

An Introduction to Directions in Digital Marking Technologies

B. E. Springett

Supplies Strategy & Integration, Xerox Corporation

Webster, New York

Introduction

There is general agreement that the technological pace of change has steadily quickened over the past 150 years. Many pundits over this time have predicted various commercial outcomes – often erroneously perhaps the most glaring of these misconceptions is the statement attributed in 1899 (ominously at the end of an earlier century) to C. H. Duell, commissioner of the US Office of Patents to the effect that the Office of Patents was no longer needed because “*Everything that can be invented has been invented!*”

Non-Impact B&W Digital Marking Technologies arrived on the scene a scant 25 years ago with a strong focus on the office work-place, plain paper and black & white printing; it was initially a substitutional technology. It soon become apparent that, allied with other aspects of the digital explosion, it was much more than that! Today, the original marketplace has slowed to an average annual growth rate of less than 10%, which still easily outpaces the population and GDP growth of most places in the world. Viable Non-Impact Colour Digital Printing showed up about 15 years ago and is still in an expansionary phase in the office work-place; additionally, all material printed in colour by various traditional printing technologies is under some measure of threat from one or more on-demand digital printing technologies. The current sizes of the various markets outside the office are large and, as with the office, a digital approach, besides being substitutional, enables things which were not possible before. This talk is intended to set the stage for the ensuing discussions which will address the challenges, the threats, the turf wars, and the opportunities which can open up for each of several digital marking technologies. Along the way, some indications as to likely outcomes will be made.

Discussion

That said, the overall intent of this focal session on the future directions of digital printing is two-fold. (1) To probe more deeply into the perception that as we pass into the new millenium, we seem to be moving into a world where anything that can be digitized is being (or will be) digitized – a world where we are moving well beyond simply “*marks on paper*” to one of “*digital colour marks on*

anything”. (2) The world-wide markets represented by this digitization of printing runs into hundreds of billions of dollars, with some sub-segments being as large as one to four hundred billion dollars. Now more than one digital printing technology can satisfy the quality, cost and other requirements of many of the sub-segments so these talks are also aimed at trying to give some sense of these technology battlegrounds and what it will take to be the victor.

To give some brief examples of the movement beyond paper, consider this following range of non-impact digital printing undertakings that have been announced or described within the past two years: birthday cake and cookie printing; carpet printing; adverts on the exterior of buses; billboard printing; digital photographs; printing on drink cans; wine bottle labels; airline tickets; event tickets printed at home; point of sale receipts; decorated textile printing; wallpaper printing; pre-press proofing; printing on plastic film and metallic foil for packaging; home furnishings and decoration; personalized greeting cards; digital offset press plates; flat panel display circuitry; more than just 4 colour [i.e. CMYK] printing such as specific trademark colour matching; whole books; one-to-one marketing / sales pieces; DNA microassays for gene probes; printing with pearlescent, metallic or iridescent pigments; printing with scented inks and toners; glow-in-the dark prints; magnetic ink printing; medical X-ray images; postage; CD labels; corrugated products; and even 3-D object proto-typing. Clearly the objects that are being printed are no longer two dimensional, nor constrained to some form of paper, nor even constrained to any particular size or shape.

So we have a situation where for some print markets such as the office or aspects of transaction printing or publishing, digital printing is very well established; we have other areas where full digitization is replacing an older technology such as analog copying, or silver halide photography, or parts of the offset (or lithographic) markets; we have other areas where digitization is transforming the printing process such as offset printing, the printing of books, repair & technical manuals, etc., and large format printing for posters, billboards, maps, backlit displays, textiles, etc; and yet other areas where highly specialised niche markets are springing up based on digital printing such as birthday cakes, CD labels, or mouse pads. Much of the printing industry is connected to advertising or sales; the

digitization of printing is opening whole new avenues of customization in support of this. Such things as personalization, one-to-one marketing, data mining for customized information or intelligence reports such as a condensed version of your favourite newspaper in your preferred language delivered to your hotel room each day of your stay; or instant newspapers or product packaging or textiles for special events. To give some sense of the market sizes (by annual revenues, as opposed to square metres, printed) associated with certain application spaces consider the following brief table (the estimates are a composite of estimates by various industry analysts).

Offset Printing Industry	>\$400B
Document printing for the office and general use	>\$200B
Flexible packaging (paper, film, foil)	>\$70B
Offset Printing & Digital Non-Impact Presses	>\$50B
Digital photography (printing only)	>\$20B
Wide format Printing	>\$15B
Decorated Textiles	>\$10B
Banners & Posters	>\$5B

At this point, it is well to try to spell out some of the characteristics of digital printing which make it capable of being considered as the method of choice for such a wide range of applications besides the pull from the attractiveness of markets with such large revenues at very attractive margins.

- ◆ Every page can be different [e.g. Variable Data Printing].
- ◆ Instant to very short turnaround times [e.g. Print-On-Demand].
- ◆ Print Quality that mostly matches the technology being replaced [e.g. Digital Photography].
- ◆ Alternatively, Print Quality that meets the threshold requirements of the user or buyer.
- ◆ Cost of colour printing in the range of affordability of many entities - from home users to graphic arts specialists to commercial and quick printers.
- ◆ Acceptable economics for a single page job.
- ◆ Printers (or digital presses or multi-function machines) are easily connected to networks and data-sources.
- ◆ Capable of adaptation to wide formats (>1000mm wide) and high speeds (>1000PPM).
- ◆ Capable of adaptation to very compact designs (e.g. <1000cm³ or < 4Kg).

However, not only is the act of printing being digitized - i.e. preparing the printing system to place bits on some substrate - but so also is the workflow of the total creation of documents, books, packaging, photographs, and on and on. The changes in telecommunication, networks, and the near-universal access to the Internet are also playing a role in the changes we are seeing. These changes include the shift from print and distribute to distribute and print; shared computing resources for collaboration in the creation process, at a distance, almost instantaneously; the ubiquity

of colour on computer screens and its increasing presence in all kinds of hard copy.

Yet another aspect of the drive to digitize everything is the movement to try to provide an electronic substitute for paper. Futurists are sure this will happen; traditionalists say that paper has too many good things going for it including low cost, light weight, flexibility, archival qualities, and the general level of cultural trust in paper. There is also the more general almost spiritual view as expressed by this recent quote from John Updike, "*Our notion of a book is of a physical object, precious even if no longer hand-copied on sheepskin by carrel-bound monks, which we can hold, enter at random, shelve for future reference, and enjoy as a palpable piece of our environment, a material souvenir of the immaterial experience it gave us. That books endure suggests that we endure, our inner tale not written in the water of an Overbook's e-ink.*" [This should be contrasted with a recently expressed view by Rick Thoman, ex-CEO of Xerox Corp., "*Documents themselves will change. They will move seamlessly between the paper and digital worlds and they will increasingly contain music and video as well as text and pictures*". Whatever the ultimate outcome, there is at least one obvious trend, depicted graphically in the accompanying Figure 1 [which itself is an amalgamation of trends predicted by many analysts], which is that there are going to be many more documents created than are going to be printed - but the rate of creation is so great that the trend for printed pages is still upward in the range of 3-5% CAGR, so perhaps the signs of a demise of paper in the office will only be apparent beyond the time horizon of this set of discussions.

Not all attributes that customers require can be satisfied simultaneously by any one technology and so customers make trade-offs amongst them. This is what allows different technologies to co-exist and why one technology can drive out another such as ink jet printers far outselling electrophotographic devices for low speed, low volume applications, or the fact that most analysts, and some companies, are publicly stating that no more analog (light lens) copiers will be designed after 2001. It is not just different technologies that are co-existing; digital printing technologies are complex enough that many variants of each major technology exist and also compete amongst themselves for dominance. This can be exemplified by the fact that there are 12 -15 different companies which have their own design for the low speed colour laser printer market, not to mention the 6 - 8 companies with ink jet variants which are also striving to compete in this same space. Figure 2 is an attempt to summarize this situation by giving a sense of where the various digital technologies play today or can play in the future. This intra- and inter-technology competition is a powerful force driving both innovation and a continual cost reduction spiral.

Conclusion

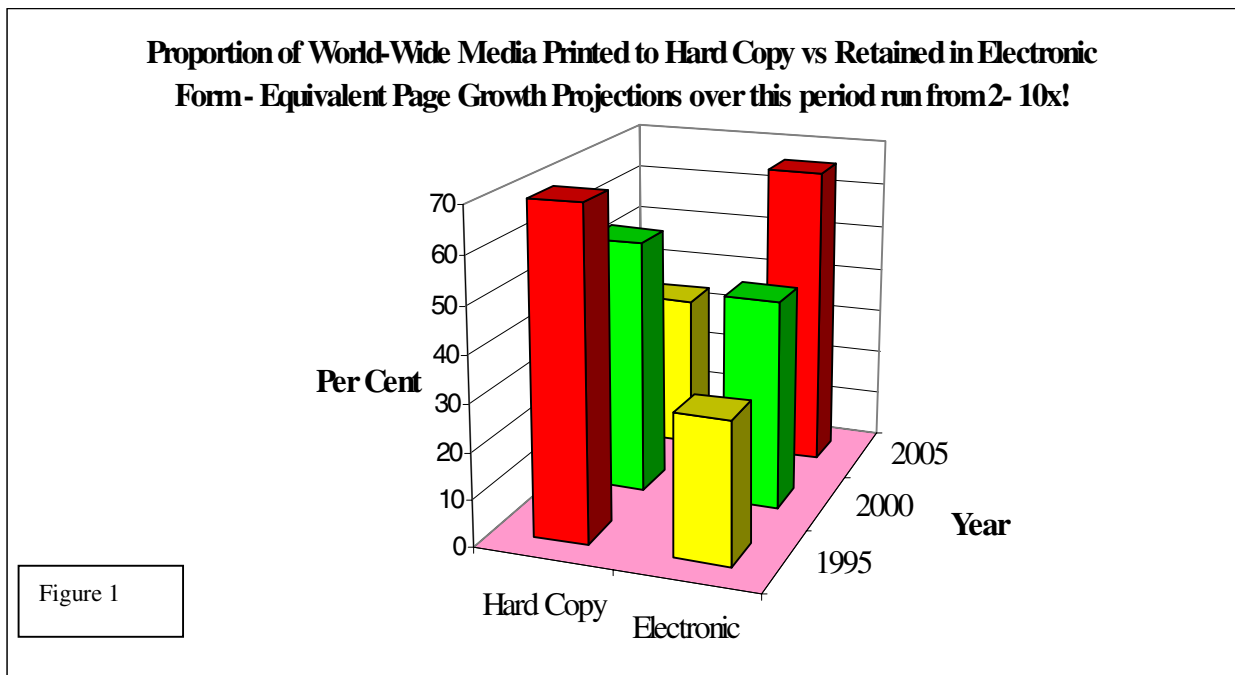
Since the time horizon of this set of talks stretches out 10 years from now, and just to give some idea of the sort of

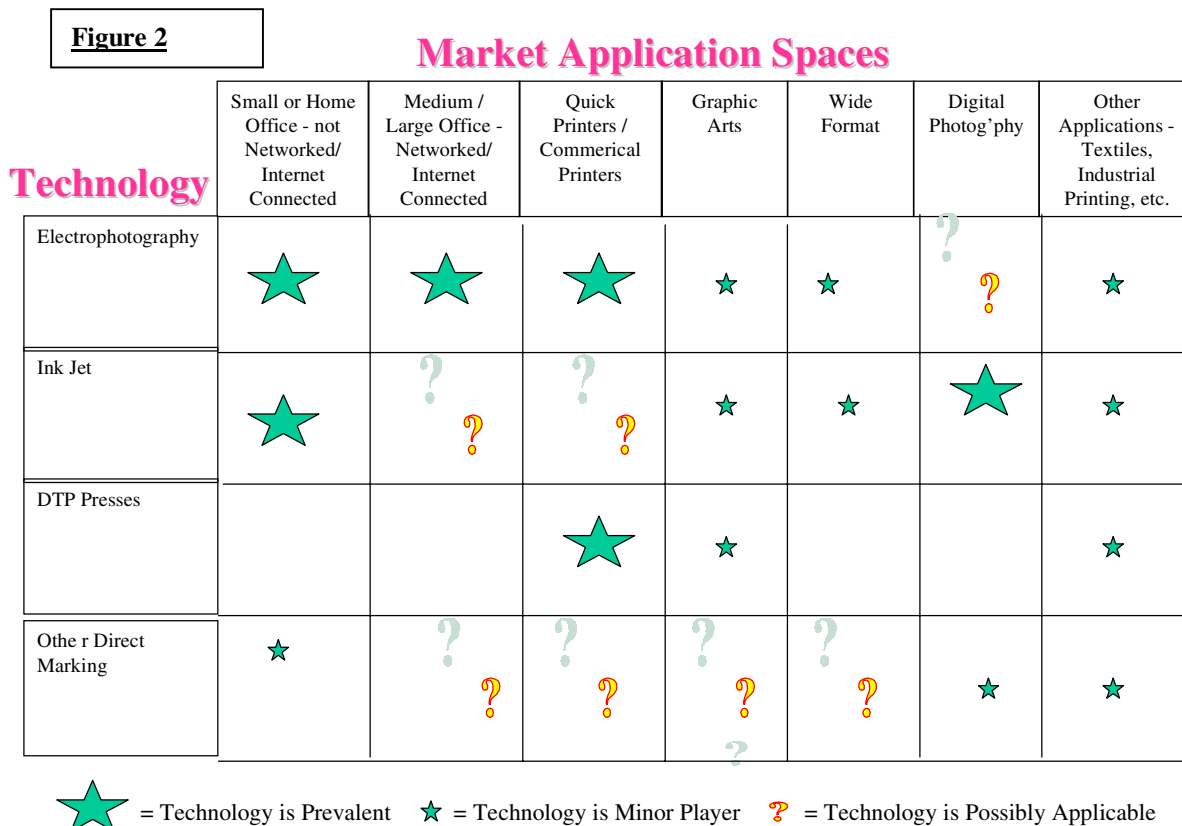
changes than can be expected in the next 10 years, let us now turn to a sample of some of the predictions regarding digital printing which have shown up in various public places over just the past 18 months.

- ◆ Small format (106mm x 154mm) digital photographic printers weighing less than 250g.
- ◆ B&W digital presses with speeds in excess of 10,000 pages per minute.
- ◆ Networkable colour ink jet printer speeds of 20 colour pages per minute for less than \$500.
- ◆ Four colour digital presses with speeds in excess of 2000 pages per minute.
- ◆ Offset printing to be all-digital within 4 years.

- ◆ Direct Imaging (computer-to-press) will incorporate variable data by 2005.
- ◆ Paper usage will start to decline by 2010.
- ◆ Electric paper will be a reality by 2010.

Apart from the absolutist C. H. Duell comment mentioned earlier, we are all familiar with the past absolutist, mostly negative, predictions by prominent personalities regarding telephones, computers, television, etc which all proved to be laughably far off the mark. So perhaps it is well not to dismiss this set of suggested outcomes out of hand – and perhaps the next 8 speakers will provide some evidence as to why they should be taken seriously.





Biography

After graduating from Cambridge University in England in 1960 with a degree in Physics, Dr. Brian Springett worked briefly in the semiconductor industry in Southern California; his principle concerns were the early efforts at LSI technology and making solar cells for NASA. He moved on to the University of Chicago where he received a Ph.D. in 1966; his principle areas of interest were quantum liquids and charge transport in disordered media. Dr. Springett held faculty positions in the USA & Canada before joining Xerox Corporation in 1974. He is the author

or co-author of more than 50 technical publications, has presented many tutorials on various aspects of electrophotography, and is the holder of 11 United States patents and 2 European patents. Dr. Springett's major focus has been the designs and manufacturing processes of large-area photoconductors, both inorganic and organic, and their integration into on-demand imaging systems which produce hard-copy output in both black & white and colour. Dr. Springett's current position is manager of Materials Strategy & Integration within the Supplies Development & Manufacturing group at Xerox Corp.