# The Colour Characteristics of Modern Printing

*Igor Zjakic, Stanislav Bolanca, and Zdenka Bolanca*
*Agency for Commercial Activity, Ltd., Zagreb, Croatia*
*Faculty of Graphic Arts, University of Zagreb, Croatia*

## Abstract

Colors are printed today mostly in offset in four-color printing, but there is the tendency of printing in digital technique. In this work, the prints were printed in conventional offset by conventional and ecological inks and in digital printing Indigo and Xerox. The usual and recycled printing substrates were used. The prints were measured by the instruments and observed under microscope. On the basis of these results the conclusions were made about the quality of prints which could be achieved using the determined printing substrates, inks and printing techniques.

## Introduction

The most usual way of color printing is four-color printing. It is the printing with three primary colors plus black one.[1] There is the tendency in printing to achieve the maximal relative printing contrast ($C_{rel}$). The ink coating, which is achieved the greatest relative printing contrast by, is considered to be normal one. With so determined thickness of ink coating, the maximal range of ink density is achieved in printing. Great range of color density is suitable for printing objective reproduction in which the print with its characteristics is aligned with the original (2). Different printing techniques and different basic materials used in printing give different possibilities of obtaining the quality of prints. With the technology progress the new printing techniques have been developed. They use some new materials and achieve new possibilities. At the same time the contemporary demand - the ecology - has not been forgotten.

Generally, the reasons for greater surrounding quality in printing, originate from the market demands, optimal costs and benefits, including the development, reputation and survival of the company as well as the ecological responsibility, care for environment and employees and satisfying the legal norms. In this segment three directions have been interesting: rationalization of raw materials in ink production in the context of greater application of the renewable raw materials, increase of surrounding quality in production of the mentioned printing materials, choice of the most suitable printing process and disposal of the used prints.

The aim of the recycling of used prints is to obtain the secondary fibers of suitable quality for production of printing papers, which depend among other things, on the particle size of ink after repulping and its form and characteristics of the surface, which depend on the ink chemistry and the used printing technique.[3,4]

This work studies the characteristics of the four-color printing, printed in conventional wet offset with two kinds of ink, digital offset Indigo and digital machine Xerox on four different printing substrates. The results of the relative printing contrast, the area of the objective reproduction in CIE diagram and the transfer quality of the dots have been discussed. The optimal combination for printing has been suggested too.

## Experimental

In this work the following machines were used: MAN Roland 300, Indigo E print and Xerox DocuColor 2060. The used printing substrates were the following ones: fine art glossy paper of 120 g/m$^2$, fine art matt paper of 120 g/m$^2$, offset paper of 100 g/m$^2$ and recycled paper of 100 g/m$^2$. The conventional offset ink, offset ink in which the mineral oil was exchanged by the vegetable oil, electro ink and powder toner were used in printing. The additional condition in printing was the following: the solid patch must be completely covered by ink, the screen area with 90% screen value must not be closed and the area with 10% screen value must be correctly printed.

Special test printed form was constructed and the prints were tested.

**Table 1. Relative printing contrast of prints obtained by the mentioned techniques on the determined printing substrates**

| | | glossy paper | matt paper | wood-free | recycled |
|---|---|---|---|---|---|
| convencional offset | C | 0,51 | 0,5 | 0,40 | 0,28 |
| | M | 0,50 | 0,5 | 0,48 | 0,31 |
| | Y | 0,50 | 0,52 | 0,33 | 0,21 |
| | K | 0,55 | 0,58 | 0,43 | 0,3 |
| offset with model inks | C | 0,52 | 0,49 | 0,3 | 0,23 |
| | M | 0,49 | 0,46 | 0,33 | 0,35 |
| | Y | 0,49 | 0,5 | 0,33 | 0,17 |
| | K | 0,47 | 0,5 | 0,23 | 0,26 |
| Indigo | C | 0,43 | 0,44 | 0,31 | 0,27 |
| | M | 0,48 | 0,5 | 0,4 | 0,36 |
| | Y | 0,47 | 0,43 | 0,38 | 0,27 |
| | K | 0,56 | 0,67 | 0,52 | 0,52 |
| Xerox | C | 0,62 | 0,62 | 0,54 | 0,53 |
| | M | 0,70 | 0,72 | 0,68 | 0,64 |
| | Y | 0,59 | 0,56 | 0,37 | 0,4 |
| | K | 0,43 | 0,56 | 0,46 | 0,46 |

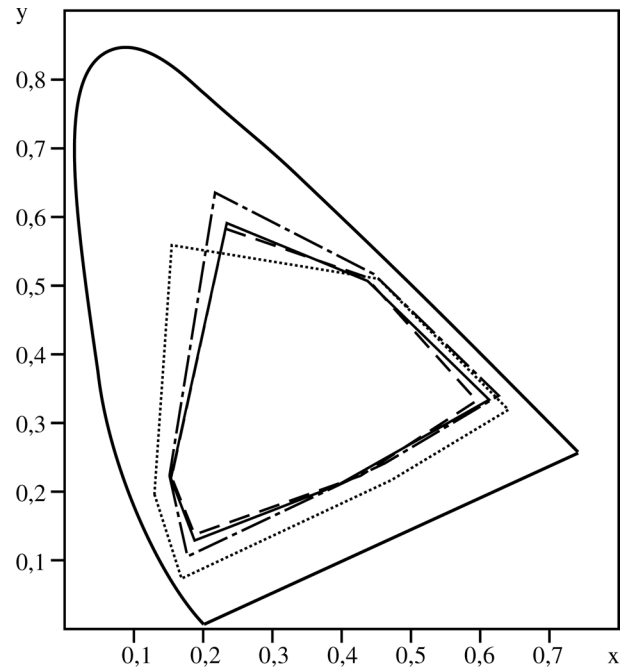


*Figure 1. Spaces in CIE diagram covering by prints obtained on fine art glossy paper:*

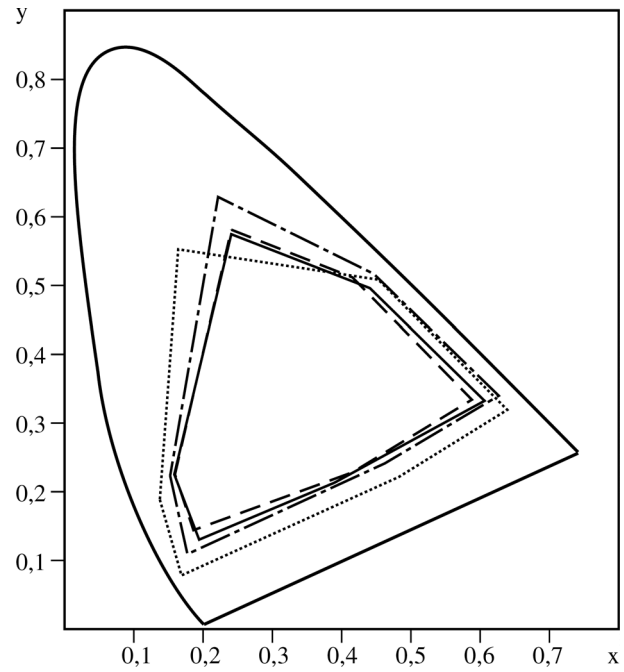


*Figure 2. Spaces in CIE diagram covering by prints obtained on fine art matt paper:*

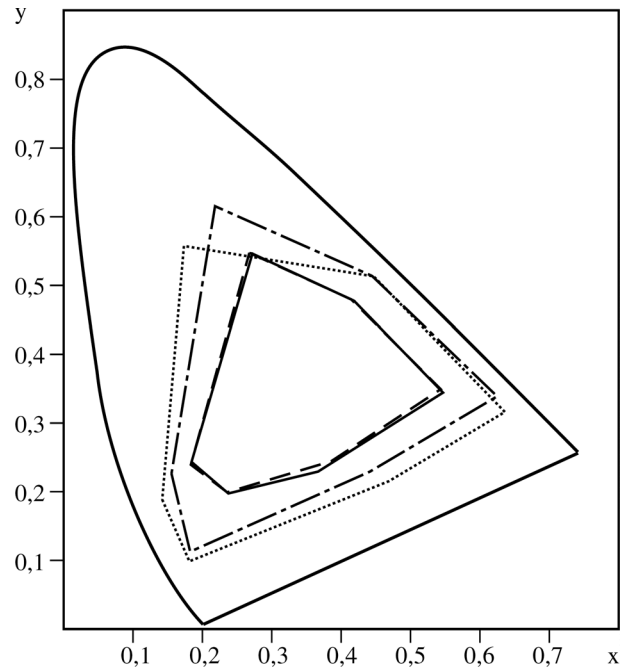


*Figure 3. Spaces in CIE diagram covering by prints obtained on wood-free paper:*

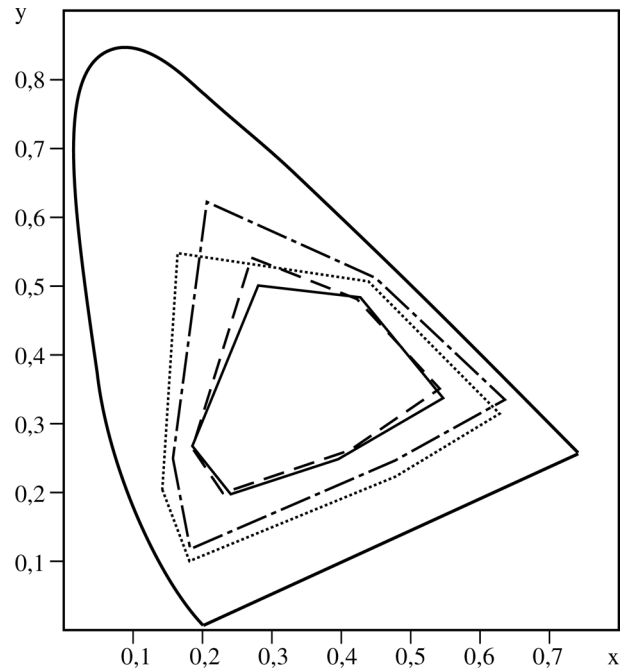


*Figure 4. Spaces in CIE diagram covering by prints obtained on recycled offset paper:*

By spectrophotometer Heidelberg CPC2-S the color density on the areas of solid printing and 70% screen have been measured. The values of the relative printing contrast have been determined.

By measuring the color density with the same spectrophotometer, the areas on CIE diagram have been determined, which cover the mentioned printing techniques on already chosen printing substrates.

Studying of some technological processes in printing by means of the instruments only, can sometimes give inadequate or incomplete picture. Because of that, it is good to use some perceptional method. In this work the areas with 30% screen value were shoot and 100 times enlarged.

After that the characteristics of prints were evaluated on the basis of the visual observations. In order not to overburden this work with figures, figures 5 to 20 presents the prints made in cyan only. They are enough representative, because the prints of other inks behave almost equal.

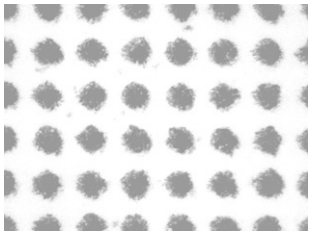

Figure 5. Convencional offset on fine art glossy paper

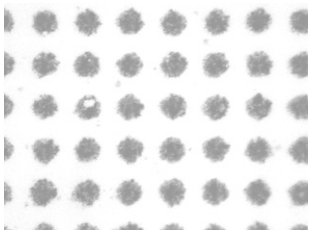

Figure 6. Convencional offset on fine art matt paper

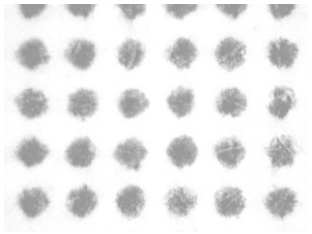

Figure 7. Convencional offset on wood-free paper

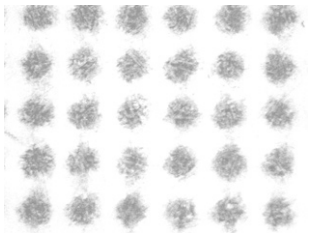

Figure 8. Convencional offset on recycled paper

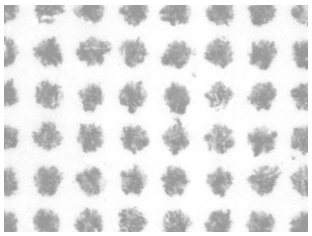

Figure 9. Offset with model inks on fine art glossy paper

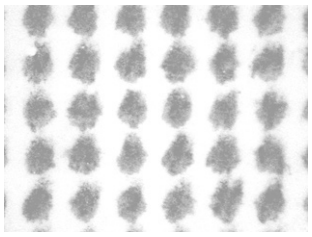

Figure 10. Offset with model inks on fine art matt paper

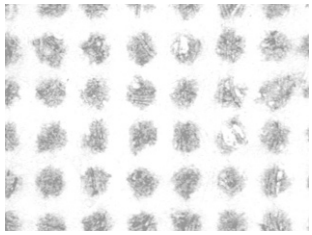

Figure 11. Offset with model inks on wood-free paper

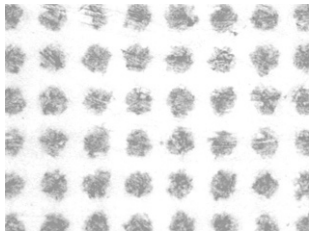

Figure 12. Offset with model inks on recycled paper

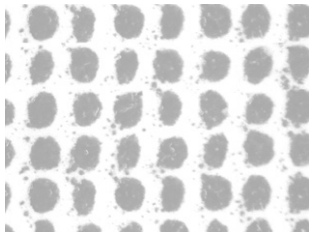

Figure 13. Indigo on fine art glossy paper

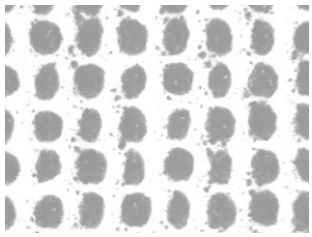

Figure 14. Indigo on fine art matt paper

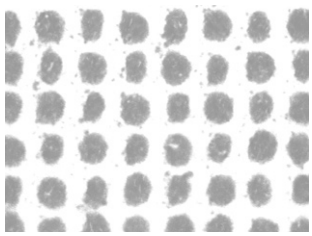

Figure 15. Indigo on wood-free paper

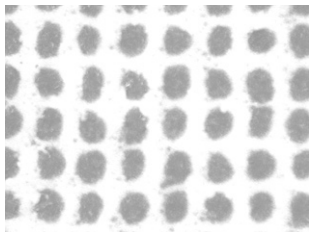

Figure 16. Indigo on recycled paper

*Figure 17. Xerox on fine art glossy paper*

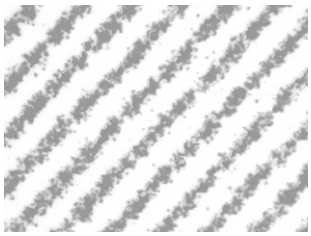

*Figure 18. Xerox on fine art matt paper*

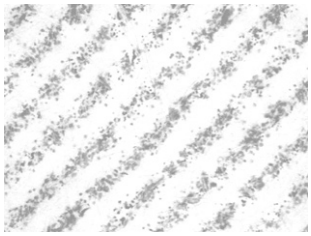

*Figure 19. Xerox on wood-free paper*

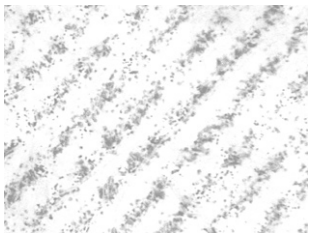

*Figure 20. Xerox on recycled paper*

## Result Discussion and Conclusion

The values of relative printing contrast on fine art glossy paper, offset paper printed with conventional ink, offset paper printed with model ink and indigo offset paper are uniform, mainly about 50 with the deviation inside 4%. At the same time, the print values of the relative printing of the Xerox machine are about 61 and they are about 20% higher. In printing on fine art matt papers the situation is mainly equal. By the quality decrease of the printing substrate, i.e. by printing on offset paper, the offset printing with conventional inks is in line with Indigo. Xerox has the position with about 20% higher contrast, but offset with the model ink shows lower result for about 20% than the conventional inks and Indigo. On the worst printing substrate, on the recycled paper, Xerox shows the results for about 30% better than Indigo, and Indigo shows the results for 30% better than offset printing with both inks.

The coverage areas in CIE diagram follow the results of the relative printing contrast fairly weakly. The prints on the fine art glossy paper on Xerox and Indigo give similar and somewhat better results than the proofs with both inks in wet offset, which show practically equal results. On fine art matt paper the results are identical to those on fine art glossy paper. The printed surface on the offset paper in CIE diagram decreases for all solutions, in Xerox and Indigo similarly small and in conventional offset printing for both inks almost equal and relatively great. In prints on the recycled paper, results are almost equal as well as on offset paper, but the printed surface with both inks in CIE diagram in the conventional offset printing has decreased

The prints with 30% screen value, 100 times increased, subdued to visual checking show however different results.

The screen dot on fine art paper in offset printing with conventional ink is very good, and on offset and recycled paper its quality decreases somewhat. In using the model inks the picture is similar, only the prints have little lower quality. Indigo gives similar results with lower decrease of dot quality on offset and recycled paper. Contrary to these three examples in our tests, Xerox prints have very irregular edges. With the decrease of paper quality this effect becomes drastic.

## References

1. N. Pauler: Paper Optics, AB Lorentzen Wettre, Österväla, Sweden
2. S. Bolanca, Suvremeni ofetni tisak, Skolska knjiga, 1991, Zagreb, Hrvatska
3. Z. Bolanca, D. Agic, K. Bauer: Possibilities of Recycling Digital Prints, Advances in Printing Science and Technology, Pira International, Ltd. Surrey, 2000
4. Thomson B.: Printing Materials, Pira International Ltd. Surrey, 1998

## Biography

Professor Stanislav Bolanca first worked in a printing house. Later on he transferred to the Graphics College. Today professor Bolanca teaches at the Graphics Faculty within the University of Zagreb as a full professor.

He is the head of the Department for Technology of Printing, and teaches several undergraduate and graduate courses. Until recently he was a vice-president of the Faculty and today he is its Dean. Professor is the author of many university textbooks, and he published a large number of scientific and technical papers.