltone print, the 50%

magenta and 50% cyan is replaced by purple-blue dye. [6] Opaltone can be used in conventional and digital printing techniques (Opaltone Inkjet). When it comes to the AM halftoning, red has the same angle as cyan, green as magenta and purple-blue as yellow, in order to allay the Moiré effect.

MaxCYM printing

MaxCYM is a Hi-Fi printing method which adds CMYK dyes to the standard CMYK printing process (CMYK+CMYK). Any CMYK colour can be added, so it represents a 5 to 8 -colour printing. The MaxCYM approach was first used by Royal Zenith. An increase in coating increases the colour gamut and reproduction quality (1-4 colours).

Printing with added lighter dyes

Printing with additional bright dyes is a Hi-Fi printing method which, in addition to the basic CMYK dyes, uses the light cyan (Lc or c), light magenta (Lm or m), representing the CcMmYK abbreviation. Some printing systems use the light key (Lk or k), which then becomes the CcMmYKk printing abbreviation. White pigments are added into these dyes. Using this technique enables a better contrast in reproduction and a less visible raster element, as well as enables smooth transitions from light to dark tones. Today, Inkjet printers for photographic printing use this system with at least six colours, i.e. CMYK + light cyan and light magenta.

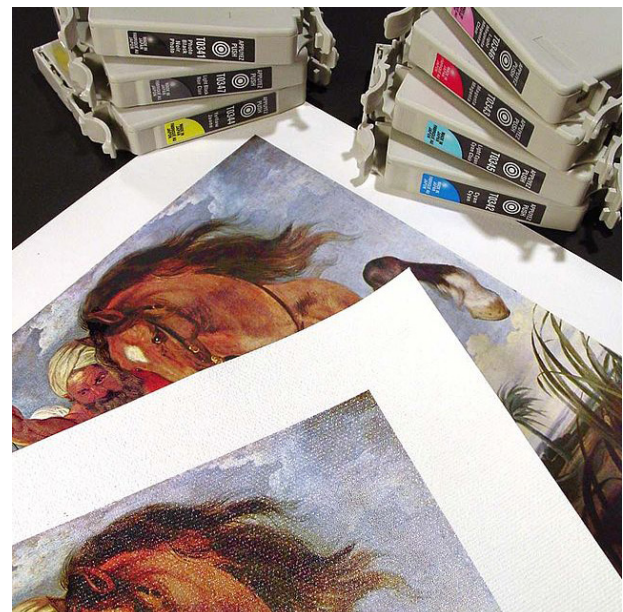


Figure 4: CcMmYKk technique of the Hi-Fi printing representation on paper and canvas; the upper part of the Figure shows dye containers

HP IndiChrome printing

HP IndiChrome is a kind of Hi-Fi printing developed by the HP (Hewlett-Packard) company. This is a typical method of Hi-Fi printing used only for the purpose of HP Digital Colour Offset technology. It uses additional spot ink dyes and bright colorants with standard ElectroInk colorants. There are a number of different types of this printing method:

- onPress (CMYK + OV) - standard CMYK printing with added orange (O) and violet (V);
- Plus (CMYK + OVG) - standard CMYK printing with added orange (O), violet (V) and green (G);
- offPress (CMYK + OVG + reflexive-blue, bright yellow, rhodamine red, fluorescent orange).

HP IndiChrome onPress and Plus can reproduce a wide range of Pantone colours without the need to install special spot colours. No additional mixing of spot colours is required. They can be reproduced by using additional colours directly in the machine. This brings dramatic vividness of colour reproduction which is difficult to achieve by regular printing, such as light orange and dark blue. HP IndiChrome offPress is able to reproduce 97% of Pantone colours using up to 11 colours. By using 11 colours, HP IndiChrome offPress is able to produce any of the Pantone spot colours. Thus the reproduction of more than 3.000 Pantone colours becomes possible.

Printing with increased concentration and richness of pigments

This method is actually a method in which additional dyes are not added, but instead, it represents a highly-pigmented CMYK printing. Unlike the classic CMYK colorants, these CMYK dyes have a higher concentration and richness of pigments. At constant imprint thickness, the reproduction has higher colouring density and therefore a greater gamut. The disadvantage is the fact that these dyes are still somewhat more expensive than the standard ones.

Printing with additional mixed dyes (one or more)

This technique is one of the oldest Hi-Fi systems because the lithographers printed multicolour reproductions with 6, 7 or 8 colours using lithography. In addition to the standard CMYK colours, this Hi-Fi technology uses additional colours that are used for increasing the reproduction gamut. Colours can have different effects (metal, fragrant, pearl, fluorescent ...).



Figure 5: A magazine cover photo print with a fluorescent dye

Advantages and disadvantages

Hi-Fi printing has not yet achieved full commercial use, even though the graphic industry companies are slowly beginning to realize its benefits. The slower development of Hi-Fi printing is mainly a consequence of the increased production costs. To perform this type of print with the conventional printing methods, a printing press with 5-8 printing units is required. If the printing shop does not have such a machine, the Hi-Fi print can be achieved through several repetitions of passing the item through the machine. The price of such machines is higher and the larger number of passes (repetitions) increases printing time as well, which also increases the cost of production. The need for additional printing forms and additional software solutions for colour separation also leads to cost increase. Due to the high cost of the final product, Hi-Fi is less used in conventional techniques, but it has increasingly high application with modern digital technologies. The reason is the use of cheaper satellite structures

in which the use of additional printing units can be easily enabled or disabled (with no additional costs or preparation). Another problem is related to AM halftoning and emergence of the Moiré. Apart from the halftoning quality, achieving an extremely precise passer is of the utmost importance because the slightest movement of the passer can lead to major problems with the Moiré.

Apart from using it with satellite constructions, High fidelity printing, can be cheaper than conventional printing methods when used with digital techniques depending on the amount of prints. Very small print amounts are often more cost-effective when printed with digital equipment because there are fewer steps involved in the process. Price per print is the same regardless of the quantity, unlike the conventional printing in which the smaller the amount, the higher the cost per print.

However, the number of printing shops which use Hi-Fi printing technique is gradually increasing. It is a consequence of all of the advantages this type of printing provides, such as: building a reputation, attracting designers and customers, better sales and making regular clients because of the unique offer. In addition, the main advantages of Hi-Fi printing are the gamut expansion, better contrast and colour definition, better reproduction of saturated colours, accurate colorimetric reproduction and thus better quality of the final product.

An example of Hexachrome printing configuration

ICC profiles

The colour management system (CMS) or colour reproduction management is an important segment of colour control in order to obtain as accurate and genuine reproduction as possible via different devices. CMS was developed in order to make high quality reproduction or colour conversion of images, which originated from a variety of sources and are to be reproduced via different devices, with minimum differences. CMS, therefore, represents a system which converts the colour data encoded in a single device (like the RGB scanner) into data for another device (such as CMYK printers) in such a way that the printed reproduction contains the same colours as those in the scan. In cases where the exact colour

matching is not possible, the result is supposed to be closer to the original colours.

ICC or the International Colour Consortium is an association / institution established in 1993, by eight leading companies in the field of colour reproduction. These companies are: Adobe, Agfa, Apple, Kodak, Microsoft, Silicon Graphics, Sun Microsystems, Fogra and Taligent. In the meantime, some companies have left the ICC, while a lot of new ones have entered. As a result, the ICC has over 50 members, including some of the strongest companies in the photography industry. The main activity of this institution is creating a standard of files (ICC Profiles), which describes the colour properties of a device. CMS, by means of the ICC (International Colour Consortium), coordinates the data, adjusts and adapts them if necessary. The most important segment of colour management represents the correct setup and use of ICC profiles which describe the specific device.

ICC profiles help us to get accurate colour reproduction when images are imported from a scanner or a camera, displayed on a monitor or printed. They define the relationship between the digital recording device, which receives or transmits, and the standard colour space defined by the ICC, which is based on a system of measurements, internationally defined by the CIE.

In this way, if we have a profile for each of our devices, e.g. scanner, camera, display and printer / printing machine, the fact that it is related to the standard colour space allows us to combine them, so that we get the correct colours when we transfer the images from the scanner or camera and when we print or display them on the computers screen. ICC profile is the profile which matches the specification of the ICC association. By aligning the profiles with these specifications, they can be replaced and properly interpreted by other users. Two main types of profiles are the source (input) and destination (output) profiles and are mainly consisted of data tables. Input profiles describe the devices which, simply put, digitalize the picture - cameras and scanners. Output profiles describe the devices which reproduce the image - primarily monitors and various types of printers / printing machines. When we use the real Hi-Fi ICC profiles, colour separation technology is different and considerably improved in comparison to the default RGB or CMYK conversion into the Hi-Fi colour technology. Separations that are used in the Hi-Fi ICC profile achieve maximum saturation. Therefore, it is currently better to print the reproduction using Hi-Fi ICC output profiles.

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Tisak visoke kvalitete - Hi-Fi tisak

SAŽETAK

U ovom radu bit će objašnjene tehnike Hi-Fi tiska te prednosti i mane korištenja ovih vrsta tiska. Hi-Fi tisak kao skup tehnika tiska zaživio je tek početkom ovog stoljeća i predstavlja približavanje što vjernijoj i realnijoj reprodukciji originala, a time i povećanu kvaliteta otiskivanja te ulazak u novu eru tiska. Karakteristika Hi-Fi tiska je da osim standardnih C (cijan), M (magenta), Y (žutog) i K (crnog) bojila koristi i dodatna bojila koja omogućavaju proširenje gamuta. Rad je preglednog tipa, zasnovan na informacijama dostupnim iz javnih izvora. U radu je predloženo i nekoliko primjera praktične primjene nekih od pomenutih postupaka tiska, koji spadaju u Hi-Fi tisak.

Ključne riječi: High-Fidelity (Hi-Fi, visoko-vjeran) tisak, dodatna bojila, reprodukcija, gamut.