Wide-Body Printer Trends — Electrography

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Introduction

The future significant trends of wide body digital printers indubitably has analogies in the past. Thus, a selective review of these can be enlightening. From such review it is seen that wide printer developments have been either revolutionary or evolutionary. The first includes developments that allow people to do things they could not do before. The second allows, or was intended to allow, people to do better, faster or more cheaply, things they could already do. These are all responses to appreciated need that can be met with newly available or newly enabled technologies. The repeating theme is the case not just for any wide format digital imaging technology as a whole, but for significant developments within the technology. The examples that led to this belief came from pen plotting and electrography. However, they are seen also in electrophotography, thermal transfer, direct thermal, digital air brush and ink jet whether using solvent, aqueous or solid inks.

The choices for this review have another premise: they demonstrate the two contrasting styles in the market with the spread of digital output devices: order and disorder. Pen plotter developments have mostly been orderly, while electrography has seen both. Electrography is also interesting because as a wide technology its demise has been predicted often, yet it has gone through three major lives. Understanding why this has happened can set the stage for more reliable prediction of the future, the trends, in wide format digital color printing.

Computer Aided Design: The Lessons from Pen Plotting and Electrography

From the first time computers could do work that could be expressed on paper there has been a demand for printers. The first common application requiring a wide machine was computer aided drawing (CAD), a vector-based activity. Calcomp made a single pen plotter with a large drum which held the cut sheet. The pen was driven across the surface of the drum, for X data, and the drum rotated for Y data. As was the case with most first generation devices it was cumbersome, large, slow and very limited in its capability. However, it was readily accepted by some end-users because *it enabled them to do something they could not do before*.

The next generation pen plotter had a belt to support the media. This reduced the foot print and mass greatly. It was faster, simpler and had greater capability. The color output when multiple pens were added was revolutionary, while the simplicity and speed were evolutionary. Both led to new demand.

The third pen plotter revolution featured friction wheels to move the media, and automatic feeders with cutters so roll stock and unattended operation were enabled. This also greatly simplified design, size, and hence cost. Easy personal computer hook-up with simple software enabling each designer his own machine was another revolutionary step. Once again, significant user groups *were enabled to do something they could not do before*.

Pen plotters also filled certain special niches where the capability was uniquely suited. One was for large, undimensioned drawings used as masters for large cutting machines. The requirements for high accuracy, less than 0.01%, were reliably met for many years, until eventually these machines were seen as slow, clumsy and out-dated - other technology advances had made them obsolete.

The individual user pen plotter also suffered from low speed, especially for complicated drawings, as each line was individually drawn . There was no way for break-through so it left another opening for some other advance.

The first technology to produce drawings rapidly was electrography, a raster based technology in which electric charge is deposited on the surface of a dielectric medium in response to the instructions from the computer. The latent image formed is developed on passage through a toner station. The full width writing head enabled plotting at about 1 cm/sec, at least one and often two orders of magnitude faster than pen plotters. These devices were expensive, difficult and messy to operate, and required special media and operating rooms. The image left much to be desired but it compared well with diazo reproduction. Nevertheless, there was a substantial adoption, and for a long time design shop computer room floor space was shared with pen plotting.

There followed a series of evolutionary developments as printer widths, speeds and resolutions all grew, and the designs were simplified and shrunk. The last machine introduced for CAD had a design and size similar to the personal pen plotters. Niches were addressed. A small number of very wide (72 inch) machines were made to produce patterns for fabric cutting in the apparel industry. A few printers were specially modified for the undimensioned drawing market, as they were small enough and fast enough to be used for distributed printing. This application was not well satisfied because the combined variability of the machine and the film exceeded the product requirements - the accuracy of any print could not be routinely predicted.

A major revolutionary development was the introduction of color by Versatec, a development that took less than a year, and opened up a new segment in the design area for which color monitors had created a major demand - the rendering of solid areas and objects in color *which could not be done before.* Printing solid colors also led to one of the major challenges the industry has faced: color matching and color consistency. Although in CAD there has been little desire for precise colors putting corporate logos on drawings raised this requirement, such symbols are frequently very vigorously specified. A substantial number of evolutionary improvements to all parts of the system followed and addressed this.

After the early days of easy success there were a number of developments made in electrography to support the CAD market. In the main these were essentially unsuccessful as they did not add sufficiently to the capability and did not enable anyone greatly. The improvements were too slow to keep abreast of market expectations.

Electrophotography was developed by Xerox Engineering Systems for CAD. Although it gave high image quality and reliable performance it was expensive and limited to monochrome in a world accustomed to color. Attempts to take it beyond 36 inches wide failed. At about the same time direct thermal plotters were introduced, at first for seismic surveying. These monochrome machines too, found a modest market in CAD and spelled the end for monochrome electrography. However, neither electrophotography nor thermal were revolutionary as they did not lead to substantial new enablement.

The final CAD revolution was the personal wide body ink jet printer, introduced in monochrome by Hewlett Packard, and color by EnCad in 1991. The cost, ease of use, speed and the availability of traditional media again allowed *people to do something they could not do before* Ñ in this case have cost effective drawings produced by the designers themselves on their schedule, at their work site. Ink Jet made obsolete all other plotting technologies except for a few specialized applications or highly centralized organizations.

The lesson from CAD is technologies have been rapidly adopted *whenever people have been enabled to do something they could not do before*. Developments that do not clearly do this are prone to at best limited success and low market share, and more likely, failure.

Wide Body Digital Full Color Printing: The Lessons from Electrography

The early raster printers were shown to reproduce graphic images. Logos and symbols were routinely preprogrammed. Reproduction of scanned images quickly followed the spread of color. However, for the printer manufacturers printing was an oddity, not mainstream like plotting. Indeed, the possibilities for using the printer as such, and not merely as a plotter or output device for geophysical and geographic information, were recognized and realized independently by innovators and enthusiasts, like Harry Bowers. Starting around 1987, a number of *value-added-resellers* (VARs), obtained the printers, coupled them with software, scanners and, most importantly, training, and promoted them in the market. The output was often stunning and there was significant adoption for point-of-purchase advertising, photo-reproduction and short run poster printing. This was in spite of not only the obvious image deficiencies such as banding from the multiplexed writing heads, background, and staining, but also the sense of disorder while the OEM ignored the market.

Raster Graphics made a breakthrough with their 54 inch wide 4 inch per second multi-pass printer In addition to greater speed and width, this device printed consistently without banding at a level very well suited for posters, signs and advertising. It featured a full width writing head with individually driven nibs. It was greatly handicapped by poor web handling—the design required media with dimensional properties (flatness and straightness) outside the capability of typical commercial paper machines supporting this industry. Redesigns, so common to electrography, improved it but, although getting good acceptance, it remained marginal.

A parallel electrographic effort was initiated in 1987 by 3M Commercial Graphics, to provide a digital printing option to a major market: screen printing on vinyl. The ScotchPrint Process, a full turnkey system, incorporated a work station with scanner, a single pass printer (initially built by Synergy Computer Graphics), a dielectric paper with release characteristics, a special toner, surface treated vinyl substrates and a hot laminator. An image was printed in mirror image form onto the release paper and then transferred to the vinyl substrate with the laminator. The system was introduced in a limited way through beta sites and the early problems worked out before it was widely promoted. When it was brought to market it enabled the fleet graphics industry to profitably produce just a few images—*something that they could not do before.* The business spread to signage, whole bus advertising and point-of-purchase advertising. Supermarket floor advertising started with ScotchPrint.

In time the ScotchPrint printer base was extended to multi-pass machines, although there were generally compromises from the single pass performance. The failure of the other electrographic OEM's to make substantial machine improvements needed to keep pace with the market, resulted in 3M designing their own new single pass printer, the System 2000. Its productivity is more than double of any other electrographic machine. It should maintain competitive positioning with recent highly productive ink jet printers. It will probably be used mostly by industrial printers, less by those adopting electrography during its first 5 years in graphic arts. Steady predictable development of this system can be expected.

Electrography has quietly commanded a substantial market in graphic arts over the last decade. Indeed, it was only in 1996 that wide format ink jet media shipments equalled those for electrography in this arena.

Role of Substrates in Wide Body Printing

It is well known that both hardware and software developments are crucial for printer technology adoption. For example, electrography was handicapped in its early seismic days because the computers could not process the data as fast as the plotter could print. It is less well known that media suppliers play crucial roles. Thus, the pen plotter market was facilitated by papers and films that could be drawn on at high speed, yet did not puddle when the pen remained stationary and in contact with the surface. Similarly, the large high accuracy plotters needed especially flat dimensionally stable polyester film. Penetration of Government and Defense Department contractors needed new vellums. All these demands were responded to by the substrate industry, in most instances in response to market insistence.

There are some systems which have been media driven right from inception. The most notable is the ScotchPrint system which centres upon a special electrographic imaging paper with toner release properties.

In a few areas, though, media suppliers have been proactive and independently developed substrates for uses that were otherwise not possible. Electrography is notable in this area in art because the media is an integral part of the image generation system—the electrical circuitry of the printer includes the conductive and capacitive parts of the medium so very special media are necessary. Additionally, it was recognized within James River Graphics that they were in an enabling position—that they *could allow people to do things they could not do before.* A number of special substrates were developed to enable the technology to penetrate new markets.. For example, outdoor poster grade paper was developed and introduced specifically for billboards and subway advertising. Similarly, a family of presentation media, high whiteness, high image quality heavy weight papers was made specifically to enable the use of the process for photo-reproductions. A unique development in transfer coatings, Wear Coat, simplified electrographic printing on an almost limitless range of substrates, again, a major enabler of the technology and a stimulant to market growth.

Thus, not only hardware or software engineers can be revolutionary - media scientists can be enablers too.

Trends in Electrography

Electrography today remains a technology where the user is required to compromise. For the benefits gained with speed, durability, good color gamut, at moderate cost, he is faced with high levels of image artifacts, image striations, high back ground from stain and artifacts, complicated technology and a limited range of directly printable materials. Revolution will come only if there can be a major breakthrough in machine cost, coupled with better speed, greater ease of use, elimination of the artifacts and availability of a much wider range of directly printable media.

There are no strong indications that another revolution will happen. The current activity is evolutionary with changes that are faster, cleaner, offer greater resolution, and more precision especially with color. Announced machine changes are, in real terms, modest and incremental. There is an extension of the directly printable substrates with adhesive vinyls but this merely replaces some of the already successful transfer processes. Color matching and consistency have been improved in the hardware and software but the media remain highly variable and so very problematic. The media also contribute substantially to the levels of artifacts and defects. There will be evolution that ensures electrography will remain accepted by the industrial printing community for the foreseeable future. The commercial photo-reproduction market is, however, expected to be lost to ink jet.

Revolution is still possible—there are total system changes that can lead to simplification. The technology can print at high speed so that the wide digital printing press is feasible. Time will tell if the critical components can be brought together before the market is taken by other full width, digital technologies. It also must be directed to markets that have not yet gone digital. The largest of the remaining analogue markets is fabric printing—a market that is an order of magnitude greater than paper printing. Where else are there untapped areas where someone is waiting to do something that cannot be done today?