Experimenting with Hifi-Printing Techniques

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Abstract

In result of the continued efforts to improve the quality of printed full-color images, new techniques, such as FM (or stochastic) screening or multicolor (the number of inks higher than the conventional CMYK) printing have emerged in recent years. The term *'hifi-printing'* links up these techniques. The new methods were first received with great enthusiasm but people engaged in research and experiments have also viewed them with criticism because of the problems with their practical applications. At VTT Information Technology, we have started research and experiments to study the potential of the new methods and their effects on the achievable print quality. In the experiments we have compared the various screening methods for printing high-quality products. The research was also carried out to find the bounds of the gamut when adding an extra color to the conventional CMYK printing. This paper reports the results of this research and the experiments and discusses the potential of the new methods.

Introduction

Competition with other media increases the demand for improvements in the print quality. However the hifi techniques have brought forth many questions to the printers. During 1994 it was written a report att VTT Information Technology about high fidelity printing. Information was gathered from literature, especially about new screening methods and multicolor printing. Hifi-printing methods found from literature were decided to tests with cooperation of local inkmakers, prepress companies and printing houses.

The purpose of these hifi-printing tests was to gain experience with Finnish printers in the new technologies and also in their use with conventional methods. The printers were willing to find out about their preparedness for the hifi-techniques, although the use of FM screening and additional process colors is not yet widespread.

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Printing tests

These printing tests were made with two presses. The printing machines and materials used are listed in Table 1. Two different ink series were selected to study the effects of the different pigment concentration on the color gamut.

Table 1. The machines and printing materials used in the test.

Printing machine:	Heidelberg Mov 48 x 65, 4-color
	Heidelberg Mov 48 x 65, 2-color (violet)
Inks:	Coates Lorrilleux
	Lotus (CMYK), Eurostandard.
	Diva (CMYK), High pigmented
	Process colors (OVG): Orange 021C, Violet C, Green C
Water:	SICPA 1,5 % + IPA 10 %
Paper:	Galerie Art Silk 150 g/m2
Plates:	Fuji FPSE 0.30
Blankets:	Fuji Kura
Films:	Kodak Scannex 2000 SLD SO 595 (AM- ja Diamond Screening)
	FUJI Laserfilm PR-F100, 0.1 mm (UGRA Velvet Screening)
	AGFA G9713 HN (Agfa CristalRaster)
	Dupont CR-4 (Scitex FullTone)

The different screening techniques were used with different films and imagesetters, except that Hell-Linotypes Diamond Screen and 80 l/cm AM-screened films were produced with the same imagesetter and film.

The test form was printed through three different print runs on two days. On the first day only violet was printed and the other colors with two runs on the following day. Selected color sequences are shown in Table 2. Orange, violet and green were the same for both Diva and Lotus color series.

Table 2. Color printing sequences

First day, 1st press: violet (2-color machine)
Second day, 2nd press: black, magenta,cyan,yellow, (4-color machine)
Second day, 3rd press: orange, green, yellow,(4-color machine)

Test form

Figure 1 shows the test form layout. At the top of the form there are color control bars for seven colors. There are four FM-screened tone scales for each screening method (listed from left: Scitex FullTone, UGRA Velvet Screening, Agfa CristalRaster, LinoType-Hell Diamond Screen) and a conventional 80 l/cm screening. Dark (82-100 %) and light (1-10%) tone patches increase by 1 % and the middletones by 10 %. The test form has also resolution control figures separately for the resolution analysis of AM and FM screening. On the right in the middle there is a black-and-white image split diagonally by two screening methods, i.e. the Hell Diamond Screen and the Hell 80 l/cm screening. Also selected color images (flower bunch and textile composition) were printed with the Hell-Linotype AM and FM screening technologies. At the bottom of the test form there are color patches for six chromatic process colors (without black) and their tone scale combinations printed with the UGRA Velvet Screen.

Assembled specimens

Three different increasing inking levels (L1, L2, L3) were printed with the Lotus colors and each level had 300 test sheets. Specimens were chosen from the inking level L2 to test the

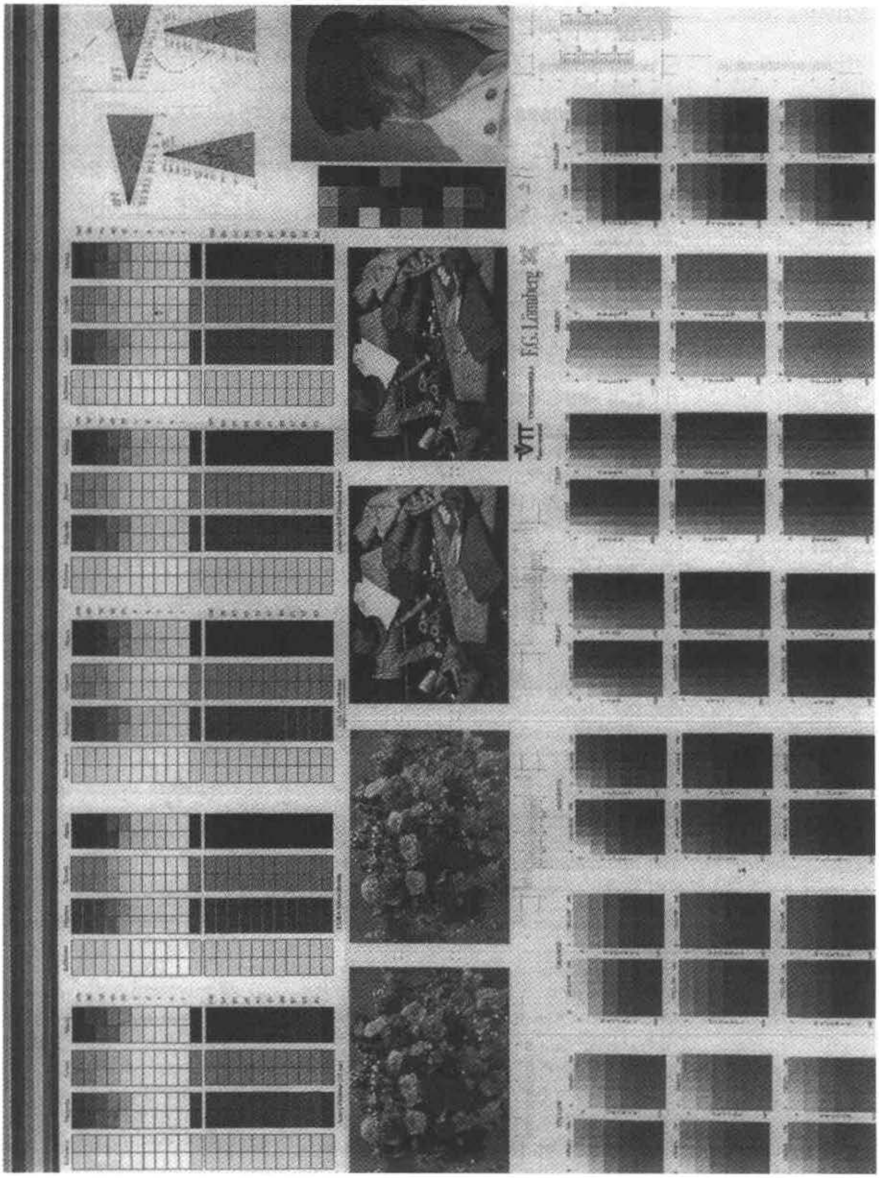


Figure 1. Test form

effects of misregister. The Diva colors were printed with two decreasing inking levels D1 and D2. The densities and tone scales were measured for each specimen and inking level. Four parallel measurements were done and their average value was used as the result.

The densities and coverage areas were measured with a Gretag D186 densitometer with 47B/P filters. The dot coverage of the films was measured with a Dottie 2-densitometer and the measurements from the plates were made with the D186 Grerag densitometer. Comparisons with the microscopic and densitometric values from the plates showed that they corresponded well. The color values and their spectra were measured with a Gretag SPM 100 spectrophotometer.

Test constraints

These tests have a number of limiting factors for the accurate analysis and comparison of the new techniques. A few words about them clarify the constraints of these tests.

We had one test form for both AM and FM-screened images. Thus the inking levels were adjusted to FM-screened test patches. So, the contrast, trapping and dark areas were not optimized for the AM screening. Also the imagesetters were from different prepress companies or printing houses and they were not optimized or linearized for these test materials. The situation resembles then printing jobs that use image materials with different screening technologies from different sources. This test print does not compare strictly different hifi-printing technologies but goes through the difficulties that the printers may have in their work.

Density levels

Table 3 gives the maximum densities for the compact areas with different inking levels and screening types. Only cyan, magenta, yellow and black are presented. The density levels were selected by the pressmans experience. D2 and L2 were chosen to be the best density levels. L2 and D2 are close to each other for the purpose of comparing the color gamut and the pigment concentration.

In comparison to the FOGRA quality specification for periodicals with 60 l/cm screening, the selected density levels were too low, even with the highest Lotus color level. The high pigmented Diva color series was closer to the standard which defines 1.4 D for cyan and magenta , 1.3 D for yellow and 1.8 D for black. In this test, AM 80 l/cm and FM screening are not directly comparable because of the smaller dot size and the greater dot gain of FM screening.

Table 3. The solid densities D(max) for every density level

	AM screening 80 l/cm				Linotype-Hell Diamond Screen			
Color/ Level	C	M	Y	K	C	M	Y	K
L1	1.15	1.19	0.95	1.43	1.13	1.16	1.10	1.45
L2	**1.23**	**1.20**	**0.98**	**1.54**	**1.22**	**1.26**	**1.12**	**1.64**
L3	1.40	1.39	1.15	1.71	1.40	1.43	1.24	1.74
D1	1.39	1.30	0.97	1.85	1.43	1.33	1.14	1.82
D2	**1.30**	**1.19**	**0.93**	**1.76**	**1.31**	**1.23**	**1.08**	**1.76**

	Agfa CristalRaster				UGRA Velvet Screen				Scitex FullTone			
Color/ Level	C	M	Y	K	C	M	Y	K	C	M	Y	K
L1	1.14	1.14	1.05	1.48	1.16	1.06	1.04	1.54	1.19	1.03	0.95	1.52
L2	**1.22**	**1.36**	**1.09**	**1.63**	**1.27**	**1.34**	**1.10**	**1.58**	**1.27**	**1.25**	**0.97**	**1.50**
L3	1.39	1.49	1.26	1.76	1.43	1.47	1.29	1.78	1.45	1.46	1.17	1.77
D1	1.46	1.42	1.14	1.76	1.51	1.39	1.14	1.94	1.46	1.38	1.01	2.00
D2	**1.32**	**1.34**	**1.08**	**1.68**	**1.21**	**1.30**	**1.07**	**1.85**	**1.12**	**1.29**	**0.96**	**1.94**

Contrast

The contrast (= $D_{100\%}$ - $D_{n\%}$)/ $D_{100\%}$) was calculated from the density measurements of solid and 60-65 % test patches. Due to the clearly different dot gain with the selected screening methods and the different imagesetters, the dot percentage of the film was individually selected in the range the 60-65 % for each screening method. Since the test form was printed with only two and three inking levels, the exact NCI level was not confirmed. The NCI levels were assessed subjectively. Table 4. shows the contrast levels for cyan, magenta, yellow and black. The yellow contrast was low, because its dot gain was the strongest. With the printed density levels, FM screening contrast was clearly lower compared with the AM screening. With the abovementioned materials the FM-screened part of the test form dominates the test printing density levels and it was adjusted to be 0.2 density units lower compared with the solid maximum densities. The AM-screened part of the test form could have been printed closely to the standard density values (C=1.40, M=1.40, Y=1.30, K=1.80) retaining high contrast of AM-screening.

Table 4. Contrast (100 %, 60 % , except for UGRA (100%,50%) and Scitex(100%,70%))

	AM screening 80 l/cm				Linotype-Hell Diamond Screen			
Color / Level	C	M	Y	K	C	M	Y	K
L1	0.61	0.61	0.46	0.65	0.48	0.46	0.34	0.49
L2	**0.58**	**0.57**	**0.45**	**0.63**	**0.44**	**0.40**	**0.29**	**0.42**
L3	0.60	0.60	0.50	0.64	0.45	0.43	0.33	0.45
D1	0.59	0.55	0.45	0.65	0.44	0.36	0.30	0.46
D2	**0.58**	**0.53**	**0.43**	**0.63**	**0.43**	**0.35**	**0.29**	**0.44**

	Agfa CristalRaster				UGRA Velvet				Scitex FullTone			
Color / Level	C	M	Y	K	C	M	Y	K	C	M	Y	K
L1	0.47	0.46	0.33	0.49	0.52	0.47	0.37	0.53	0.50	0.50	0.33	0.55
L2	**0.42**	**0.41**	**0.28**	**0.43**	**0.45**	**0.43**	**0.32**	**0.47**	**0.46**	**0.46**	**0.30**	**0.50**
L3	0.43	0.44	0.33	0.45	0.48	0.44	0.36	0.49	0.50	0.48	0.35	0.54
D1	0.43	0.35	0.29	0.46	0.47	0.36	0.32	0.50	0.48	0.42	0.31	0.55
D2	**0.42**	**0.34**	**0.27**	**0.44**	**0.46**	**0.36**	**0.31**	**0.48**	**0.45**	**0.41**	**0.29**	**0.52**

More accurately than with the different dot percentage patches, the contrast comparisons can be made by using linear interpolation to estimate the same dot coverage for each screening method. Table 5 shows the contrast values with linearly estimated density levels produced by the film dot percentages 60 and 75 %. The inking level was L2. The density levels for the contrast calculation have no standards for the stochastic screening, so these figures are not valid in general.

Table 5. Contrast with the linearly interpolated film percentages of 75 % and 60 % for CMYK.

	Contrast with 75/100%				Contrast with 60/100 %			
Color / Screening	C	M	Y	K	C	M	Y	K
AM 80 l/cm	0.42	0.42	0.30	0.48	0.58	0.58	0.47	0.63
FullTone	0.34	0.31	0.18	0.36	0.50	0.50	0.35	0.55
CristalRaster	0.31	0.27	0.16	0.27	0.48	0.47	0.35	0.47
Velvet Screen	0.26	0.23	0.14	0.27	0.47	0.40	0.30	0.50
Diamond Screen	0.24	0.22	0.13	0.24	0.40	0.48	0.13	0.45

Dot gain

The dot gain curves (from film to paper) with the different screening technologies and the Lotus ink series are shown in Figure 2 for the inking level L2. AM screening produces a low dot gain, as expected, which is at most 16%. FM screening had a dot gain of 20 to 25%, except for yellow (30%). The maximum dot gain was mostly near a 50% dot coverage in the film. The dot gain figures for the Diva ink series resemble the dot gain curves for the Lotus but their levels were much higher, except for yellow where the dot gain curve follows the dot gain of the Lotus yellow.

In Figure 3, the dot gain curves are viewed on different density levels for black. There are irregularities due to measuring errors but the curves show that their maximum values are mostly at 50 %(except for Scitex FullTone). As a rule of thumb, the dot gain increases by 5 %, when the density level is 0.2 density units higher but by increasing inking level by 0.1 density units the dot gain does not change at all.

Light tones dot rendering

One of the known problems with FM screening and the small dot size is that the dots may drop off during plate exposing.. The dots shrank by approximately one percent when they were transformed on positive plates. Since AM and FM screening need different exposing, masks were used to prevent overexposing of the FM screening. The AM-screened areas were exposed to 40 units and the FM-screened areas to 20% less, giving the UGRA test figures a resolution limit of 8 µm for AM screening and 6 µm for FM screening. Linearization by the Scitex FullTone imagesetter failed to produce the smallest dots.

Figure 4 shows a dot gain of under 10% to give an overview of the differently screened image range of colors in light areas. Figure 4 shows the screened patch curves between 1 to 9 % on the plate and on the paper. It was noted that the deviation in these measurements was 2-3% , when using a densitometer for the plate analysis. Especially measurements made in the yellow patches increased the deviation.

Dot rendering on the paper varies considerably, especially the yellow dark tonal range is very narrow due to the dot gain. All the selected screening methods for the dot ranges of CMYK are gathered in Table 6. FM-screened 1 % patches are well visible when they are reproduced on paper with a stronger dot gain than in the AM-screened patches. The tone rendering is good in the dark areas with cyan but magenta and yellow tones are narrowed considerably.

Table 6. The dot range on the paper with an inking level L2

Screening	Cyan	Magenta	Yellow	Black
AM 80 l/cm	2-98 %	2-94 %	3-90 %	2-97 %
Diamond Screen	2-95 %	1-83 %	1-70 %	1-90 %
CristalRaster	1-99 %	1-83 %	1-65 %	1-85 %
Velvet Screen	1-83 %	1-70 %	1-50 %	1-70 %
FullTone	7-98 %	7-94 %	9-85 %	7-98 %

Subjective tests

Differences between conventional and FM screening were compared with subjective tests for two four color images, flower bunch and textile composition (Fig. 1). Both selected screening techniques were from Hell Linotype; the conventional 80 l/cm and the Diamond Screen. Overall image quality comparisons were made for the test prints with two inking series (L,D), having two (D1,D2) and three (L1,L2,L3) inking levels. The pigments for the different color series were the same, but the pigment concentration was higher in the Diva series. Ten images were ranked giving the best image the highest points. The summary of the results is in Table 7.

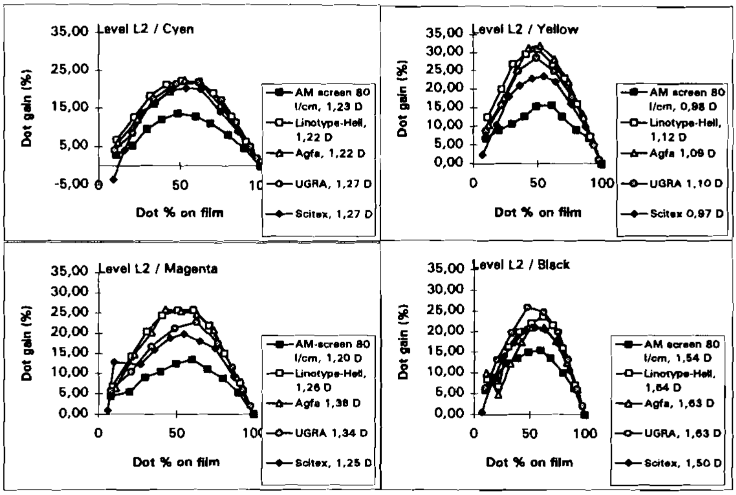
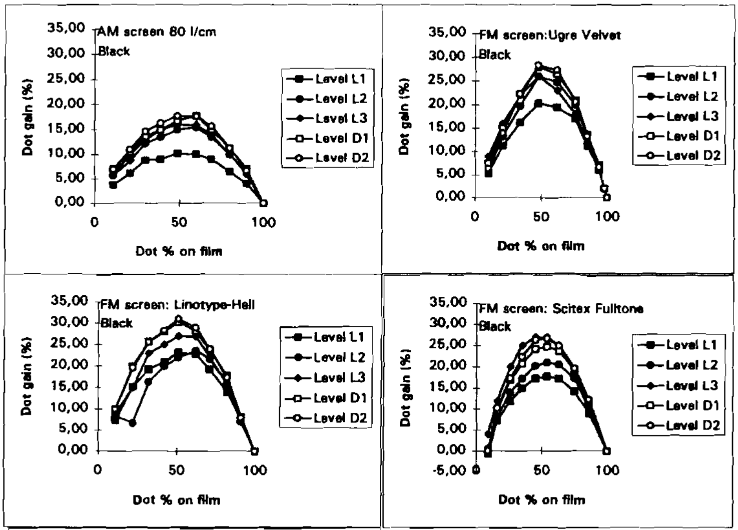
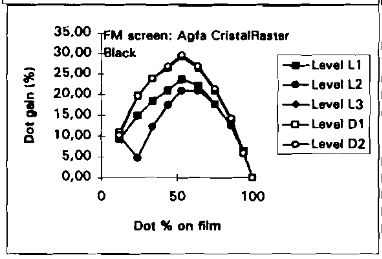


Figure 2





Maximum densities

	AM screen	Velvet	CristalRaster
Level L1	1,43	1,54	1,48
Level L2	1,54	1,58	1,63
Level L3	1,71	1,78	1,78
Level D1	1,85	1,94	1,76
Level D2	1,78	1,85	1,88

	Diamond	FullTone
Level L1	1,45	1,52
Level L2	1,64	1,50
Level L3	1,74	1,77
Level D1	1,82	2,00
Level D2	1,76	1,94

Figure 3

The selected test images differ from each other remarkably. The textile composition is mostly gray and filled with edges and lines, while the flower bunch is colorful and the red and green tones dominate the image. The flower image do not have straight lines. The lowest Lotus color density level (L1) with FM screening produced best textile composition images in our subjective tests. By increasing the density level for FM screening, the dot gain narrows the dark tonal range and the subjective quality approached the level of AM screening. The highest density level with the Diva series was found to produce the poorest images. The AM- screened images had no strong dot gain and were better than the FM -screened images with the highest density level (D1). The result is not a surprise, because AM screening had the best contrast values and the slightest dot gain compared with the intense dot gain of the Diamond Screen in every chromatic color. The Diamond Screen was also ranked poorest in regard to the contrast values (Table 5).

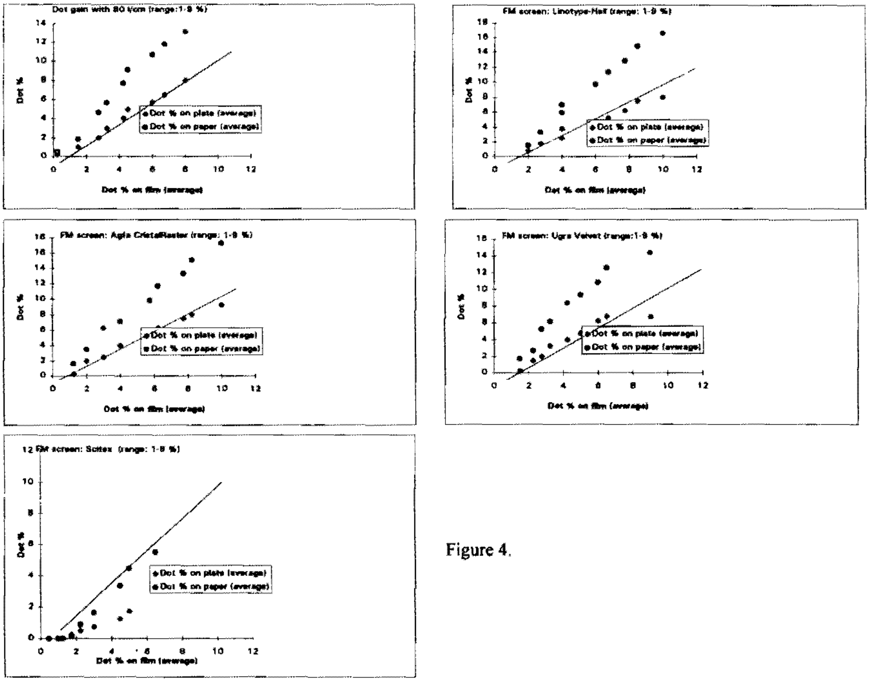


Figure 4.

With the flower composition, the subjective assessments yielded different results (Table 7). Here, the best position was held by the conventionally screened image printed with the highest Lotus density level (L3) and the worst position was taken by the lowest density level of the same color series (L1). The image content in the flower composition favours high density levels where the image details do not dominate the global image quality as the colors do. However, reproduction was not optimized for any selected techniques in this test printing and the FM-screened flower image seems to have too strong dot a gain losing the image details. The AM-screened images hold the details much better in this case and they tolerate higher densities producing richly colored flowers. With the strong dot gain of the highest density level (D1), the image details were wiped off the FM-screened test prints.

Table 7 gives Kendall unanimity coefficients for both images and screening techniques, showing a great disagreement, especially in the flower test images.

Table 7. The global image quality with a subjective assessment.

Specimen	Textile composition		Flower bunch	
	Points	Ranking	Points	Ranking
L1 / FM	85	1.	38	8.
L1 / AM	68	2.	19	10.
L2 / FM	67	3.	68	2.
L2 / AM	67	4.	59	3.
L3 / FM	52	5.	56	4.
L3 / AM	47	6.	82	1.
D1 / AM	42	7.	52	5.
D2 / AM	35	8.	44	7.
D2 / FM	27	9.	48	6.
D1 / FM	12	10.	34	9.
Unanimity	0,538		0,350	

The effect of the register on the print quality

One argument for using FM screening was that the images tolerate more misregister. In this test printing the register was deviated on purpose from the cross machine direction by 0.05mm, 0.1mm and 0.2mm with Lotus black and the inking level of L2. The images were compared to the printing with no register error and the results are summarized in Table 8.

Table 8. Subjective misregister effects.

Specimen	Textile composition		Flower bunch	
	Points	Ranking	Points	Ranking
0,05 / FM	74	1.	51	5.
0,05 / AM	67	2.	65	2.
L2 / FM	65	3.	65	3.
L2 / AM	65	4.	72	1.
0,1 / FM	53	5.	38	6.
0,1 / AM	38	6.	60	4.
0,2 / FM	17	7.	24	7.
0,2 / AM	15	8.	24	8.
Unanimity	0,604		0,386	

In this subjective comparison also the textile composition was easier to judge, because it has a lot of details where to detect register errors. Unexpectedly the FM textile test image with a 0.05 mm register error was ranked slightly better than the test image with no register error, but the FM screened images were consistently judged to be better than the AM screened images with register errors. Again, the observers in our subjective test group did not agree well with the flower test image.

Selected process color gamuts in the CIE-Lab coordinate

The color gamuts spread with the Diva and Lotus color series were very much alike, although the density levels with both color series were near each other (Table 3, UGRA Velvet Screen, levels L2,D2). The IGT tests with an inking level of 1 g/m^2 verify the test printings. In this case the unmeasured accurate NCI-levels might show if the high pigmented color series produces larger gamuts compared to the Eurostandard color series, since inking was justified for FM screening and lower density levels. The following CIE-Lab gamut examination is based only on the inking level L2 with the Lotus ink series. The inking levels and solid densities of additional process colors are shown in Table 9.

Table 9. The density levels for the OGV colors with standard CMY filters

Ink	Max. density	Filter
Orange	1.36	Yellow
Violet	1.22	Magenta
Green	1.42	Cyan

The CMYOGV colors each had their own tone scale to find their color hue angles with the Galerie Art paper. Figure 5 shows the constancy of color hue angle, which predicts the shape and linearity of the color gamut. Yellow, magenta and violet colors do not keep their hue angles, while orange, green and cyan hue angles are almost constant.

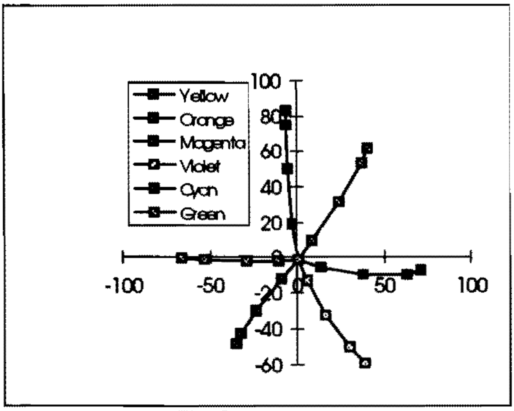


Fig. 5. Color hue angles

CMY colors and CMYOGV colors gamuts on an ab-projection in the CIE-Lab coordinate

The chromatic three-color-formed and six-color-formed CIE-Lab gamuts on an ab-projection show the color gamut enhancement in Figure 6. Orange was very dominant and filtrated light efficiently. Oranges pairs in its subspace were yellow and magenta. Unexpectedly the CMY series expanded the color gamut more than the GYO colors around pure yellow. The shape of the gamut was also found to be very irregular. These defects due to the varying inking conditions in the printing machine and were confirmed from the test strips at the top of the test sheet (Fig 1). Orange and yellow spread the gamut better together if yellow was printed after orange.

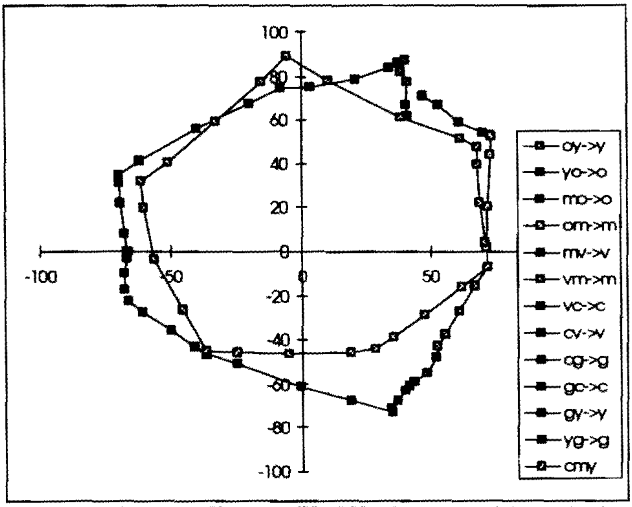


Fig. 6 CMY and CMYOGV color chromaticity projections.

3-D CMY and CMYOGV color spaces in the CIE-Lab coordinates

The effects of additional process colors (violet, orange, green) on the color gamut were assessed in the CIE-Lab coordinate. The measuring points were selected on the test patch so that one of the two chromatic process color was solid and the other process color coverage varied from 0 to 100 percent by steps of 20 percent. Additional points were the pure paper and the solid black ink. The 3D color space body is then a linear interpolation of these points and estimates the color gamut in 3D Lab space.

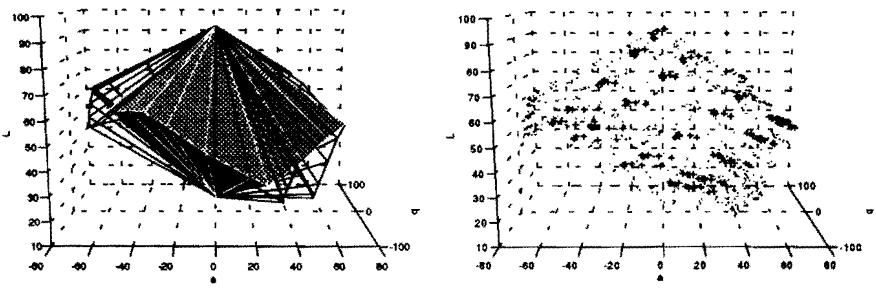


Figure 7. Color gamuts with a hue angle of 270° and 10° above the ab-plane.

In Figure 6, the additional process color, violet seems to spread the gamut more than green but in the following 3-D Figures 7-11 the result was found out to be different. In Figure 7, the color space is a projection from the direction of cyan and cyan-violet that shows the green subspace on the left side and the violet subspace on the right down. The green process color spreads the color gamut in the direction of the b-axis regularly and broadly. Violet makes the tones dark and the color gamut more irregular. In Figures 7-11 there are also all the measuring points for CMY (+) and CMYOGV(.) color patches, so the linearly interpolated color gamut can be compared with all the color data points.

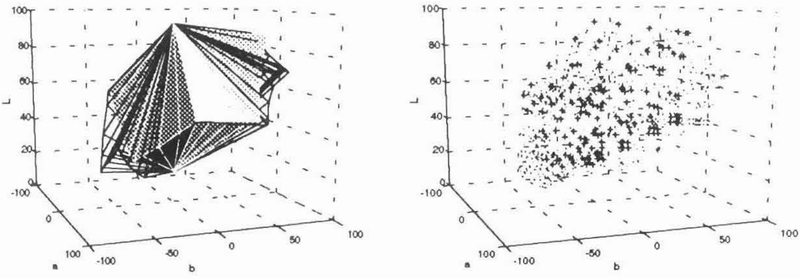


Figure 8. Color gamuts with a hue angle of 340° and 10° above the ab-plane.

In Figure 8 the color gamuts are compared in the direction of magenta and magenta-violet. The shape of the gamut around the orange process color is irregular, so is the subspace around the very dark violet process color. The shape of the CMYOGV gamut is clearly comparable with gamut of CMY process colors.

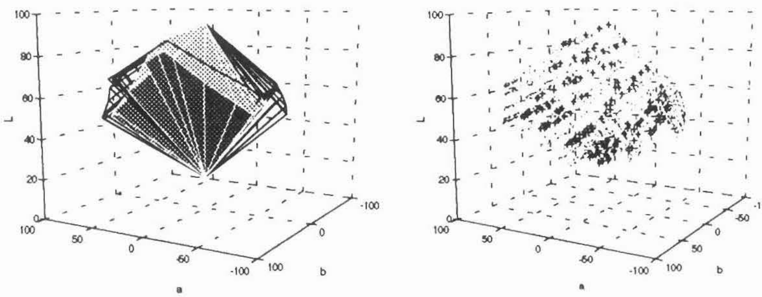


Figure 9. Color gamuts with a hue angle of 120° and 10° above the ab-plane.

In Figure 9, the color space is viewed in the direction of yellow and yellow-green. The irregularities of the orange subspace are clear.

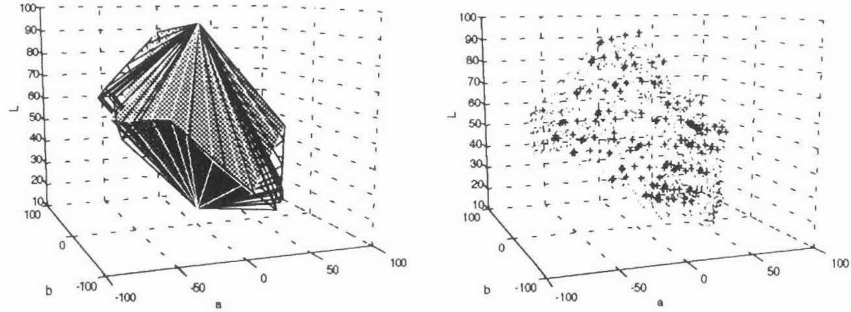


Figure 10. Color gamuts with a hue angle of 250° and 10° above the ab-plane.

In Figure 10, the color space is viewed in the direction of cyan and cyan-violet. The green spread blanket can be seen clearly and violet draws the color space in the direction of the neutral axis.

Violet seems to spread the color space efficiently comparied with the cmy-spread color space but it hides the strong irregularities near the pure violet part of the subspace. The volume of the violet subspace is actually smaller compared to the violet volume of this projection.

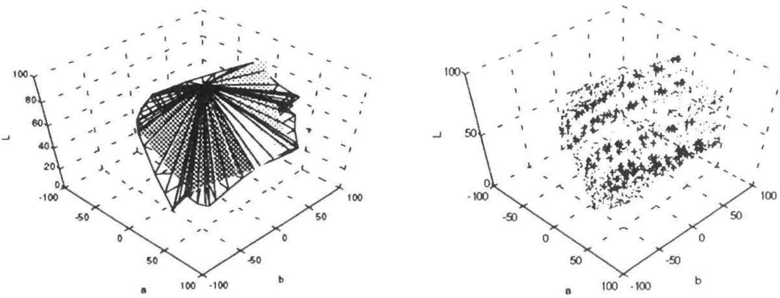


Figure 11. Color gamuts with a hue angle of 315° and 45° above the ab-plane.

A better overview of the color gamut can be seen in the Figure 11 although it hides in some places surprisingly great irregularities. The color space is viewed in the direction of violet.

In summary, the green process color spread the color space most efficiently and regularly. Orange and violet were more troublesome process colors. Orange dominated the color space when the printing order between orange and yellow or orange and magenta was changed. In better printing conditions the color space is evidently more regular around orange than it was in our tests. Better results might be possible when the process colors are selected with a spectrum analysis.

Process color spectra

The color gamut analysed here through the process color spectra. Overprinting generated secondary colors are precalculated with a simple experimental formula. New secondary colors can be calculated rather well to find out how they pass light through the layers of color and paper. In the following figures, the precalculated spectra are marked with an F-key. The formula is as follows an example with cyan and green:

$$R_\lambda = MIN(R_{\lambda(cyan)}, R_{\lambda(green)})$$
$$R_\lambda \le 0{,}2 \Rightarrow R_{\lambda(F)} = (R_{\lambda-2} + R_{\lambda-1} + R_\lambda + R_{\lambda+1} + R_{\lambda+2})^2 * 0{,}2/5$$
$$R_\lambda > 0{,}2 \Rightarrow R_{\lambda(F)} = (R_{\lambda-2} + R_{\lambda-1} + R_\lambda + R_{\lambda+1} + R_{\lambda+2})/5$$
$$\lambda = 380, 390 \ldots 720, 730$$

The green subspace

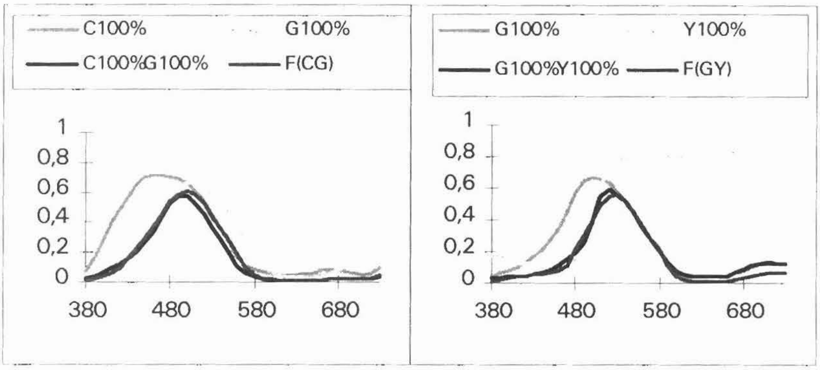


Figure 12. Overprinting spectra in the green subspace.

The green color forms a regular subspace with cyan and yellow. The color space is spread regularly and efficiently. Green and yellow filter each other's spectrum equally, as do green and cyan together.

The violet subspace

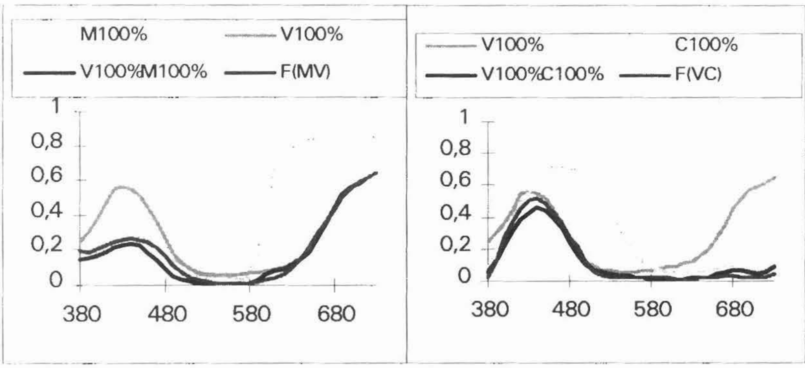


Figure 13. Overprinting spectra in the violet subspace.

The process color spectra explain the irregularities around violet (Fig.13). The violet spectrum is narrow in the area of 380-480 nm and, together with cyan, the reflections are filtered with in the area of 620-720 nm. Chromaticity increases and violet-cyan overprints get darker. Violet acts with magenta very similarly but with less chromaticity. The violet and magenta overprints filter each others most reflective parts forming dark tones.

The orange subspace

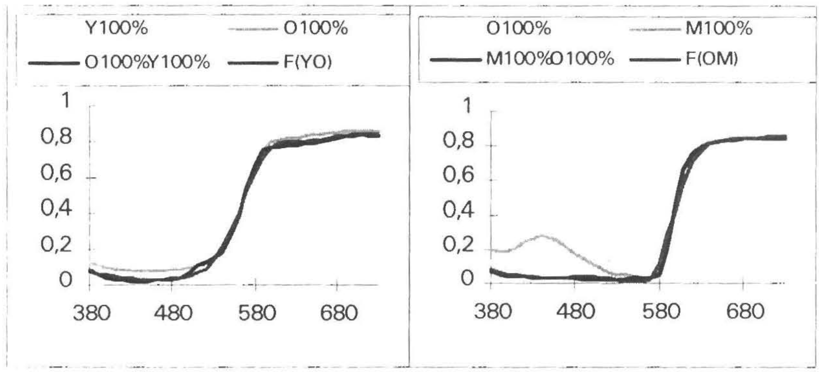


Figure 14. Overprintings spectra in the orange subspace.

The orange spectrum explains the overprints and the 100 % yellow-orange tones very well. The yellow spectrum covers practically the whole orange spectrum and the 100 % orange filters yellow also in the area of 480-580 nm. With magenta, orange is better balanced, since magenta filters also part of the orange spectrum (530-580).

The shape and volume of the color space are estimated rather well for general purposes with a simple spectrum formula. This method could be used to browse the color spectra of the process colors to estimate color gamut without specific test prints, although is not accurate and black color is not taken into account.

Conclusions and discussion

The claims or questions about the hifi techniques have been presented in the literature. The following questions which we gathered in this project, are answered on the basis of our test printing results. Here are the conclusions we drew.

1. FM screening is free from moiré patterns, rosette figures and conventional screen angle problematics.

Test prints with textile composition image are reproduced free from any defects of the screening.

2. FM screening produce smooth tints and images that resemble photographic pictures

It depends on the image and the selected dot size. Images with less compact areas and lots of details could be printed with a good quality. The results of the subjective tests are similar. In our test printings cloth materials were clearly better in the FM-screened images than in the AM-screened images.

3. The FM screen produces better details.

It depends on the selected images but problems arise with light and dark tones. In general the FM-screened images were better with details.

4. Tone rendering in the dark area is better and the density levels are higher with FM screening

The test printings did not show any improvement. In fact, due to the strong dot gain, the tonal range was clearly compressed. In these test printings, the density levels were dropped to get a better contrast. With our materials, the density levels in the FM-screened images were around 0.2 density units lower than in the AM-screened images. However subjective tests showed that test images with lower density levels were ranked very well. Lower inking levels could be even an advantage, because less ink is needed to print FM-screened images and pressman has better latitude with inking.

5. Register deviations are not discovered easily with FM screening

It depends on the printed test image. The textile composition tolerates subjectively better misregister with FM screening. The results show that errors were detected almost in the same way with AM and FM generated flower bunch images. Register deviations were tested only with black.

6. Additional process colors expand color gamuts of printed images

The color gamut expanded remarkably with additional orange, violet and blue. Tones could be formed with two chromatic components but dark tones might need additional third chromatic color.

7. FM screening techniques are well suited for multicolor processes

FM screening do not produce moiré patterns of overlapping screened process colors. Multicolor printing requires stochastic screening when the color tone is produced with four color but stochastic screening also decreases the density levels. Thus the expansion of the color gamut by 6 chromatic colors requires well-optimized color separation and material selection.

8. Plate exposure is a critical product step in FM screening

Plate expose had to be well controlled with FM screening. Positive plates were exposed about 25% less with FM screening than with AM screening. In this case, masks were used to control the different exposing on the same test form. In practice, masking films slow down the production considerably.

9. Measuring with standard densitometer filters is not sufficient

Measuring with standard densitometers and standard filters makes the follow-up of printing unreliable with additional nonstandard (green, orange, violet) process colors. Some printing machine manufacturers already use spectrophotometers to inspect the print quality.

The above questions were only some of the problems in the hifi-printing field. A plethora of techniques need a selective analysis of individual printing houses, since the goal a of better quality could be achieved in many different ways. A combination of conventional and hifi techniques for the same product will need carefully considered steps.

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