How Papermakers Can Appreciate the Evolution of Digital Printing on the Field of Offset Quality

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ABSTRACT: Industrial printing running higher than 500 copies are still highly dominated by the printing process termed "analogue". However, we know that in the near future Digital printing will supplant the usual printing processes such as Offset, Rotogravure, and Flexography. Some experts announce that 25 % of printing will be termed "digital" within 10 years (Table 1). So that to accurately understand this figure of 25 %, it is necessary to understand precisely what means digital and which are the main digital printing systems in terms of today's market. Then, the printing processes will be rapidly described as well as the names of the different existing devices in the different classes of processes. This study carried out by CTP since 1995 is described in terms of machines studied and papers which are used .The results presented here concern the studies of runnability of papers, optical density, gloss and tests of use of papers.

Processes	USA		
	1995 (%)	2000 (%)	2010 (%)
Lithography	46	42	30
Rotogravure	18	17	15
Flexography	18	19	22
Others	10	9	8
Digital	8	13	25

Table 1: Distribution by processes (MH Bruno 1995)

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INTRODUCTION

The main printing processes in the industrial field are the following: offset, rotogravure and the flexography. These processes are in use since about 100 years and all of them need a high-resistant printing form, which will allow a great number of prints and always the same information at each turn. The printing forms are carried out by different ways such as photographic ways and now they are starting to be performed by electronic means. The rotogravure cylinders are now engraved without film, the offset plates can be performed by CTP systems (Computer To Plate) with laser beams engraving dot by dot the information, and this still without film. In the printing field the transfer of information is digitized. Therefore, this corresponds to the change in the transport of the information from a physical way into an electronic, digital ways. The beginning of the digital change started in 1987-1988 with the introduction of Desktop Publishing process. As years advanced, the digital information mowed towards downstream of the printing flow.

Since 1993, digital machines can print four-colour papers with printing qualities similar to offset ones. The first known machines are GTO DI (Heidelberg), DCP-1 (Xeikon) and E-PRINT 1000 (Indigo). Of course, these types of machine evolved these last eight years and this does not concern only the sole digital printing.

Major classes of Digital Printing: Any printing receiving the information from electronic ways and which transfers it after to the paper by different processes can be classified in the digital printing range. Any printing machine not using preparation of printing form at upstream level of the machine can be classified as digital printing machine. The first category, which can be described as digital printing machines are the SOHO printing machines so-called ink jet machines and laser, machines. These devices print in monochrome (often black) but also in different colours. These devices give medium quality in terms of printing results and their productivity is very low. However, the amount of paper (in tons) used on these machines are very consequent. Some paper mills dedicate their total production to this type of products when fine paper is manufactured. However, when in use, it cannot be said if the paper is used directly on an office machine or on a photocopier. At this level, it is difficult to obtain statistics of use of papers. The fact of using paper on a photocopier rather than a laser-printing machine modifies only the theoretical concept of digital printing or analogue printing. But, this basic reflection is evolving because most of photocopiers under way of installation are now connected. Today a same machine can be used as a fax, printer and copier. The common point of these apparatuses will be called the printing engine describing the printing process being used. This leads us to say that papermakers must be reasoning in terms of printing processes rather in terms of digital or analogue printing.

The other major categories of digital printing are defined by the quality, which can be obtained according to the number of copies, which can be ordered to the device. Still at the same level of quality as the SOHO printing machines, there are printing machines which can perform a great number of copies (monochrome and with additional colours). These machines are marketed by IBM, Xérox, Océ, Nipson, Siemens, etc... The printing speeds are about 40 inches/minute for 20 inches-width. This equipment is used to perform companies' documents or to carry out books in small series. These machines are fitted with digital printing engines and systems for converting the digitized product. Let's talk about the following classes. There are high-quality and large format digital printing but with low speed, termed ink jet plotter. Presently, in the same class, there are ink jet-printing machines, which are beginning to supplant cromalin. These materials are used for the trial proofs before the analogue prints. The best known is the Kodak Iris. Afterwards, We can mention the colour-photocopiers, which can reach volumes close to the following class that we are going to describe. The last digital printing class that we mention in this report corresponds to the machines, which aim at proposing apparatuses competitive in terms of printing quality and cost in relation to the usual offset-sheet printing. The study that CTP has organised since 1995 corresponds to the study of the materials ranking in this class.

Descriptions of processes: Numerous processes are used in the field of digital printing. There are the electrophotographic processes, the ink-jet processes, the specific Indigo process, the digital offset Waterless processes, etc... The processes concerned in this study are offset Waterless, Indigo and xerography. The Waterless process corresponds to specific plates engraved inside the machine and then the use of usual offset ink with a waterless plate. The xerographic process corresponds to the information transfer on the photoconductor drum which by means of local electrical charge, will transfer ink toner powder to paper, then this toner is fixed to paper by heat or by a pressure accompanied with heat. The Indigo process corresponds also to the transfer of information on a central photoconductor drum by local modification of electrical charge and then the use of ink termed liquid toner which will be immediately fixed on the paper after its transfer. This liquid ink being transferred from the photoconductor drum towards the paper by means of the blanket.

IMPLEMENTATION

The digital study carried out is related to the behaviour and to the qualities of paper, which can be obtained with four-colour machines, competing the offset process. The apparatuses used are: Indigo E-PRINT 1000, Xeikon DCP-1, Xérox Docucolor 40, Canon CLC-1000, Quickmaster DI 46 and a print on a Heidelberg GTO 4 offset machine with Waterless plates. These apparatuses are made for performing few copies and also for thousand copies. Their formats are

close to A4 page and they can print on one or both sides of the sheet. They do not have the same specifications but it is not the subject of this presentation. In order to know the behaviour of paper on these machines, a batch of papers having the characteristics of the major printing and writing classes has been selected. These papers have been described in **Table 2**.

Type	Grammage (g/m^2)	Options
Fine papers	80, 90, 110, 135	
LWC	70	Gravure Lithography
Art papers	110	Matt & glossy
	135	Semi-glossy
	200	Matt

Table 2: C.T.P's digital papers panel

Market concerned by the study carried out by CTP: Table 3 shows the number of machines installed in the world and their paper consumption in terms of ton/year. The machines able to produce qualities more or similar to the offset ones represent now 500 000 tons of paper / year in the world. This figure is only estimation due to the uncertainty of some numbers.

Presses	Number of presses	Paper consumption Ton/Press/year
INDIGO	2000	50
XEIKON	2000	50
DOCUCOLOR & Similar	6000	20
QM DI 46 & Similar	1500	100
Paper Volume		470 KT

Table 3: Paper volume of the offset quality market

Criteria of the assessment: First papers are assessed in relation to the runnability, i.e. their ability to be accepted or not in the machines. Then, the printing quality is assessed thanks to the optical densities, printing gloss, printing homogeneity, behaviour to application tests such are resistance to ink scuffing, adhesive tape, rubber, folding.

RESULTS AND ANALYSIS

Optical densities: to summarise the densitometric results, we can present the **Figure 1** corresponding to the optical densities obtained with the entire 11 papers on the same Indigo machine. Most of digital printing machines give this result of optical density variation, which entirely corresponds to what is obtained with analogue machines, that is to say the densitometric results are higher for gloss paper and higher for coated papers. The other result linked to optical densities is the graduations of tones.

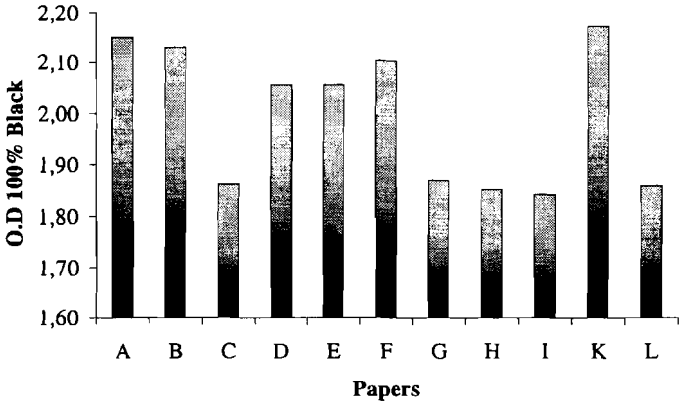

Figure 1: Optical densities according to the papers

Figure 2 presents the graduations of tones obtained for a same paper with three different machines. The maximum optical densities are variable from a machine to another and the graduations are also variable. It does not mean that certain machines do not accept some types of papers but this means that it absolutely necessary to calibrate the digital machines according to the papers being used. This calibration work is very simple with a digital machine but must be done when we try to accredit a paper on a machine.

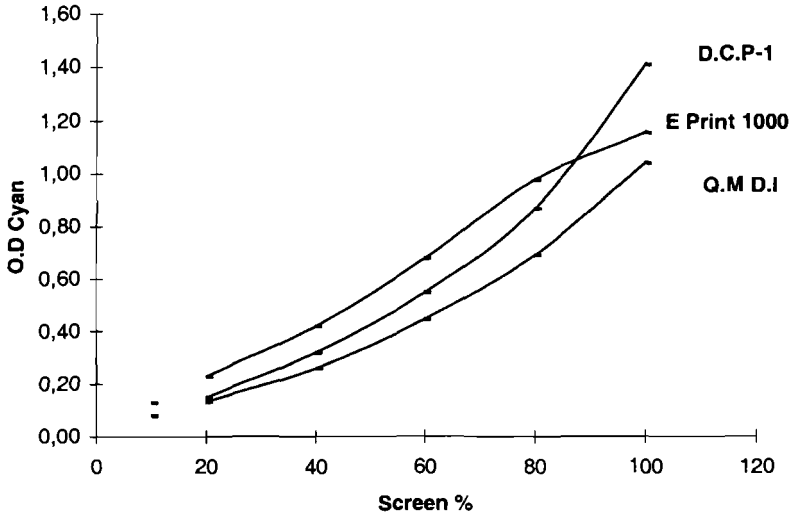

Figure 2: Graduation of tones on three machines

Printing gloss: Figure 3 shows on a same paper the comparisons of printing gloss depending on the machines. It is generally noticed: Indigo E-PRINT 1000 machines give low gloss, Waterless QM DI and Xeikon DCP-1machines give medium gloss and very high gloss degrees are obtained with connected photocopier such Xérox Docucolor 40 or Canon CLC 1000. Prior manufacturing, it may be necessary to know the use of papers. For example, it is not necessary to manufacture very gloss paper for Indigo machine while it would be necessary to have very gloss paper for the other processes. At the beginning of marketing the Indigo machines presented loss of gloss between the blank areas and the printed areas. New trials carried out in 2000 on the same papers show a good evolution of this characteristic (**Figure 4**).

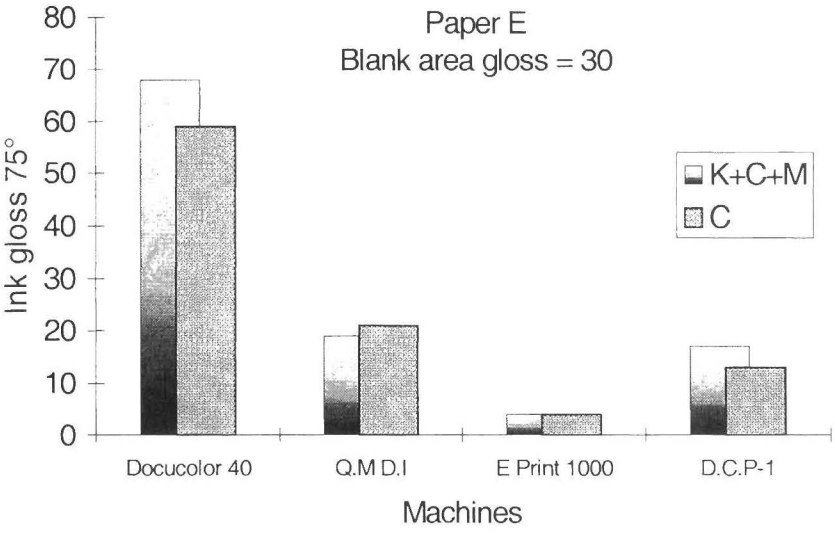

Figure 3: Printing gloss on 4 machines

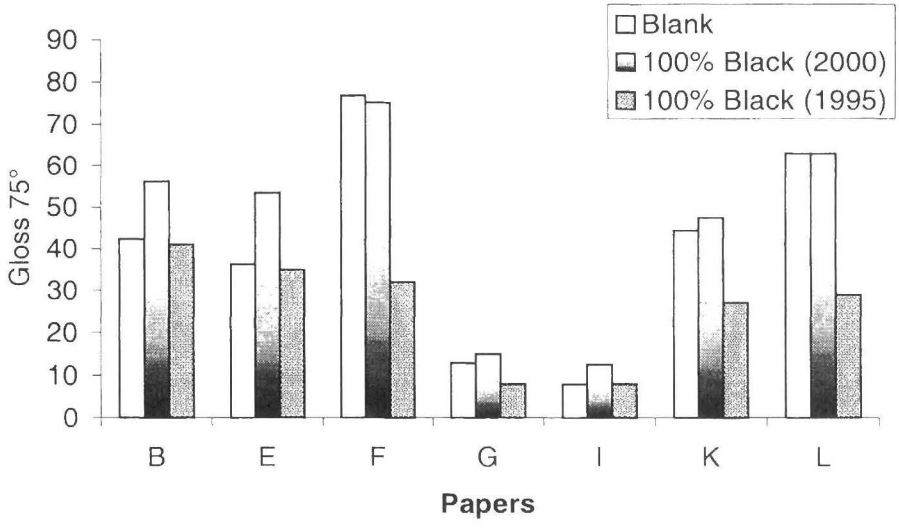

Figure 4 : Evolution of gloss on Indigo (1995–2000)

Printing unevenness: Figure 5 shows the printing unevenness obtained with three papers on four different machines. To sum up, it is necessary to know that the unevenness: noticed on digital machines is more linked to the apparatus than to the paper. For instance, few problem of unevenness: are noticed with Indigo and Offset Waterless machines. But it is necessary to manufacture specific papers with a good formation of sheets, a controlled moisture and rigorous electrical characteristics for the papers which are used on machines termed xerographic (Xeikon, Xérox, Canon). In addition, machine constructors using a printing xerographic engine are making progresses in the field of adjustment of machines aiming at reducing these problems of unevenness:

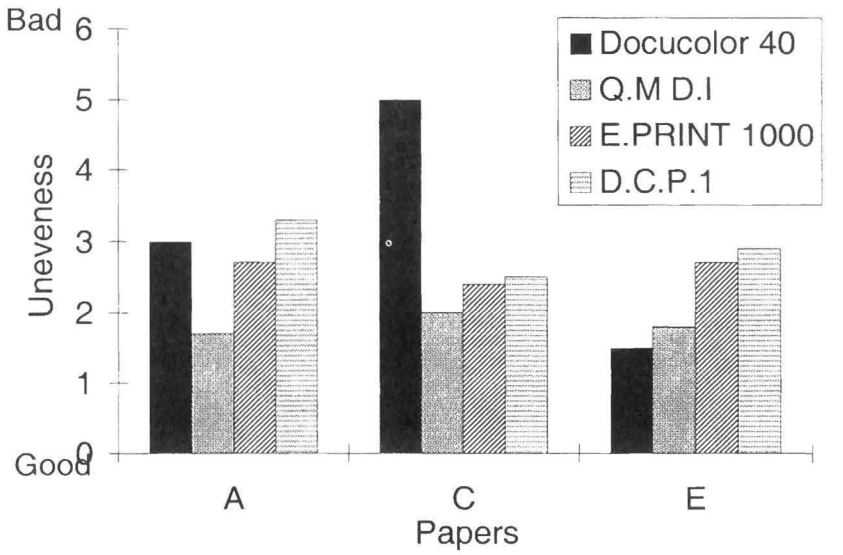

Figure 5 : Printing uneveness on four machines

Application tests: Four application tests are used. Only the results of two tests are presented here. **Figure 6**: tests of resistance to scuffing on 3 papers with two machines (Indigo and Xeikon). Then, **Figure 7** shows the same papers with the same machines but this with the adhesive tape test. To sum up, it is neccessary to keep in mind that the papers will present different degrees of resistance to aggression depending on machines. For example, as for the xerographic processes, it will be necessary to have good resistance to the Wallace test and to the folding test. But, as for papers for Indigo, it would be necessary to be careful at scotch test and at rubber test.

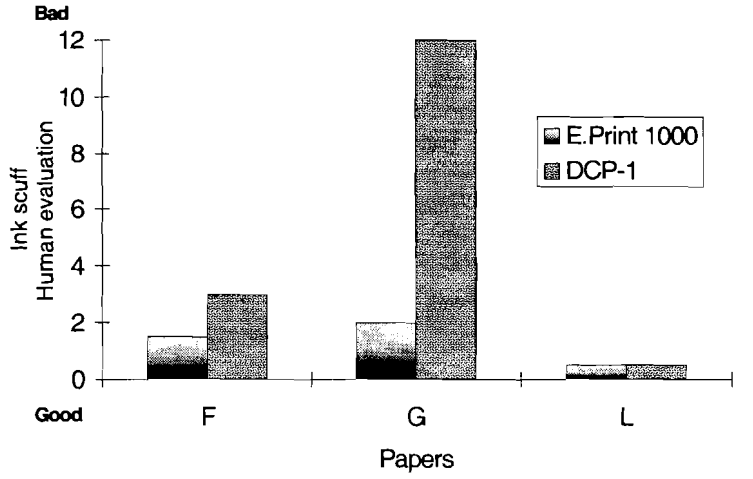

Figure 6: Ink scuff on two machines

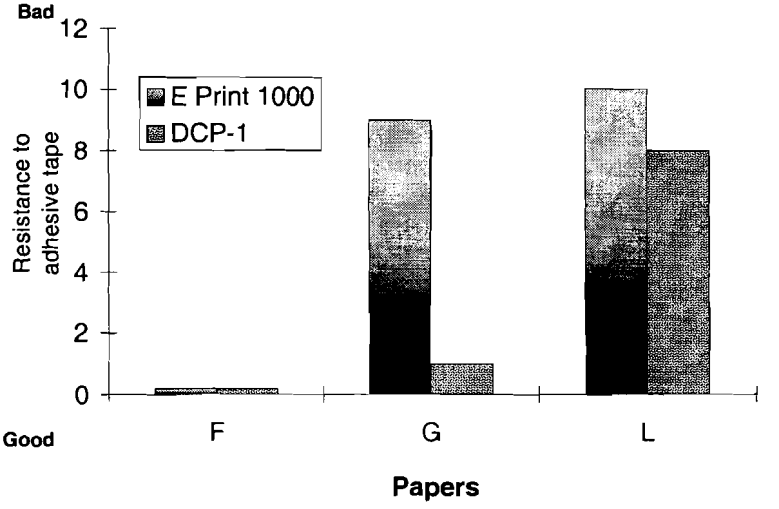

Figure 7: Adhesive tape test on two machines

Runnability:

Most of papers comprised between 80 and 250 g/m² can be printed on the present digital machines. The limits, which are actually met, are only linked to problems of too low or too high stiffness. It has also to be noticed that they are problems of ink refusals with the Indigo process on some kind of papers. It has to be noticed that some printers using this Indigo equipment resort to the "Saphir" treatment in order to dress the paper before use on Indigo machine. However, some papers do not present at all problems of ink refusal and this without being "Saphir" treated.

CONCLUSIONS

In the future, the digital printing will supplant at least 50 % of the present printing. By digital printing, it has to be understood the "new" printing processes in term of process and not anymore in term of digitization of information. The processes such as xerography, Indigo, elcography, Scitex ink jet, etc. will take more and more place and it is absolutely necessary to know the problems that can be met with these types of installations in order to know the tests that must implemented so that to characterise the papers on commercial level and further on laboratory level in paper mill.