Colour Quality Measurement of digital versus sheet-fed offset printing products

Hab. Dr. I. Endrédy, Hab. Dr . I. Patkó

In this paper we shall give a brief overview of the development of digital printing. We shall describe the methods and results of our print examinations carried out jointly with Xerox Magyarország Kft. The tests were carried out on the first Xerox iGen3 printing press ever used in Hungary.

The major phases of the digital revolution

Over the last 20–25 years, one of the most frequent questions asked by printing industry experts related to the future of paper-based information, that is to the future of printed media products. This question was raised for the first time in the 1980s, which saw the advent of personal computers, and the starting of the digital revolution.

It is not an exaggeration to say that the conventional printing industry (in spite of the remarkable development) had not changed as deeply and as rapidly in the 530 years between Gutenberg's book printing in 1455 and the year 1985, as in the years afterwards. The printing industry went through fundamental changes, new technologies appeared and a new structure was developed. The printing phases which had been in existence for decades - design, typography, typesetting, repro, platemak-ing, printing, post processing – were disintegrated and transformed.

In the second half of the 1980s, when open computer systems appeared, most printer employees were not able to envisage the extent of change about to happen, because who would have thought that in a few years time such traditional trades would cease to exist like typesetting or reproduction photography.

In the mid-1990's, the rapid development of computer networks, the appearance of the Internet, and the 'eruption' of digital printing had altered the structure of traditional printing and brought about a new approach.

In the printing industry, the advent of digital printing has paved the way for short run print jobs and personalised prints. The market has imposed three basic requirements on digital printing: orders should be met quickly, cost-efficiently and in good quality.

The transition from the conventional printing industry to the world of digital technology had started more than thirty yeas ago, primarily in the field of printing industry preparations. In 1975, the first digital scanner appeared and then a few years later the electronic device dependent prepress systems were introduced. In 1985, the introduction of the PostScript page description language allowed the setting up of device independent, open prepress systems. Platemaking work had also changed. The late 80s saw the appearance of digital image setters (computer to film systems) appeared. In the years later on, numerous CtPlate (computer to plate) printing systems were introduced to the market, for example in 1993 the Kodak thermal plate. The impact of the digital revolution on the printing technologies resulted in the appearance of two development approaches. One was the combination of prior art reproduction procedures with digital systems, and the other was aimed at new digital based reproduction processes and machines. In 1991, the first digital printing press Heidelberg GTO DI was introduced. The equipment was the developed version of a traditional small offset printing press, in which the plate was directly made in the printing press by means of computer controlled laser diodes. After its appearance, almost all printing machine plants introduced digital printing presses and technologies to the market. Through the development of computer technology and elec-tronics, it became possible to work out such reproduction processes, which produce the print with-out the use of a plate. The basic operating principles of these equipment already existed in the office duplication machines. In 1993, the first such digital printing press (Xeikon DCP-1) appeared, which created the image directly on the basis of data received from the computer. In the same year, Indigo's digital printing press E-Print 1000 was introduced, along with Agfa's Chromapress.

The 15 years that passed since have seen a rapid expansion of digital printing, not only electropho-tography but inkjet too including a substantial improvement in the colour quality of prints made on colour CTPrint systems becoming 'comparable' to sheet fed offset printing. The statement today that the colour quality of a four-colour digital print is equal to or even better than that of web offset printing is not a marketing bluff from the manufacturers or distributors of digital systems, but it is a fact. This is proven by the results of the tests we have carried out jointly with Xerox Magyarország Kft., by means of the first Xerox iGen3 printing press ever used in Hungary.

A brief description of these tests and some results will follow below.

Test methods

Test printing was carried out under normal operating conditions according to the following:

- location: Prime Rate Kft. digital plant,
- printing press: iGen3 digital printing press, testform: Xerox special test form (Fig 1), calibration settings: linearized; printing settings: CMK–175 line/inch, Y–FM screening; UCR/GCR: medium
- climatic parameters: RH 39–44%, t=24–25oC,
- media: the paper types shown in Table 1,
- print run: 250 prints for each printing medium type
- sampling: from each printing series, the starting sheet (print No. 1) and each 50th sheet (50, 100, 150, 200, 250) were removed for measurements.

Table 1: Substrates used in test printing

No.	Type and grammage of media
1.	Xerox Colotech 170 g/m², silk coated paper
2.	Euroart 170 g/m², matte-coated paper
3.	Euroart 170 g/m², gloss-coated paper
4.	Niveusprint 80 g/m², uncoated offset paper

The colour and density measurements of test prints were carried out by an X-Rite SpectroEye spectro- photometer, 9 days after printing. Measurement conditions were the following: in colour measurement: D50/2o/Abs/black backing, density measurement of black prints: DIN (Status E) /Abs/Pol/black backing.

The results of iGen3 digital prints was comparised with data of ISO 12647-2 P1, P2 and P4.

Figure 1

Results

The reproducible colour gamut achievable on the examined media are shown in Figs. 2 and 3. In the figures, the areas confined by thick lines depict the colour gamut reproducible by the prints made on the digital printing press iGen3, and the areas confined by thin lines show the colour gamut reproduci-ble by sheet-fed offset printing in accordance with ISO 12647-2.

The results of the tests show that when printing on coated papers, the reproducing ability of iGen3 is substantially higher than specified in the standard ISO 12647-2 regarding primarily the ranges of blue, purple and red hues. In the yellow range, the reproducible colour gamut is also broader, but in this case the difference is smaller than previously. Only when printing on Euroart gloss-coated paper and even then only in the green range is the 'loss' smaller than stipulated in ISO 12647-2.

When printing on offset paper, the reproducible colour gamut of the print made on the iGen3 digital printing machine is substantially larger in all colourings than in the case of the paper category P4 iden-tified in ISO 12647-2.

The advantage of the examined digital printing over the colour reproduction ability of sheet-fed offset printing can be attributed to two factors: one is the larger colour strength of CMY primeries (see Fig. 4: colour strength), and the other is the stable toner transfer, that provides constatntly high saturation to secondary colours.

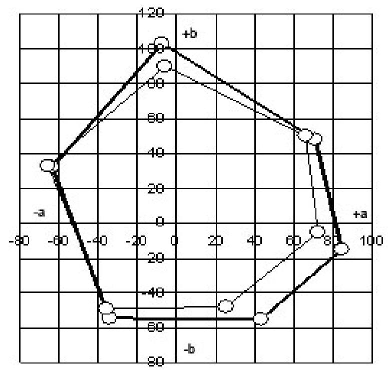

Figure 2:
Colour gamut. Reproducible colour ranges in the CIELAB system. Thick lines: an iGen3 print made on Euro Art 170 g/m² matte-coated paper. Thin lines: associated with the (matte coated) P2 paper identified in ISO 12647-2:2004

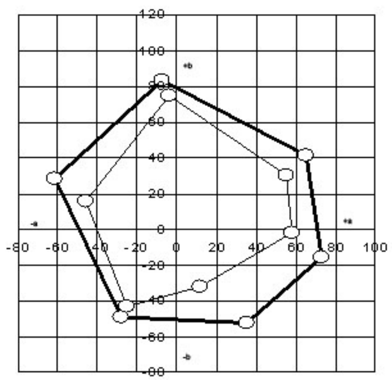

Figure 3:
Colour gamut. Reproducible colour ranges in the CIE-LAB system. Thick lines: iGen3 print made on Niveus Print 80 g/m² offset paper.. Thin lines: associated with the P4 (offset) paper ac-cording to ISO 12647-2:2004

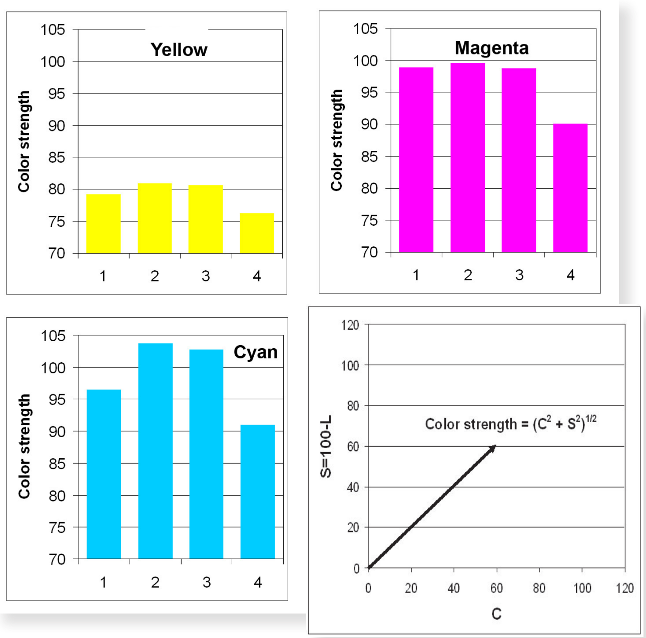

Figure 4:
Colour strength. iGen3 prints made on various coated papers (1: Xerox Colotech, 170 g/m², 2: Eu-roart matte-coated, 170 g/m², 3: Euroart gloss-coated 170g/m2) colour strength vis-à-vis the appro-priate rates (4) identified in ISO 12647-2:2004

The concept „Colour strength" used at the assessment of tests comes from R.S. Hunter. With the increase of chroma and the simul-taneous decrease of lightness (i.e. with the 100-L* decrease of darkness), colour strength increases.

Table 2: The characteristics of black basic colours of iGen3 prints made on various media

Media	CIELAB coordinates			Visual density
	L*	a*	b*	D_W
Xerox Colotech 170 g/m², matte-coated paper	15,00	1,35	1,06	2,08
Euroart 170 g/m², silk-coated paper	11,79	0,76	-0,35	2,50
Euroart 170 g/m², gloss-coated paper	11,82	0,45	-0,57	2,56
Niveusprint 80 g/m², uncoated offset paper	20,62	1,27	1,39	1,78

Note: colour measurement: D50/Abs/D65/black backing; density measurement: DIN/Abs/Pol/black backing.

Table 3: The variability of the process colour solids in production (colour differences between a production copy and the OK print)

CYAN		MAGENTA		YELLOW		BLACK	
Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum
ΔE^*_{ab}, CIELAB (standard) colour difference							
1,3	2,6	1,9	3,0	1,3	2,4	0,9	2,2

On iGen3 prints, the colour and density values measured on the tone prints of the fourth basic colour (K) (see Table 2) represent excellent dark-ness high density blacks.

Summary

We have examined the prints made on coated and offset papers. The finding was that the qual-ity and reproducing ability of the prints made on all three papers are higher than those specified in ISO 12647-2:2004.

References

[1] Endrédy I, Szentgyörgyvölgyi R. (2006): Inves-tigation of digital printing papers. 2nd Inter-national Symposium on Novelties in Graph-ics [and] 7th International Symposium of SCA: Colors of National Symbols, Ljubljana, Slove-nia, 15-17 June 2006. Book of proceedings. [edited by Barbara Simoni]. Ljubljana Faculty of Natural Sciences and Engineering, Depart-ment of Textiles, 6 f.

[2] H. Kipphan (2001), Handbook of Print Media. Springer-Verlag, Berlin

[3] Schulz P., Endrédy I., Szilágyi T. (1998), Dig-itális nyomdatechnikák. PrintConsult Kft., Bu-dapest

[4] Schulz P., (2007/1), Ma már nem marketing-fogás, hanem tény. Nyomdavilág, pp 4-5

[5] ISO 12647-2:2004 szabvány és kiegészítése, az ISO 12647-2:2004/Amd. 1:2007

(first received: 25.11.2008)

Hab. Dr.
I. Endrédy

Obuda University,
Printing Industry
Department,
Doberdo-ut 6,
H-1034 Budapest,
Ungarn

endredy.ildiko@rkk.bmf.hu

Hab. Dr.
I. Patkó

Obuda University,
Light Industry,
Doberdo-ut 6,
H-1034 Budapest,
Ungarn

patko@bmf.hu