DEVELOPMENT OF A SYSTEM FOR COMPUTERIZED, AUTOMATIC INK-FLOW CONTROL

Bruce L. Quilliam*

Abstract: A system for computerized, automatic ink flow control greatly simplifying the task of presetting ink fountains (for web and sheet-fed presses) is described. The system design embodies two basic principles: (1) establishing reliable, easy to use, programmable ink density criteria via a plate scan process; (2) converting and utilizing the plate scan data to program motor driven, leak-proof segmented fountain blades. Although the concept of a segmented fountain blade originated approximately one hundred years ago, it was universally considered unworkable because of ink leakage. For nearly a century, attempts to produce a workable segmented blade resulted in failure. Sufficient concept design data was available, but practical improvement consistently appeared unfeasible; therefore, design optimization (or re-design) of a segmented blade was a paramount consideration in the development phase of this system. The second important design consideration in the development phase of this system consisted of establishing a method to obtain programmable ink density data in zonal configurations corresponding to individual blade segments; this led to the plate scan concept. This paper describes all of the promulgating criteria, design and development considerations and the resulting equipment design of the Perretta I-77 Ink Flow Control System.

* Perretta Graphics Corporation

BACKGROUND INFORMATION

Automated ink fountain control has been a dream of the printing industry for a long time. Since the invention/development of the conventional ink fountain, printers (those directly involved with laying ink on paper) have been trying to eliminate or to minimize (to the greatest degree possible) the need to rely on: (1) visual color judgments as a method of determining ink density (film thickness) criteria; and (2) manual fountain key adjustments in order to achieve proper ink film thickness. Historically, it had been thought by many that automation necessarily meant the achievement of both goals in a "closed loop" system...and that only such a system would provide significant contribution to improved ink flow control (Mertle and Monsen, 1957). In the last few years, several systems (both "closed loop" and "open loop") have been developed and marketed, each claiming to be the utopian answer to automated ink flow control.

Unfortunately, certain variables inherent with the offset printing process, along with material cost factors have precluded, to this day, the practical adaption of a "closed loop" system to the press. Probably the most important stumbling block or consideration in the achievement of a successful "closed loop" system has been the development of an on-line scanner that would accurately monitor and control:

(1) plate moisture
(2) ink flow for each fountain key...this would necessitate a determination re: the need for fountain key adjustment <u>vs.</u> the need for

fountain roller stroke adjustment vs. the need to replenish the fountain ink supply.

Assuming that such a scanner could be (or has been) developed, the practical matter of material cost necessary to afford paper space for color monitor bars (or other means) for the purpose of adjusting individual fountain keys on an in-process basis tends to be formidable.

With the thought that on-line, ink scanning control might someday be developed to a point where the variables previously mentioned would no longer be problematic, Frank Perretta of Perretta Graphics began, in 1974, to develop an "open loop" automated ink flow control system that could easily be converted to "closed loop" when and if the occasion/conditions warranted. The primary aim of this system was: to provide remote, reliable and precisely repeatable control of the ink fountain while eliminating or minimizing (to the greatest degree possible) visual color judgments for ink fountain presetting...a system that would still allow the pressman to evaluate the printed sheet vs. press conditions, to make necessary corrections based on experience, and to readily re-program the remote control system to accept these corrections. Increased productivity brought about by reducing fountain present time to a minimum and the reduction in material waste brought about by achieving salable product in the shortest possible time makes such a system very attractive economically. Based on industry averages, it was estimated that web offset printers could realize the following savings. Refer to figure 1.

(1) 4,000 sheets of paper per makeready

(2) 20 lbs. of ink per makeready

(3) 55 minutes of press time from startup to salable product

(4) energy costs (variable according to locality) for 55 minutes of press operation

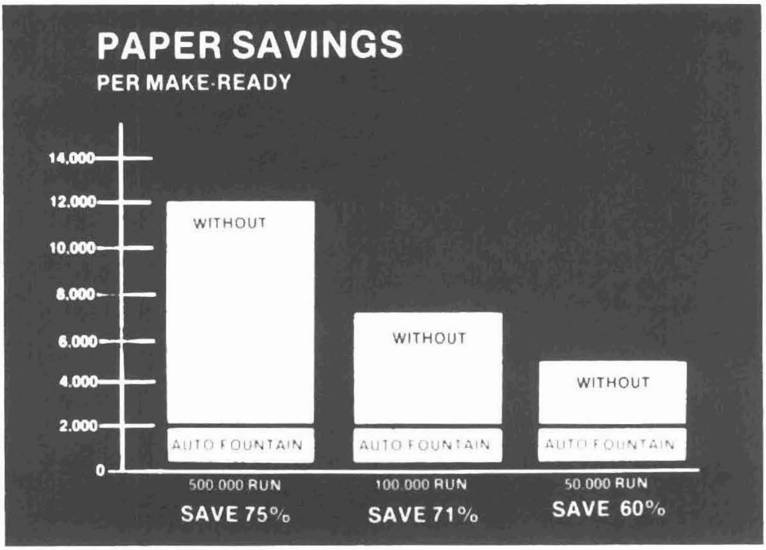

Figure 1. Estimated Savings With Automated Ink Flow Control

Although waste factors for sheet-fed presses are lower, substantial savings could still be realized.

As far back as 1887, it was recognized that the conventional ink fountain (still in universal use today), employing a continuous spring steel blade (doctoring or ductor knife) with a plurality of adjusting keys, possessed several deficiencies which have gone unchanged for nearly a century. Notably, these are:

(1) Surface irregularities caused by inevitable fountain roller and/or blade wear preclude the possibility of obtaining precise ink

flow apertures between the blade and the roller, thus limiting the ability to achieve proper ink flow characteristics in accordance with demands of the press plate.

(2) By overcoming internal stresses, the adjusting keys "warp" or "shape" the spring steel blade to form variable ink flow apertures between the blade itself and the fountain roller. However, the adjustment of one key affects the neighboring key settings; consequently, when sensitivity varying the ink blade adjustment, it is not possible to effect limitations to a narrow strip (Jeschke, 1977). Every key along the entire fountain blade must be worked and reworked until all internal stresses in the blade are set for proper ink flow. This phenomenon has proven to be a major stumbling block in achieving any degree of automation using the conventional ink fountain.

.(3) The action of a single key upon a fountain blade can, at times, cause the blade to torgue or to twist (sometimes called "spring a blade") along its entire length or any portion thereof.

One of the first attempts to rectify any of these deficiencies was made approximately one hundred years ago, with the invention of the segmented blade (Jaeck, 1887). This blade comprised a plurality of knives that could either be raised or lowered or moved in rectilinear fashion toward or away from the fountain roller. Portions of this latter principle were found, at a later date, to be sound; but, unfortunately, mechanical technology of the times did not permit development of a leakproof blade. Subsequent attempts at development of a segmented blade with rectilinear movement (Bradford, 1899; Wood, 1981; Faeber, 1952; and others) had considerable merit; but, each attempt failed to overcome the ink leakage problem.

Experimentation and research with segmented blades was not confined to those with rectilinear action. Jaeck's concept of a blade containing a plurality of knives that could be raised or lowered toward or away from the fountain roller did not go ignored. Notable amongst these experiments was a cleft blade; in principle, a ductor knife divided into zones by cutting a continuous steel blade into uniform segments which are raised or lowered toward or away from the fountain roller by the flexing action of attached spring bands (Jeschke and Pfizenmaier, 1978). With this type of blade, ink leakage/accumulation between the raised and/or lowered segments poses an obvious and serious maintenance problem. It was, however, the cleft blade principle that Frank Perretta first researched in 1974. One design after another was subjected to extensive experimentation and research. Note: As a practical point, it should be noted that with a cleft blade:

(1) Press washup necessitates that each segment of the blade be returned to "zero". Unless each segment is returned to an absolute "zero", the uneven edges of the segments make washup a more difficult task.

(2) Ink accumulation on the exposed edges of the raised and/or lowered segments poses and

additional problem in press washup.

Because of these problems and because of incorrectable ink leadkage (although this could be minimized), the cleft blade principle was ultimately abandoned.

DEVELOPMENT OF A WORKABLE SEGMENTED BLADE

In view of the foregoing, the following broadly defined mechanical/technical/performance characteristics were established (and achieved) as design targets for development of the I-77 in fountain (Perretta, 1977). Refer to figure 2.

Ink Metering: The fountain had to contain a plurality of adjustable knives (blades) that traverse toward or away from the fountain roller in rectilinear fashion. The end of each blade had to be shaped to conform to the curvature of the fountain roller to allow a smooth flow of ink while maintaining the curvature of the roller as wear occurs.

Ink Leakage: Adjustable blades (segments) had to be installed and caused to move in such close proximity to each other so as to prohibit ink leakage between them. I-77 fountain segments are laterally pressed against each other with sufficient tension to allow freedom of movement and yet prevent water droplets from seeping between.

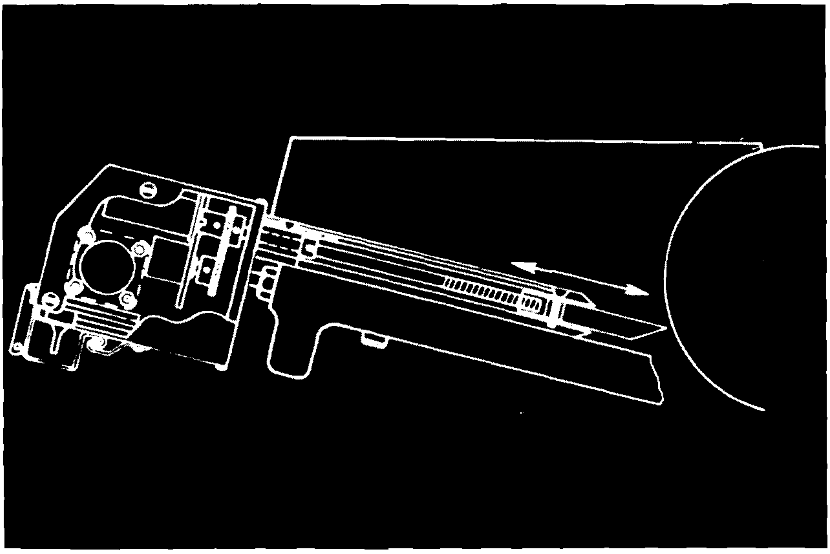

Figure 2. Pictorial Diagram, I-77 Segmented Fountain Blade

Repeatability of Blade Settings: Traversing action of individual blade segments had to be positive, and final settings had to be one hundred percent accurate. Note: Because of the inherent inaccuracies introduced by their use, cams and springs were not considered in the development of the I-77 ink fountain. The precision lead screw principle has been employed, with all final blade settings being accomplished during forward travel (i.e. towards the fountain roller); thus, internal threads in the individual blade segments are constrained against the rearward taper of the threaded precision screw, consequently eliminating any possibility of backlash.

Monitoring of Blade Settings: Drive mechanisms for individual blade segments had to be arranged in such a

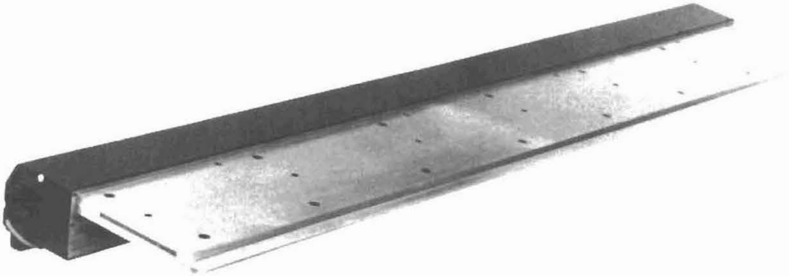

Figure 3. I-77 Segmented
Fountain Blade

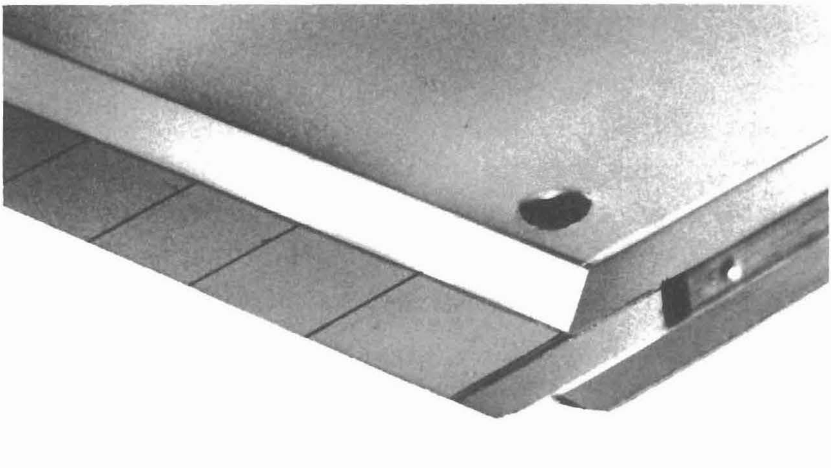

Figure 3A. I-77 Segmented
Fountain Blade

as to permit connection to some form of scale or indicator that would monitor the position or adjustment of each segment. Servo motors and potentiometers have been employed in the ultimate I-77 system design.

Fountain Adaptability: The fountain assembly had to be self contained and capable of replacing any existing fountain (for web or sheet-fed press) without modification to existing fountain rollers or castings.

Once the design parameters above were realized, manually-operated segmented blades (see figure 3) were installed on an ATF press and were subjected to production-run testing from 1976 to 1981.

AUTOMATION PARAMETERS AND SYSTEM DEVELOPMENT

Remote Fountain Control: The concept of a workable, remote control system for adjustting a fountain blade had been inaugurated as early as 1973 and was successfully developed some four years later (Crum and Treff, 1977). This concept comprised an inspection table containing a plurality of switches that operated individual fountain blade actuator motors, and a CRT readout for simultaneously displaying the profile of all fountain keys (screws). Each switch was aligned with a respective portion (zone) of a printed image and with its associated fountain key. The geometrical relationship of printed image, remote control switches, fountain keys and readout display in this system provided many operating conveniences.

Although this concept was a step in the right direction, there were some shortcomings. (i.e. the one piece steel blade and the absence of digital readout for each zone).

To overcome the inherent inaccuracies of the solid steel blade, computerage electronics coupled to the leak-proof segmented blade (Perretta, 1977) led to the development of the I-77 system.

(1) Ink fountain segment acutator motors were connected electronically to a remote console keyboard (instead of the switches just mentioned) and to computerized data-input circuits, located in the remote console, so that I-77 fountain segments can be adjusted by pressing buttions on the console keyboard (see figure 4) or by input of pre-recorded digital data to the console computer control circuits.

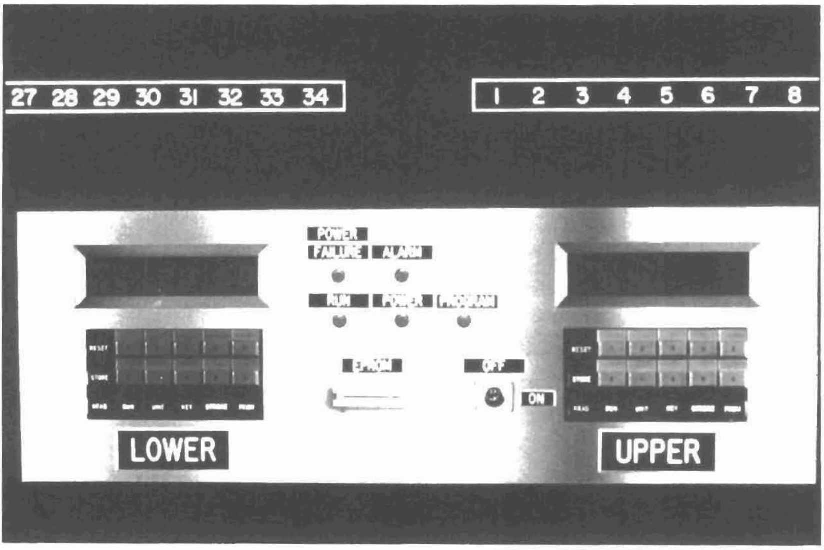

Figure 4. I-77 Console Keyboard

(2) Individual segment control switches are also mounted on the fountain itself and are configured with appropriate circuitry so as to permit operation of the fountain independently of computer power:

(a) In the event of computer power loss

(b) During maintenance procedures that would require removal of one fountain from computer control while allowing other fountains to remain on line

(3) A digital display is provided on the remote console for monitoring fountain segment settings. Override features in the console computer permit pre-recorded fountain settings to be changed and the new settings to be recorded as new control data on the I-77 data-storage/transfer chip (discussed later in this paper).

Ink Density Data Scanning and Data Transfer: In order to employ the remote fountain blade adjustment concept first invented by Crum and Treff in the area of press makeready most in need of automation (i.e. fountain preset) it was first necessary to develop a means to derive ink density (film thickness) data by scanning either of the two sources of density information: (1) the film from which the printing plate is made; or (2) the printing plate itself. Since the plate is the composite of all its elements, the choice of plate-polymer scanning is obvious.

Utilizing reflection densitometric principles, the I-77 plate scanner has been designed to read the polymer density across plate (zones) which correspond to individual segments of the fountain blade as the plate is drawn across the measuring beam of a fixed scanning head. A dedicated microcomputer (which is compatible with the computer in the remote control console mentioned earlier) converts these readings to digital data, computes the average density for each segment (ink zone), and stores this data until it is transferred, on command, to a data-storage/transfer device. Note: Direct wire data transfer was not considered because of the complex memory storage equipment required and because of the cost involved in providing sophisticated hard wiring to eliminate or, at best, to relieve noise interference.

Because of its reliability, one hundred percent accuracy, and ease of handling, the EEPROM (Electrically Erasable Programmable Read Only Memory) chip (see figure 5) was selected as the data-storage/transfer device for the I-77 Ink Flow Control System. The EEPROM chip (very similar to the chips used in home video games) can store information for as many as ten 78 inch plates; thus, an entire job can be recorded on one chip; a separate data-storage/transfer device is not required for each plate. Additionally, information stored on an EEPROM chip can be easily changed with appropriate electrical impulse...and only by electrical impulse. The EEPROM chip is completely impervious to press room conditions; further, its output cannot be distorted by ambient conditions that might affect another type of data-storage/transfer device.

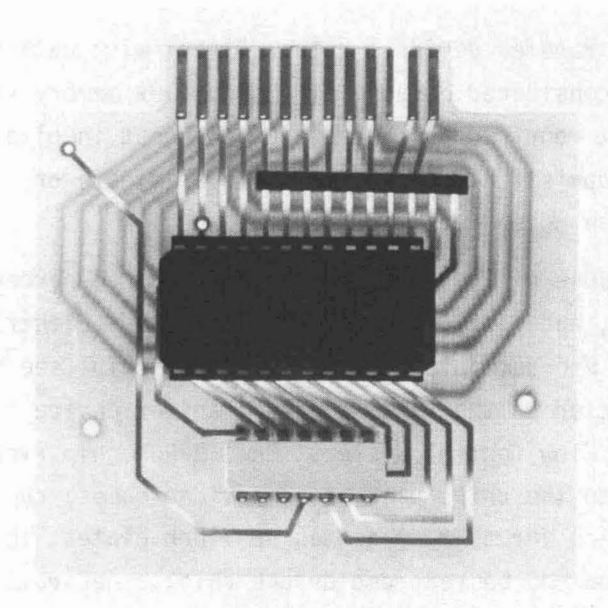

Figure 5. EEPROM Chip, Data-Storage Transfer Device

APPLICATION AND SUMMARY

The automatic ink flow control system described in this paper (see figure 6) has been used successfully in various applications. As of February, 1983, four commercial presses had been retrofitted with the Perretta I-77 Ink Flow Control Syste, with others waiting for installation. The first system was installed on an eight unit Harris M1000-A1 web press in September, 1982. Subsequent system installations include: a seven color, sheet-fed Planetta, installed in October, 1982; a four unit Harris M200 web installed in November, 1982; and a six unit Hantscho web press installed in February, 1983. On an average, each of the four systems installed has achieved cost savings, during makeready, of approximately forty percent. The performance statistics achieved with the

Perretta I-77 Ink Flow Control System have demonstrated its applicability with web or sheet-fed presses of any size.

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