

COMPARATIVE ASPECTS REGARDING THE TECHNICAL CHARACTERISTICS AND THE QUALITY CHARACTERISTICS OF THE PRINTS SPECIFIC OFFSET AND DIGITAL PRINTING METHODS

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Rezumat. *Lucrarea de față prezintă o analiză comparativă a două metode de tipar și anume: tiparul offset și tiparul digital. Mai exact, analiza presupune identificarea soluțiilor constructive ale mașinilor de tipar, determinarea fazelor tehnologice implicate în tipărirea acelueași tip de produs – revistă, durata de timp necesară realizării acestora precum și aspecte privind calitatea printului (densitatea optică, punctele de raster, culorile). Studiul a fost realizat pe mașina de tipar offset MAN Roland 704 și mașina de tipar digital Ricoh Pro C9210. Această lucrare evidențiază aspecte tehnologice care vor pune în lumină cea mai optimă metodă pentru tipărirea produselor tipografice în cel mai scurt timp și de cea mai bună calitate.*

Abstract. *The present paper presents a comparative analysis of two printing methods, namely: offset printing and digital printing. Specifically, the analysis involves identifying the constructive solutions of the printing machines, determining the technological phases involved in printing the same type of product - magazine, the length of time needed to make them as well as aspects regarding the quality of the print (optical density, dots gain, colors). The study was carried out on the MAN Roland 704 offset printing machine and the Ricoh Pro C9210 digital printing machine. This paper highlights technological aspects that will bring to light the best method for printing typographic products in the shortest time and of the highest quality.*

Keywords: Technological steps, manufacturing time, dot gain, optical density.

1. Introduction

Currently, we are witnessing the widespread and rapid deployment of digital technologies in the typographic field and especially in the typographies, which were not long ago the faithful of offset printing. On the one hand, this phenomenon is argued by the performance of the equipment, the diversity of the finishing and binding processes (which can also be made in line) and short term of realization / delivery, and on the other hand of small and medium runs.

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We would like to emphasize that even if the niche of digital printing is constantly evolving, the offset printing - for now - is in the leading position on print market development. However, digital printing is a definite response to the demands of a market that requires increasingly shorter delivery times and small / medium runs once the information passes, „at an accelerated tempo, from the paper to the electronic medium”¹.

Whereas both methods play an important role in the printing industry, both nationally and globally, through this paper we set out to determine the differences and similarities in terms of technology and quality of printing. That is why a comparative analysis was performed that aims at the characteristic aspects, the sequence of manufacturing stages, the manufacturing time, the quality of the pattern. Analysis performed with the involvement of the MAN Roland 704 offset printing machine and the Ricoh Pro C9210 digital equipment.

2. Aspects characteristic of offset and digital printing methods

The first stage of comparative analysis of offset and digital printing aims to highlight the characteristic aspects of these two methods. But first let's review their simplified principle of operation. In the case of offset printing (figure 1):

- for each color (CMYK) is made a monometallic printing plate (on whose copy layer are inscribed, through CtP technology, the printing/non-printing elements);
- the offset plates being fixed in the printing machine (on the plate cylinder) transfers the ink to an intermediate surface – blanket cylinder, then on the surface of the paper.

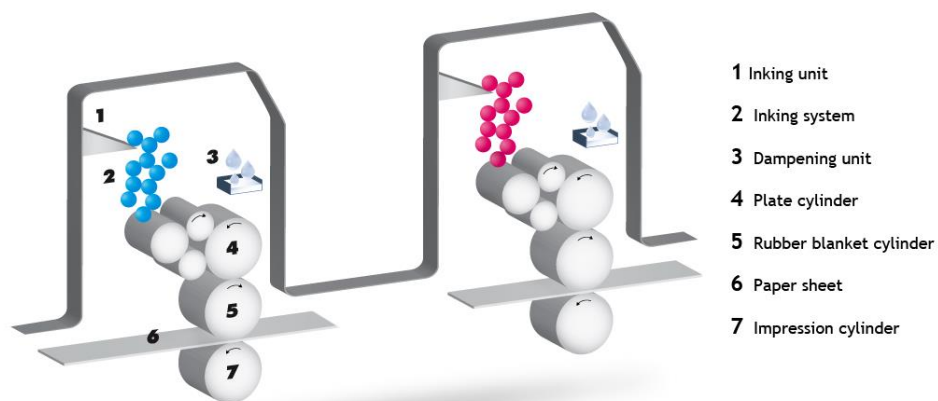


Fig. 1. The principle of offset printing [2]

In the case of digital printing (referring to the Ricoh Pro C9210 we are talking about laser printing), figure 2:

- the plates are missing;
- the image is made on paper with a single click;
- the image is formed by means of electrical charges and a beam of light, first on the surface of the photoreceptor cylinder which then passes through electrostatically charged toner is fixed only to those parts of the photoreceptor cylinder which have been previously also electrostatically charged by the laser.

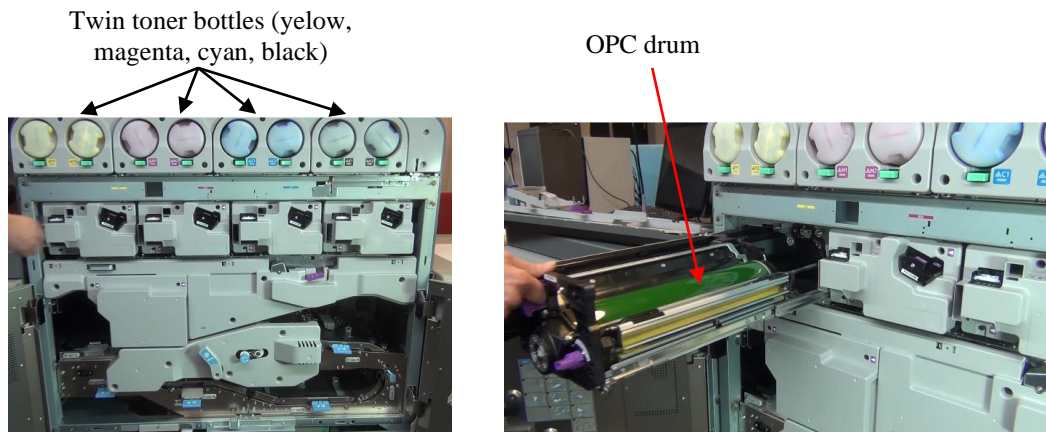


Fig. 2. The printing units of Ricoh Pro C9210

Table 1 presents some of the strengths and weaknesses characteristic of offset and digital printing, which were identified by a multicriteria analysis.

Table 1. Comparative aspects of the offset and digital printing methods

No.	Characteristic aspects	Qualifying	
		Low	High
1.	Number of materials involved	digital	offset
2.	Time to set up	digital	offset
3.	Delivery time	digital	offset
4.	Cost for large runs	offset	digital
5.	Cost for small runs	digital	offset
6.	Accurate color matching	digital	offset
7.	Easier Proofing	offset	digital
8.	Diversity of ink options	digital	offset
9.	Brightness of colors	offset	digital
10.	Frequency of using coated paper	offset	digital
11.	Paper usage	digital	offset
12.	Efficiency of using the ink	offset	digital
13.	VOC emission (that emissions are well below regulatory emissions) [3]	offset (length run)	offset (short run) digital
14.	Size	digital	offset

3. Case study

3.1. Printing products and printing equipments included in the study

In order to achieve the proposed purpose, the following printing products were submitted for analysis - the brochure "Saloanele Moldovei" XXVII edition, 2017 (figure 3) and dvertising/information magazine „Formula krasoti” (figure 4). Both were printed by the offset printing method and the digital printing method.

The characteristics of the brochure "Saloanele Moldovei" XXVII edition, 2017 are: publication volume 32 pages, A4 format, color: 4 + 4, type of binding: sewing with wire, equipment: offset machine Roland 704 (table 2) and digital machine Ricoh Pro C9210 (table 3, fig. 6); the brochure run printed by offset and digital methods is 520 copies.

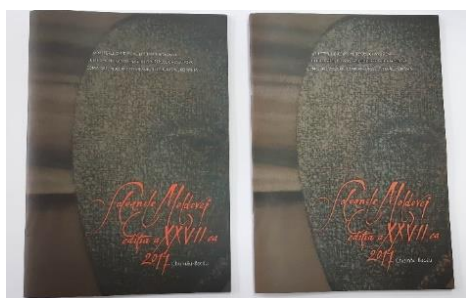


Fig. 3. The brochure "Saloanele Moldovei"



Fig. 4. The magazine "Formula krasoti"

The magazine "Formula krasoti" has the following characteristics: publication volume 60 pages; A4 format; color: 4 + 4; type of binding: adhesive non-sewn; equipment offset machine MAN Roland 704 and digital machine Ricoh Pro C9210; the run of the brochure printed by offset and digital methods is 650 copies.

Table 2. Technical characteristics of the offset machine MAN Roland 704

No.	Technical characteristics	Description
1.	Number of printing units	4
2.	Size	3B
3.	Max. Sheet size, mm	740 x 1040
4.	Max. print area, mm	715 x 1020
5.	Size of offset plate, mm	785 x 1030
6.	Thickness of paper, mm	0,04-1,0
7.	Speed s/h	15.000

Due to the fact that digital printing is gaining momentum, we want to pay special attention to the technical characteristics of the Ricoh Pro C9210 machine, which is successfully operated in the printing houses. Ricoh Pro C9210 – this is the most productive configuration, capable of printing up to 135 pages A4 per minute (with duplex printing on sheets of A3 - even 144 pages A4 per minute). Its resource is designed for 60 million prints or 5 years of operation, and the maximum paper density is 470 g/m² [4].

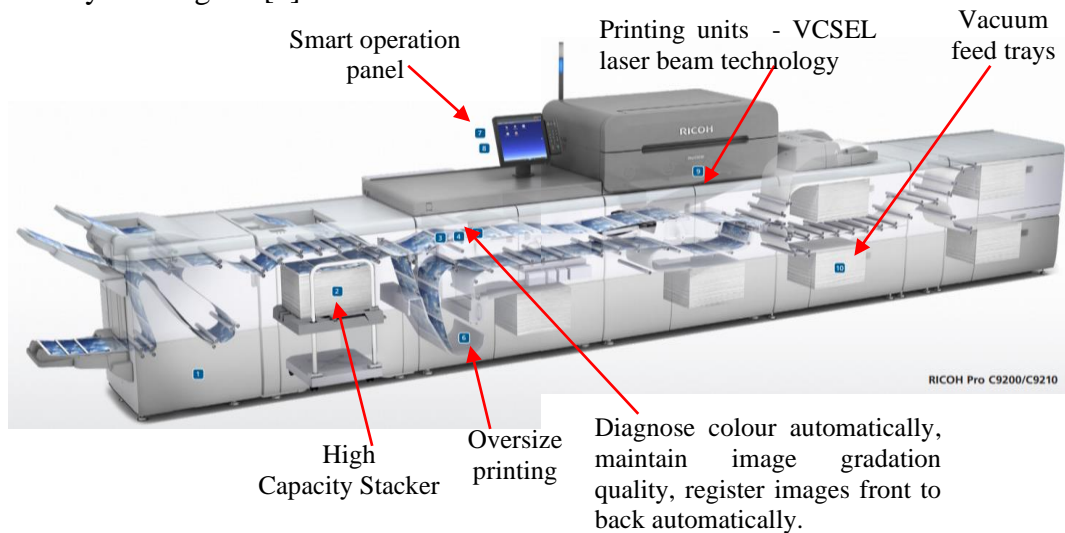


Fig. 6. Component parts of Ricoh Pro C9210 [5]

Table 3. Technical characteristics of the offset machine Ricoh Pro C9210 [5]

<i>No.</i>	<i>Technical characteristics</i>	<i>Description</i>
1.	Process	4-drum dry electrostatic transfer system with internal transfer belt
2.	Laser Resolution	2400 x 4800 dpi VCSEL
3.	Paper Size	13" x 19.2"/13" x 49.6" (when using Oversize Tray Option)
4.	Maximum Printable Area	12.7"x18.9"/12.7" x 49.4" (when using Oversize Tray Option)
5.	Paper Weight	Trays 1-4: 52-470g/m ² Duplex: 52-470g/m ² Trays 5-8: 52-400g/m ² Bypass Tray: 52-216g/m ²
6.	Paper Type	Uncoated Paper, Coated Paper (gloss and matte), Recycled Paper, Preprinted, Letterhead, Pre-punched, Tab Stock, Textured Paper, Label Paper, Carbonless Paper
7.	Paper Capacity	Trays 1- 8: 2,200 sheets per tray Bypass Tray: 500 sheets Total Standard Capacity: 4,400 sheets Total Optional Capacity: 18,100 sheets

It is important to mention that this equipment is equipped with intelligent control systems such as: image density control, toner control, color diagnosis, auto calibration, and others - shown in figure 7.

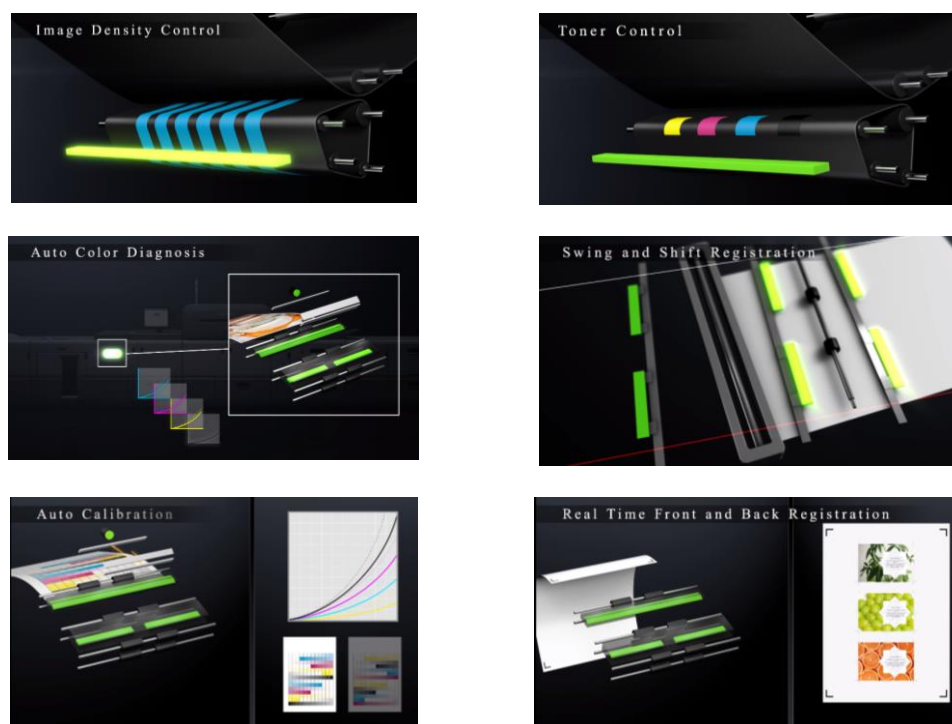


Fig. 7. Automatic quality control technology [6]

3.2. Comparative analysis of the technological characteristics

Were established the stages and technological operations specific to the production process of the printing products involved in the study (brochure and magazine), with the involvement of offset and digital printing methods. Subsequently, they were compared in terms of the total number of technological operations, the time required to perform each operation, the total manufacturing time, the type of operation and the number of workers (tables 4,5). In this sense was followed the pre-press process, the printing process on the MAN Roland 704 offset printing machine and on the Ricoh Pro C9210 digital printing machine, the post-press process. In the figure 8 is presented the succession of technological operations of making the brochure (run 520 copies for both printing methods).

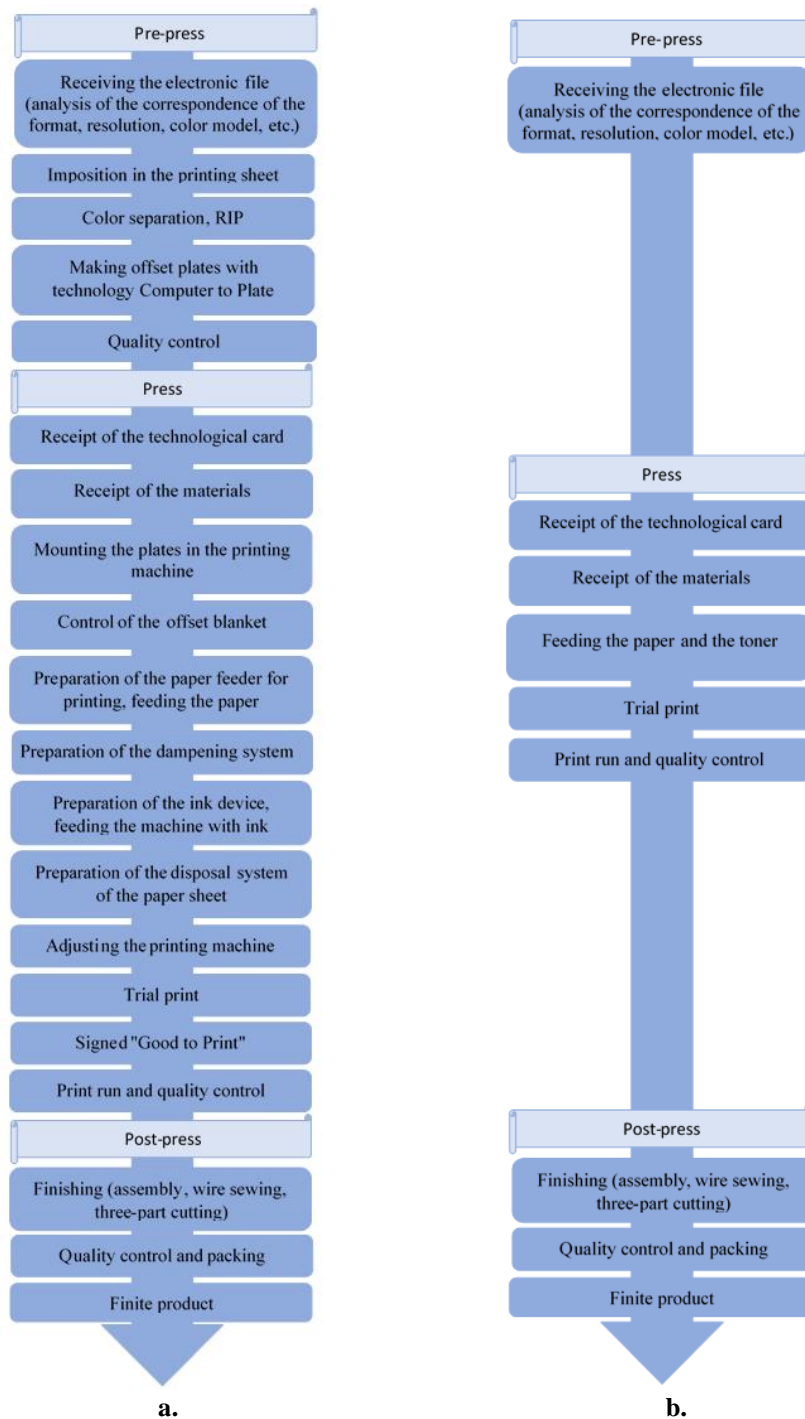


Fig. 8. The succession of technological operations of making the brochure
a. offset printing; **b.** digital printing

Table 4. The technological operations specific to the process of making the brochure involving the offset printing method

No.	Technological operation	Type of technological operation	Time required (min)	Number of workers
<i>Pre-press</i>				
1.	Receiving the electronic file	manual-machine	10-15	1
2.	Imposition in the printing sheet	manual - machine	48	
3.	Color separation	manual - machine	20	
4.	Making offset plates	machine	15	1
5.	Quality control	manual	15	
<i>Press</i>				
6.	Receipt of the technological card	manual	5-10	2+1 (foreman)
7.	Receipt of the materials	manual	15	
8.	Mounting the plates in the printing machine	manual- machine	119	
9.	Control the offset blanket	manual - machine	20	
10.	Preparation of the ink device, feeding the machine with ink	manual - machine	40	
11.	Preparation of the paper feeder for printing, feeding the paper	manual – machine	20	
12.	Preparation of the dampening system	manual – machine	15	
13.	Preparation of the paper sheet	manual-mașină	10-15	
14.	Adjusting the printing machine	manual- machine	10-15	
15.	Trial print	machine	5-10	
16.	Signed "Good to Print"	manual	10	
17.	Print run and quality control	machine	48	
<i>Post-press</i>				
18.	Finishing (assembly, wire sewing, three-part cutting)	machine	55	3
19.	Quality control	manual	15	1
20.	Packing	machine	20	1
<i>TOTAL</i>			540	10

Table 5. The technological operations specific to the process of making the brochure involving the digital printing method

No.	Technological operation	Type of technological operation	Time required (min)	Number of workers
<i>Pre-press</i>				
1.	Receiving the electronic file	manual- machine	15	1
<i>Press</i>				
2.	Receipt of the technological card	manual	5	1 (even as for the pre-press)
3.	Receipt of the materials	manual- machine	15	

4.	Feeding the machine with paper and toner	manual - machine	20	
5.	Setting the specific data of the run		5	
6.	Trial print	machine	1	
7.	Print run	machine	58	
<i>Post-press</i>				
8.	Finishing (assembly, wire sewing, three-part cutting)	machine	55	3
9.	Quality control	manual	15	1
10.	Packing	machine	20	1
<i>TOTAL</i>			209	6

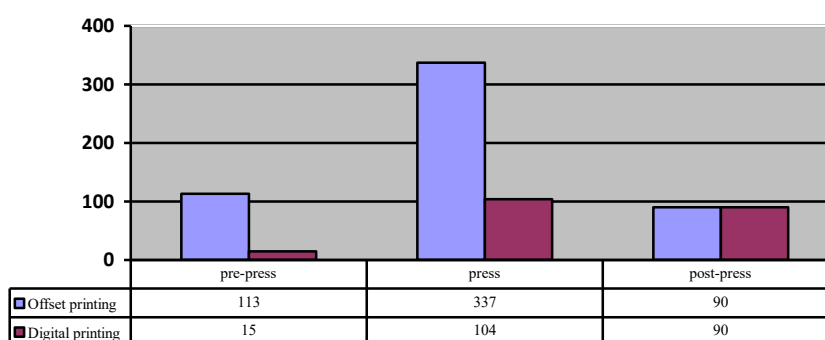


Fig. 9. Brochure manufacturing time diagram (minutes)

3.3. Comparative analysis the quality of the prints

The stages of analyzing the quality characteristics of the prints involved:

1. Visual analysis of images, color contrasts, color intensity.
2. Analysis of the „screen structure”⁷ (dot pattern) and „dot gain”⁷ with the help of the loupes (20x and 50x)⁸.
3. Determination of optical density of the studied samples.
4. Evaluation of the above stages of quality characteristics.

To determine print quality, we studied these samples using a densitometer (fig. 10). These studies made it possible to carry out an accurate analysis of optical density with offset printing method and digital. All data is entered in table 6.

Table 6. Optical density measurement results

No	The name of the printing product	Optical density for offset printing method (D)	Optical density for digital printing method (D)
1.	Saloanele Moldovei	0,95	0,98
		0,91	1,05
		0,96	1,01
		0,60	0,79
2.	Formula krasoti	1,36	1,52
		1,24	1,32



Fig. 10. Optical density measurement with a densitometer
a. brochure "Saloanele Moldovei"; **b.** magazine "Formula krasoti"

There is another method of checking print quality - this is the analysis of the dot gain and screen structure. The analysis is carried out using a loupe (figure 11).

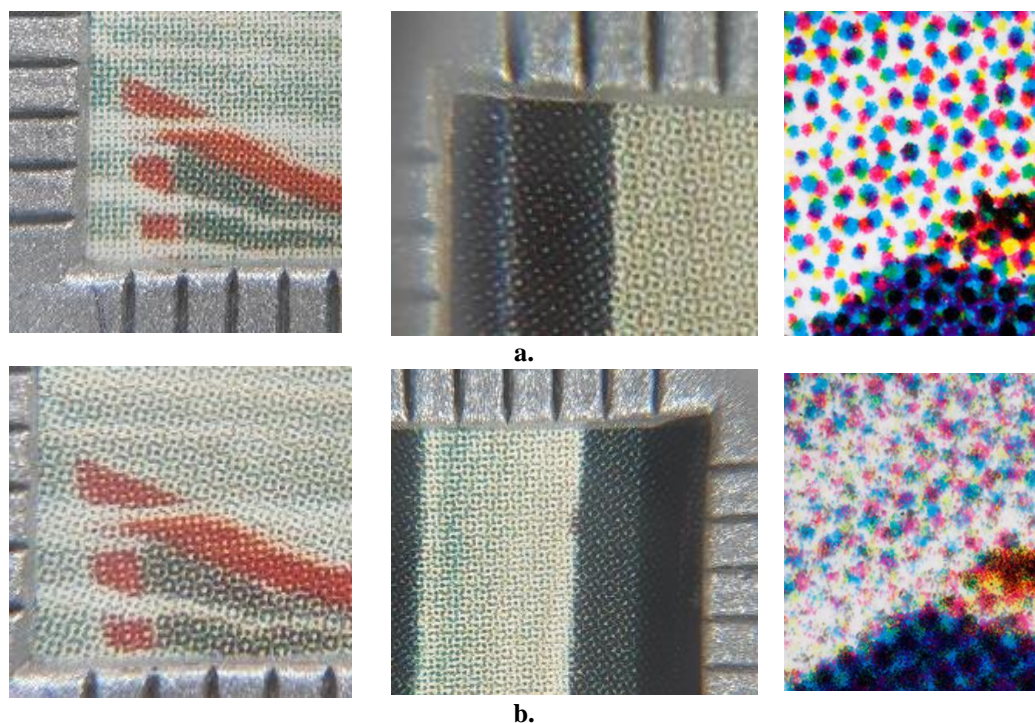


Fig. 11. Analysis of the dot pattern and de dot gain
a. offset printing; **b.** digital printing.

As a result of the analysis of the distinctive characteristics of prints whit loupe are presented the following observations: glossy coated papers, image created by dots, dot pattern and size of dot they seem to be similar, the shape is the same for both methods but for digital printing the dot it's just a little smaller, on print are observed four principal colors (Cyan, Magenta, Yellow, Black) – in the case of

the offset printing and multiple spot colors. In figure 12 are presented other aspects regarding de quality of the prints (printing dot pattern).

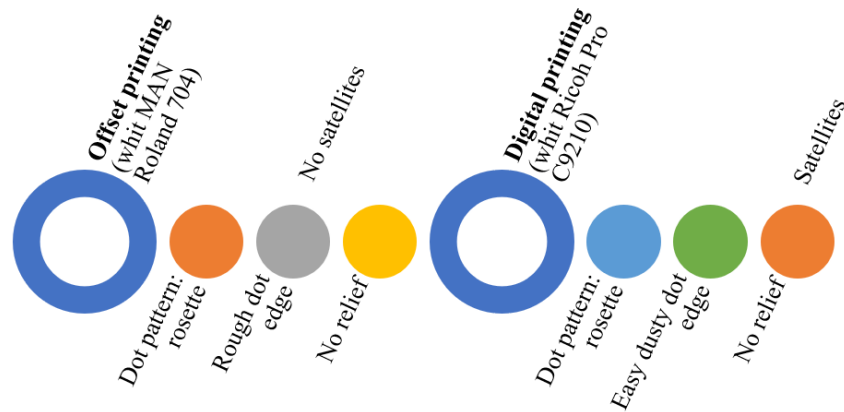


Fig. 11. Aspects regarding de printing dot pattern of the printing product – brochure and magazine

At first glance, to the untrained eye, two works with the same aesthetic solution, one offset printed and the other digitally, may seem identical. But, if you look very carefully, can be observed that the works printed by the digital printing method have lighter shades and a little brighter.

4. Conclusions

Conclusion (1). The value characteristic aspects of offset printing are: diversity of ink options, size, cost for large runs, accurate color matching; of digital printing are: brightness of colors, time to set up, delivery time, low paper usage, efficiency of using the ink.

Conclusion (2). Referring to the equipment involved in the study, we cannot overlook the digital machine Ricoh Pro C9210 – graphic arts edition, the most productive configuration, with very high and appreciated characteristics of the prints quality. Characteristics that can be achieved due to intelligent control systems: image density control, toner control, color diagnosis, auto calibration, swing and shift registration, real time front and back registration.

Conclusion (3). As for all technological operations, then in the case of making the brochure with the involvement of offset printing for pre-press - 5 technological operations (production time - 113 min), for press - 12 technological operations (337 min), for post-press - 3 operations technological (90 min); in case of involvement of the digital printing method, for pre-press - 1 technological operation (15 min), press – 6 technological operations (104 min), post-press – 3 technological operations (90 min) (the same technological operations and

finishing equipment are required as well as offset because the digital printing equipment involved in the study is not equipped with finishing systems). Analyzing only the press process, it is observed that, in the case of offset printing, most of the time is consumed for the preparation of the machine for the printing process, namely: mounting the plates in the printing machine, mounting the offset blanket, preparation of the ink device, preparation of the paper feeder, preparation of the dampening system, preparation of the paper sheet.

Conclusion (4). The number of workers involved in making the product in the case of offset printing is 10 workers, in the case of digital printing - 6.

Conclusion (5). Analyzing the quality of the prints we can conclude that at first glance the works printed by the digital printing method have lighter shades and a little brighter. If a more in-depth analysis is done, using optical measuring instruments, then is that for digital printing the dot edge it is easy dusty, are found in the image the satellites. Technological advancement has made the result of the two printing methods very appropriate in quality. Thus the choice in favor of one printing method or another will be made depending on the time required for manufacture and the size of the print run. At the same time, attention will be paid to the price per unit, which at the moment, in the case of digital printing, is higher.

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