CURRENT AND FUTURE ELECTRONIC/COMPUTER CONTROLS IN OFFSET LITHOGRAPHIC NEWSPAPER PRODUCTION

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ABSTRACT

The revolutionary developments in electronic, optical and microcomputer technology have had and will continue to have a very large impact on newspaper production. This paper describes developments in press automation, electronic/computerized controls and production information systems over the last ten years at Rockwell Graphic Systems and applications to Goss newspaper production systems. A projection of next-generation features and control/automation subsystems is made and a comparison of features in existing systems with the "next-generation system" is presented. A look into the future is attempted and the author's view of opportunities for application of adaptive controls, learning systems, expert systems, robotics and artificial intelligence is presented.

INTRODUCTION

The printing industry is a major segment of manufacturing in the United States and, in fact, throughout the world. Printing, however, by its very nature, is a unique manufacturing segment. Why is this the case? Its uniqueness results from the fact that printing is the manufacture of information-conveying products. The uniqueness of which I speak is a burden upon the process to produce products which are continuously variable, as opposed to most processes wherein the objective is to produce products which are continuously constant and homogeneous. For example, steel mills, glass plants,

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chemical plants, paper mills and many others strive to produce products whose characteristics are constant. In fact, the more constant they are, the higher the quality of the product being produced, e.g. uniform thickness of rolled steel, uniform composition of fluids, etc. The application of coatings to materials is another good example.

Printing, on the other hand, must produce a product which is nowhere the same, since information is conveyed only by varying the images being printed. The result is that the print manufacturing process - whether the product be a package, book, magazine, newspaper or any other of a multitude of products - must transfer images to substrates, leaving bare substrate around the images. This characteristic leads to many complexities in the process, even after assuming that the host of complexities inherent in image preparation having been mastered.

The materials-handling segments of printing production also offer many unique and challenging situations. The materials are flexible and must be unrolled, tensioned, guided, printed upon, pulled, turned, formed, cut, folded, collected, stacked, bundled, and skidded for further handling or delivered to trucks for distribution. Sound complex? It is, with each industry segment and even each product, have its own idiosyncrasies.

It's no wonder then that for many years this industry was considered backward and nearly devoid of technological innovation. Nor is it any wonder that the industry is now under attack as one which could(1) (should in the minds of some) be entirely replaced and passed by with technological innovations (2).

The purpose of this paper is not to explore the potential for technology applications in the industry in the broad sense, but to focus on the newspaper industry. In many areas over the last decade or two, newspaper people have been technological pioneers. This continues to be true, but other segments of the printing industry have caught on, and the outlook is very exciting in virtually every segment of the industry. The most encouraging aspect of this whole matter is that the industry has become "technology literate". I believe the vast majority realize they are not "running a railroad" but that they are in the communications business, and are changing with the times. In fact, they are helping to make the changes, rather than being victims of change.

In this paper I will discuss what the newspaper production industry has been doing with technology over the last decade, where I think it will go in the next decade, and what some long-range possibilities are for electronics, computerization and automation.

DEVELOPMENTS OVER THE LAST DECADE

In preparing this paper, I came across another paper - an internal MGD (Rockwell Graphic Systems was formerly Miehle-Goss-Dexter, or MGD. Goss is the newspaper business segment) proposal "Computer Control of Newspaper Press Operations" authored by Geoffrey F. Wilcox, then Director of Research, dated 1965. Many of the concepts which have been brought to commercial practice in the last decade were in clear focus even before 1965 [3]. Though the concepts were there, few (if any) could envisage the incredible developments which would take place in electronics and computers and offer innovative engineers and printers such resources to work with.

Without a doubt, the application of computers in the prepress areas of newspaper production is one of the most impressive revolutions within an industry that the world has ever seen. Not that this revolution was without problems and failures, and the inevitable "pioneers with arrows in their backs," but the successes were truly phenomenal. The stakes were high - major reductions in production costs by eliminating hot metal plates and replacing hundreds of people in the composition rooms of large newspapers. It didn't stop there either. Computerized terminals moved right onto the reporters' and editors' desks, into the ad-takers' departments and then out into remote bureaus and even provided portable terminals for reporters.

The momentum continues in prepress as the long-predicted full-page pagination is now emerging. Several initial systems are installed and additional vendors are developing systems. Continuing improvements in the cost performance ratio of both microprocessors and computer memory assures continued advancement of such systems.

All of the foregoing may be considered the "soft" side of newspaper production, for it involves information processing in a soft form. Indeed, computer software has played as significant a role as has the hardware of CRT's, integrated circuits and mini/micro computers.

But, what about the "hard" side of newspaper manufacturing, all those phases involved in turning this "soft" information into finished, printed, folded and assembled newspapers? The past decade hasn't been nearly as glamorous on the hard manufacturing side. Certainly, significant progress has been made, but at a much slower rate and with much lower paybacks. Automation and electronic controls have progressed in stages, these stages being related to both the particular printing process utilized and the phase of production - press and post-press. Let's look at these stages in the development of electronic controls and automation.

AUTOMATION (?) IN LETTERPRESS PRINTING

Going back ten years in time, all large newspaper plants utilized letterpress printing, with offset lithography relegated to small plants with only one or two presses. These large letterpress plants achieved their interface to the developing electronic prepress systems by utilizing various pattern plate techniques. These allowed the photographic-output typeset pages from the computer-based systems to be converted to the raised-character letterpress plates required by the presses. But even before this was accomplished, it was recognized that automation could be applied to these letterpresses. The primary function of the earliest control systems was to provide centralized remote control for those functions which had to be adjusted during makeready, ink settings and cutoff/print register. The minicomputer gave these early systems one fundamental capability which remains a key characteristic of the most modern systems - the automatic routing of control commands to the proper machine elements with no need for the operators to know/remember the location of each newspaper page being printed. The operator enters commands in normal newspaper terminology - section, page number, column - and the minicomputer routes the commands automatically to accomplish changes in printed density, cutoff register or printing register.

This should have been a big step forward in newspaper production automation, but several things were wrong, and these control systems were a little ahead of their time. First, the labor/management atmosphere wasn't yet right. Nearly all newspaper plants were unionized, and the unions feared and fought automation. Management tended to buy automation as a bargaining tool against the unions; "With this new automation, we can operate the presses without you, if we have to!" Is it any wonder that the early systems weren't well received and didn't prove out too well? But, there were other problems as well. It is well known that the major problems of waste and lost time on printing presses occurs during makeready and start-up. To be effective enough to have real impact, any control system would have to attack the makeready and start-up problems. Two approaches were possible: 1) Open-loop preset control systems; or, 2) Closed-loop feedback control systems. For closed-loop controls, the hurdles were much too big. Neither process knowledge, sensing technology or cost effectiveness were adequate for this to even be attempted. For open-loop preset controls, no medium was available from which to derive the required ink preset data, since the printing plates were lead stereo plates. Further, the reliability of then-current commerical-grade electronics and minicomputers was inadequate in the hostile pressroom environment. Military-grade electronics would have been much too expensive.

The results were not good. Systems considered to be the foe in a hostile environment with frightened and unfriendly operators, offering marginal benefits at a low level of reliability -- what should be expected? These disappointing results in fact were a set-back to the rapid advancement of such control systems, But, on the other hand, maybe that wasn't all bad either. Both the system engineers and printing plant managers had to get serious about the real case for automation; productivity, efficiency, utility, reliability and pay-back.

AUTOMATION IN OFFSET LITHOGRAPHIC PRINTING

The offset lithographic process offered a key to this automation quandary. The lithographic plate required a photographic negative to provide the transformation from computer data base to printing plate. These negatives contained all the information needed about ink coverage requirements of the pages to be printed. It was recognized that such negatives could be scanned with an optical-electronic subsystem to determine the ink coverage of each and every control zone on the entire printing press. By determining the relationship between ink film thickness and printed density [(4)], the minicomputer of the control system could calculate the required ink flow for each and every zone, and preset the ink control mechanisms to feed the proper amount of ink, before the presses were started. Finally, the critical pieces were coming together! The same minicomputer could route the preset commands to the ink control mechanisms and also allow the operator to make changes as required during makeready and running phases to achieve the final desired quality. Thus, the emphasis in controls for newspaper printing switched from large letterpress plants to small offset plants. The switch was successful. The first installation of the Goss Press Control System I (PCS I) was made at the Post-Cresent newspaper in Appleton, Wisconsin. Both the management and press crew seemed receptive, even eager, to use this computerized press makeready and control system. The initial set-up demonstrated that the subsystems must truly be integrated into a on-line system, as the paper tape output from the negative scanner, the Printed Area Reader (PAR), proved to be too slow to be effective. Equipment operators were waiting on the system, which is a problem in any automation project. Connecting the PAR output directly to the PCS I computer put the scanner on-line, and this did the trick.

This start made in a small offset newspaper plant proved to be a harbinger of things to come. This time the timing was right. Accelerating prepress developments had brought about high-speed, high-quality electronic phototypesetters. Typeset output on photographic paper was the perfect link through the photographic negative to offset lithographic printing plates. In fact, offset printing presses were now needed to take advantage of the automated prepress processes. The sale of offset press units accelerated over the next 5-7 years and the sale of letterpress units declined rapidly. This trend in newspaper printing production brought about one of the great decision points in the industry's history: could, or should, large newspaper plants make the transition to offset printing?

Offset printing offered important advantages over letterpress in addition to the natural interface to electronic prepress. The major advantage was higher quality, particularly printing four-color process and smooth solids on rough newsprint. Color television had demonstrated the keen marketing advantages of color in advertising. Offset printing was the key to providing quality color for newspapers.

The planographic nature of offset lithographic plates requires a two-fluid system in order to print, as water is required to prevent the non-image area from accepting ink. The addition of water to the printing process placed major new demands upon the pressmen. They must be masters not only of ink, paper and registration, but had to also become lithographers. Ink-water balance was a must, and achieving it quickly was a new and sometimes frustrating challenge to letterpress crews. Early offset installations without any automation experienced very high waste - 5 to 10 percent or more, compared to 3-4 percent for letterpress. The big question was then, could large newspapers ever convert to offset? Would waste be manageable down to a level approaching that of letterpress and meet the economic requirements so important to the industry's health?

Goss knew that this was a critical issue and that the industry was at a crossroads. A major offset printing operations analysis was undertaken. It was known that among small offset plants, some plants achieved low waste while others with identical equipment experienced high waste. The results of this co-operative program between Goss and a group of newspaper plants was a set of start-up sequences and operating procedures combined with the preset and operating functions of the PCS I. The result was successful operation of offset presses at waste levels near those of letterpresses. In fact, several plants have now reduced their wastes to the same level that they had with letterpress. What did it take? It required good systems engineering, good management in the pressrooms, dedicated press crews and automation.

In the five years following this program, the industry has seen major newspapers all over the world develop modern, highly-automated offset printing plants. They are too numerous to try to name lest some be overlooked, but perhaps two of the most modern, most highly automated are the Baltimore Sun and the Chicago Tribune. The next section will discuss the state-of-the-art in newspaper production control systems as can be seen in use today at these two, and other, plants. Certain customized features of other plants also discussed.

STATE-OF-THE-ART IN CONTROLS AND MIS

The preceding sections have discussed the background events leading to the widespread introduction of electronic/computerized controls in offset newspaper production. This section will discuss state-of-the-art systems recently installed. The development of low-cost high-performance microprocessors and large but low-cost solid-state computer memory has opened the door for dramatic changes in control system architectures. The system architecture and control hierarchy for the Goss PCS II and other major newspaper production areas was described in a paper presented by this author at the IEEE Electro conference in 1979. (5) The system architecture envisioned in that paper and shown in Figure 1 has been implemented, and the modularity and distributed character of that architecture is expected to remain valid for the next decade. Figure 2 is a schematic representation of a commerical system. Figure 3 is a picture of a press control center in a quiet room. Figure 4 illustrates the application of computers and automated electronic controls across the total newspaper production arena.

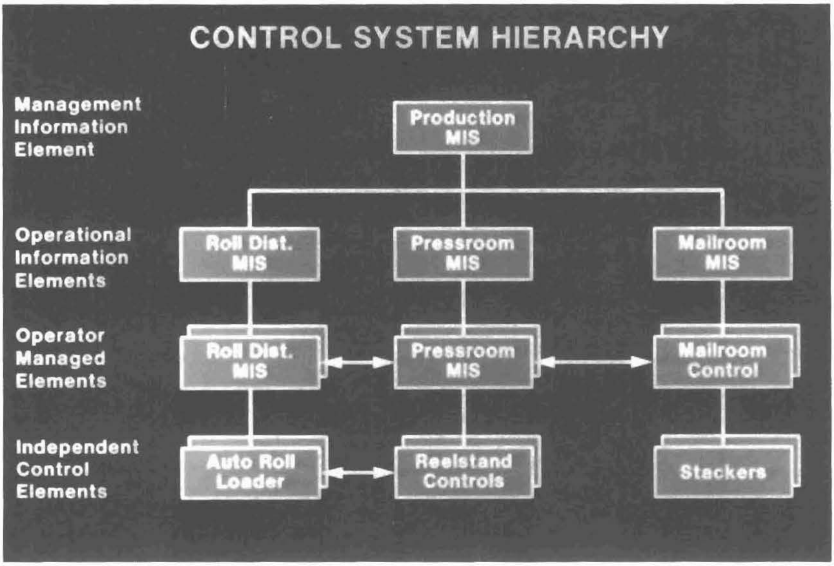

FIGURE 1

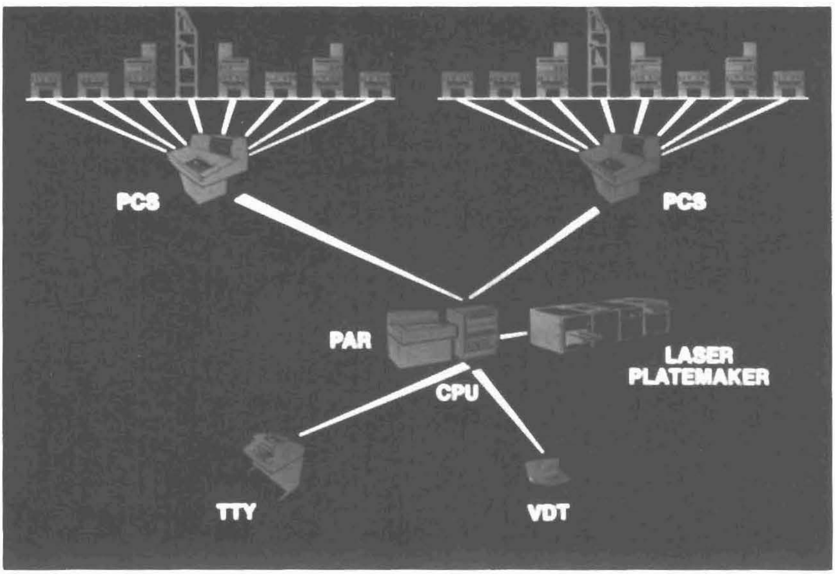

FIGURE 2

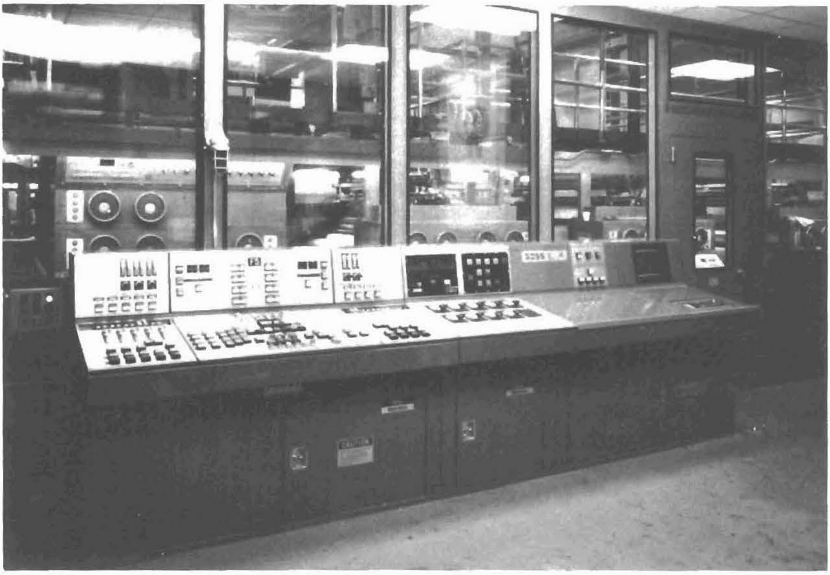

FIGURE 3

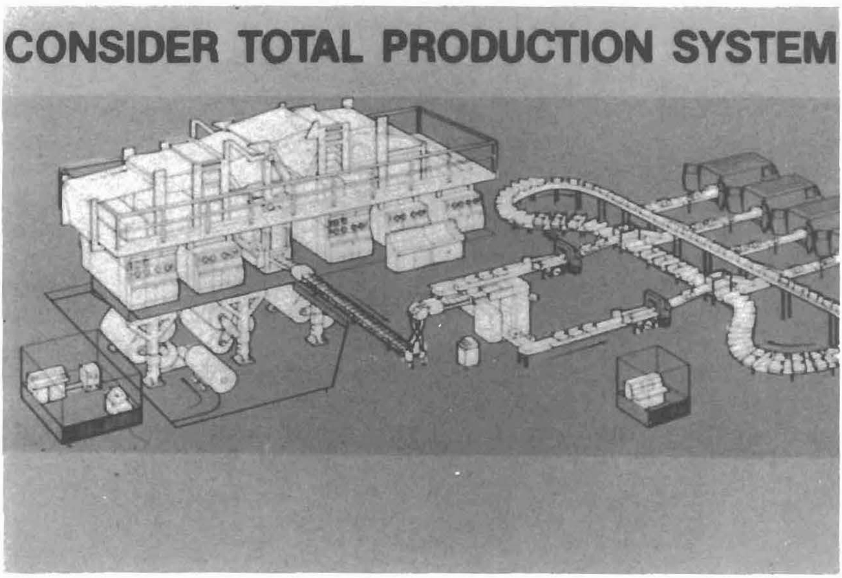

FIGURE 4

The modern systems under discussion contain the following subsytems, operating at the indicated levels of the system hierarchy.

CLOSED-LOOP CONTROLS

Press Speed (electrical drives)
Paper roll supply to the press
Roll loading into the roll unwind units
Roll pre-drive for web-surface speed matching
Automatic roll pasting (or splicing)
Tension control into printing units
Roll side-lay at the printing unit.
Dampener fluid supply and recirculation
Product totalizing and press shut-down
Conveyor speed tracking
Web break detection

OPEN-LOOP PRESET CONTROLS

Dampener setting
Ink control settings
Cutoff register compensator settings
Conveyor lap setting for product size

MANUAL PRESET CONTROLS

Web leading through the press
Folder settings
Bundle count at stackers

OPEN-LOOP RUNNING CONTROLS

Printed ink density
Dampening
Cut-off register
Color register
Bundle delivery to distribution trucks

INFORMATION SYSTEMS

The next logical application of computer technology beyond equipment control is in collecting information about the production process. Current systems monitor certain selected production variables and the data is collected into a database for use by so-called MIS, or management information systems. The Goss system philosophy made a clear distinction between Production Management Information and the more general Management Information. The objective was to concentrate upon those areas related to real-time information, that which is useful to equipment operators in meeting production schedules and improving productivity and efficiency. This is not to diminish the importance of the latter, but MIS is a very broad subject - as broad as one wishes to make it.

The Goss system architecture breaks information systems down into definable, manageable segments rather than addressing the universe. This is considered to be vital in the development of such systems, as this approach establishes a mutual understanding between developer and user about what is being done. The user has an equal, if not stronger, voice in system definition, for it is the user who either has the need for information, or has little or no need for it. Information collecting is not free, as both hardware and software are required (neither in non-trivial amounts) to collect, process and organize information for presentation. In some cases, the value of the information could be less than the cost of only the conduit and wiring required to collect it.

THE TOTALIZER

Perhaps the most useful production information is handled in the totalizer subsystem. This information system starts with the production schedule - products, quantity required, presses assigned and completion times required. The Goss totalizer provides color CRT displays of this information, Figure 5. One display shows each product to be produced, quantity required, presses assigned, current quantity produced, scheduled completion time and projected completion time. Another display, or set of displays indicates each press in the plant, product being run, status (available, on hold, running good product, running waste, or stopped), current running speed, average productivity, projected completion time, Figure 6.

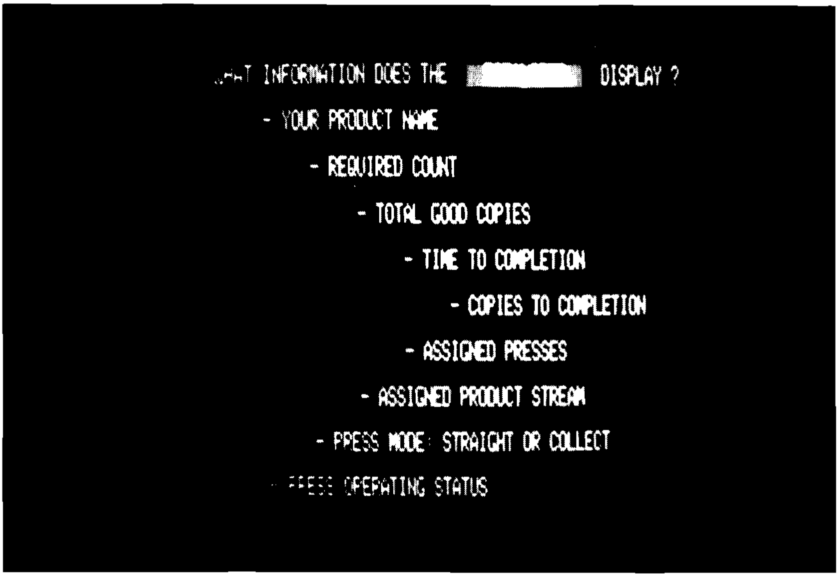

FIGURE 5

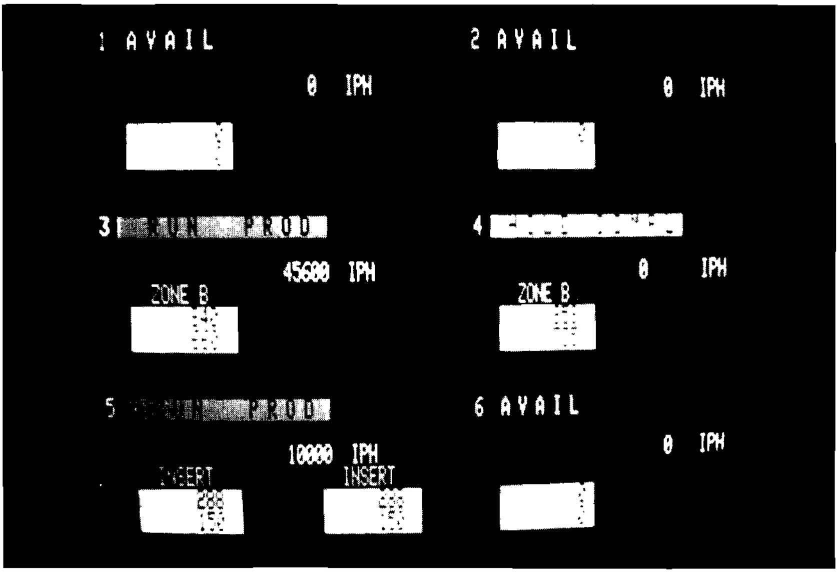

FIGURE 6

The totalizer integrates the product count from multiple presses, Figure 7, and stops designated presses at the proper time. One press will be kept running to produce the last few hundred products and be kept on-hold until verification is received that the full production quantity required in the mailroom is complete.

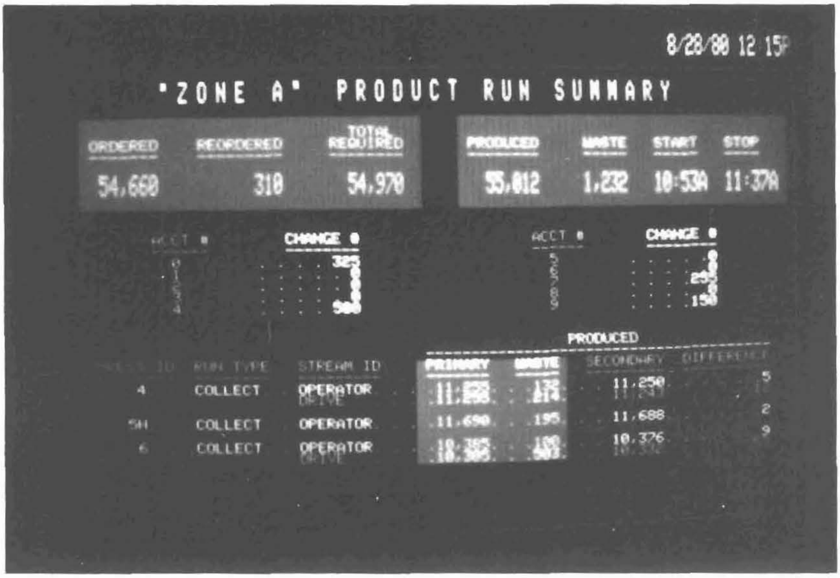

FIGURE 7

Figure 8 shows schematically the PCS II with the Totalizer option. Other suppliers may imbed the "totalizer" within a larger system, or may describe its functions differently, but the foregoing features should be considered as the minimum essential tools of production management.

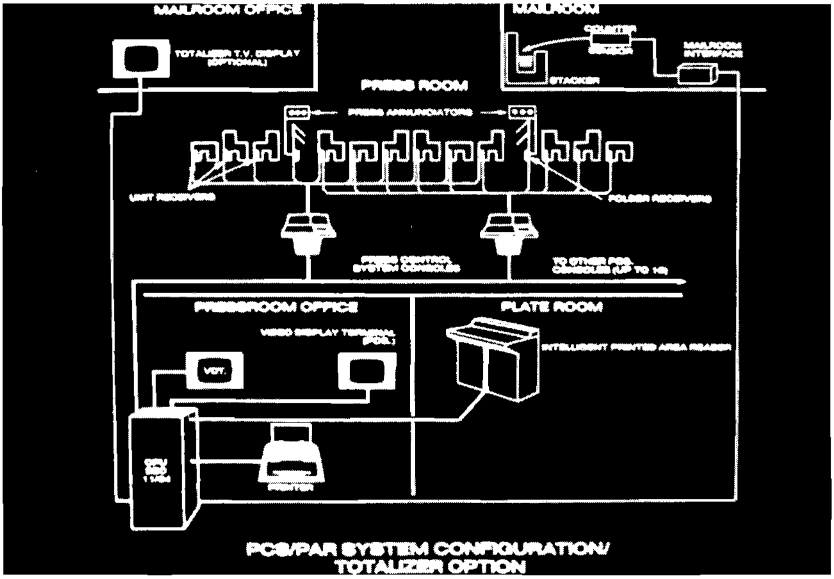

FIGURE 8

EQUIPMENT MONITORING

The second segment of the Production MIS is the equipment monitoring function. This function in the Goss system is referred to as Press Monitor I (PM I). The "I" suggests that there might be a "II", "III", etc, and this is exactly the case. Why? A press monitoring system, like a MIS, can be as broad as one wishes to make it. For this reason, the PM I was defined as the first stage of monitoring to collect essential data about the reasons press stoppages occur, Figure 9. At this first level, monitoring treats a complete press as a production machine, without automatically recording the details of which element within a press caused the stoppage. (It is recognized that knowledge of certain details may be important, with certain elements appearing to be obvious. More on this will be addressed in the section on Additional Features). This data allows pressroom/production managers to identify and assess which factors contribute most to lost productivity and decreased efficiency.

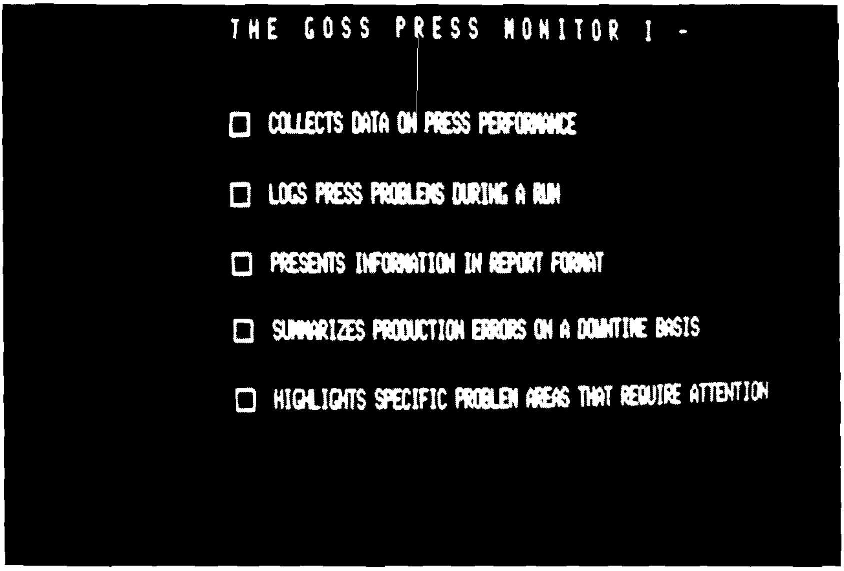

FIGURE 9

The data recorded are:

PRESS MONITOR I - AUTOMATIC DATA COLLECTION

- Time that press stopped
- Press stopped from mailroom
- Press stopped by web break
- Press stopped by folder break/jam
- Press stopped by pressman

PRESS MONITOR I - MANUAL DATA INPUTS

Control system prompts with lighted (?) symbol if press was stopped by pressman; reason for stoppage is input by activating appropriate button:

o Plate	o Dampening
o Paper	o Repairs
o Ink	o Revision

In theory, some of these manual inputs and many others could be monitored by sensors and input automatically. The systems and marketing studies by Goss established that the data sets listed above represent the essential data elements with cost justification.

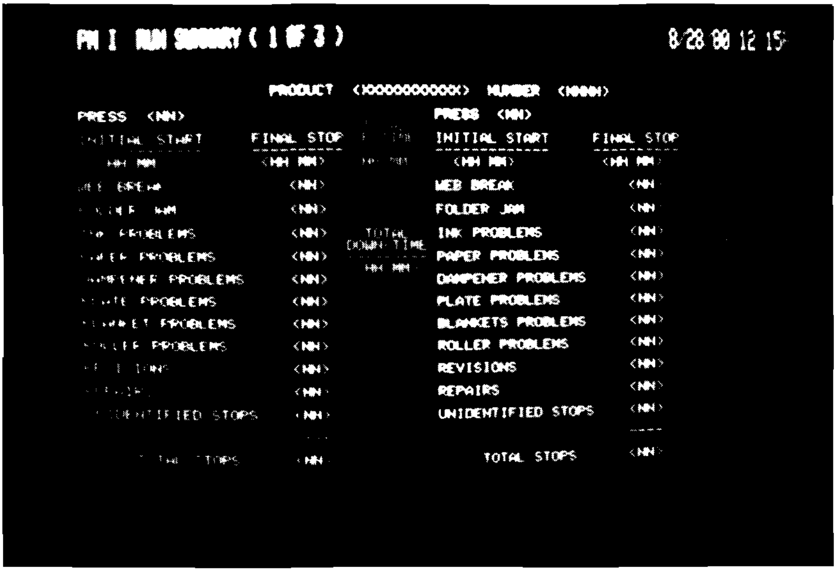

Figure 10 - PM I Run Summary on Color CRT.

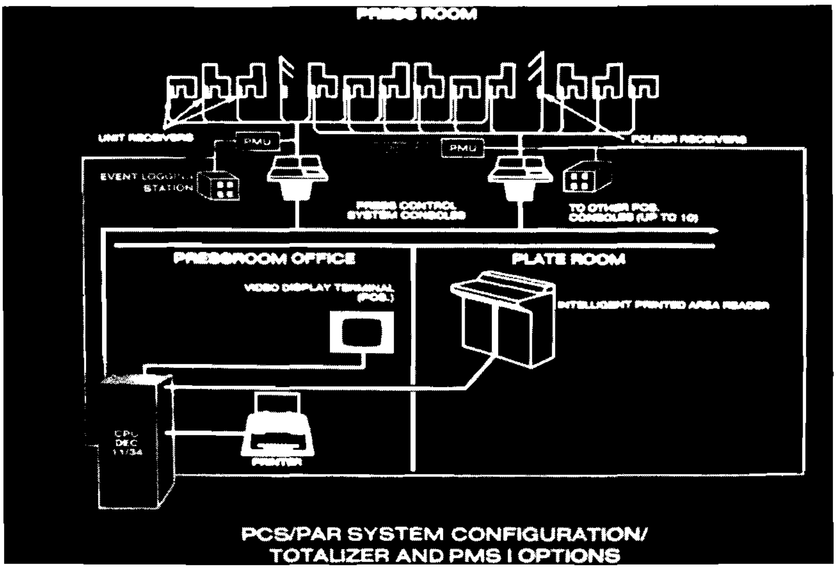

FIGURE 11

PRESS IMPOSITIONS

One of the functions of the original PCS was setting up a table of the press imposition in the computer. This table is what allows the pressman to enter commands by section, page and column and have the computer route the commands to the proper press elements. When the original PCS was developed in the early '70's, newspapers were relatively simple as far as being limited to a few editions with little, if any, zoning. The approach to impositioning in the original PCS was to set up the job by defining where each plate (page) was to be mounted and identifying each folder compensator to be used. The minicomputer utilized had limited memory of 32K words, but was adequate for the simple requirements of that time. Over the last decade, however, newspapers have introduced more editions and extensive zoning in response to advertising needs. To accommodate newspapers with larger page counts and significantly more spot and process color, presses installed in the last few years have been comprised of more units (8 to 10 per press) and more color half-decks. The result has been a great increase in the complexity of impositions, the number of web leads possible and the number of set-ups required to produce the editions and zones. Figure 12 shows the PCS II Imposition Screen.

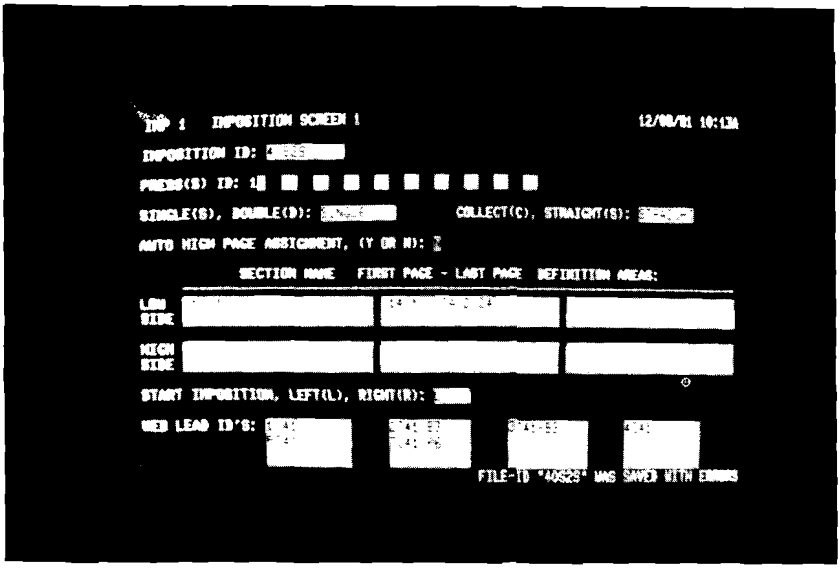

FIGURE 12

The PCS II is a result of extensive modification, (actually, "starting with a clean sheet of paper") to meet these needs. The PCS II has interactive disc storage which provides storage capacity for a large number of defined jobs. Figure 13 shows the basic PCS II menu screen for setting up jobs.

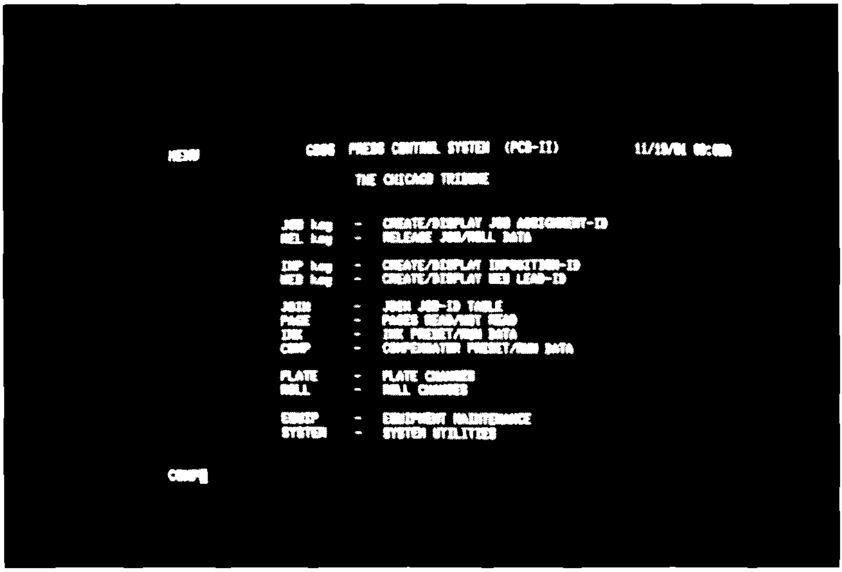

FIGURE 13

Further, the system has been structured with a library of web leads; essentially every practical web lead is stored once in the library, rather than with each job, by means of the Web Lead Description Screen, Figure 14. A job need only refer to the appropriate web leads and new jobs can be easily set up by referring to web leads existing in the library. New jobs can also be created by modifying copies of existing jobs. These features make the PCS II a system which meets the needs of nearly all US newspaper publishers. This is not to suggest that all newspapers use the same procedures and page make-up, or even the same terminology. Each may have its own particular requirements, but the modularity and structure of the PCS II software make meeting most of these relatively easily.

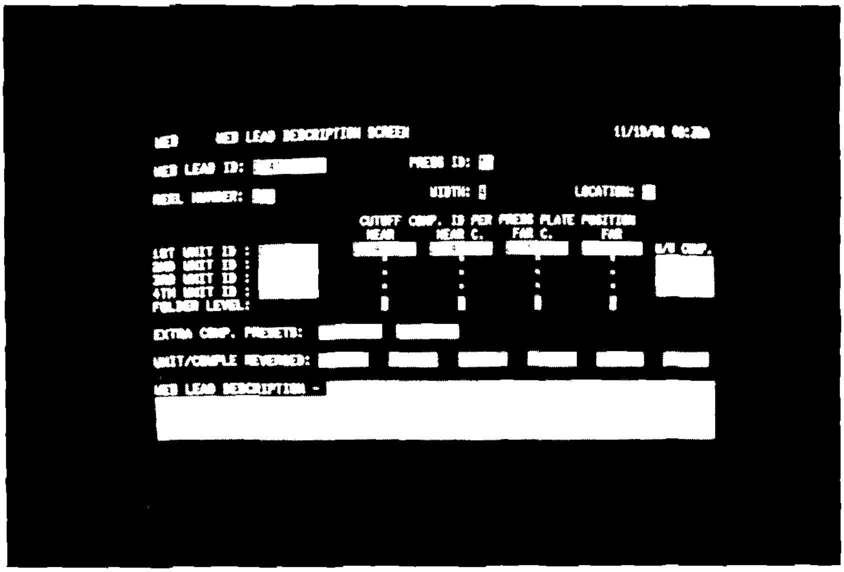

FIGURE 14

The PCS II is designed around the DEC 11/34 and 11/44 minicomputers utilizing DEC's standard RSX11M operating system. The software was written in the high-level C language to provide benefits in being able to support the product in the field and to add future features. A structured modular software design was utilized. These attributes obviously required significantly more memory than non-structured assembly-language programming, but the decreased cost of memory have made this a good choice. Modifications, when required, have proven to be readily implemented and managed.

SPECIAL FEATURES OF PCS II

EDITION MANAGEMENT

Certain customers have needed special features to be added to their system. One example is Edition Management software for the newspaper Le Provencal in Marseilles, France. This newspaper consists of many, 30 to 40, short-run editions. The changeover from one edition to the next has to be quick and easy. The position of pages within successive editions varies greatly, with pages dropped for one edition, brought back for another - new pages added, and current pages relocated. This requires that the inkers be reset to accomodate the changing pages, otherwise the waste would be unacceptably high. With so many edition start-ups, the waste for each start-up has to be kept quite low and the time to achieve good copy on each edition has to also be kept short.

Edition Management added the capability to set-up an edition table, mapping the page sequencing and positioning in the successive editions. This allows the PCS II to determine the changes which occur between editions and reset only those inkers whose corresponding pages have changed. Further, since pages change position within the paper, normal page numbers lose their significance. Each page is identified by a composition number which is then used as its identifying name, or ID. This ID can then be used as input to the PCS II press console to make changes on-press as required. The same ID is used to identify the page when its negative is scanned on the Printed Area Reader to determine its coverage for ink presetting.

PRINTING UNIT DISPLAYS

Several newspapers, the Baltimore Sun being the first, were supplied with digital displays on each printing unit to identify the plates which should be mounted in each plate position. These displays are computer driven, with the appropriate data coming directly from the imposition table for the job being run. By comparing the plate numbers with these displays, inadvertently putting plates in the wrong position should be completely avoided by these press crews. These displays also replace some of the analog meters indicating ink changes and other functions on these presses.

ADDITIONAL FEATURES OFFERED BY OTHER SUPPLIERS

Other suppliers offer some features which are not standard in the systems from Goss. The features discussed below have been identified from published technical articles in trade publications, advertising literature or from speeches/presentations made at industry conferences. It is not known in every case whether these features are operating in the field, are under development, or only being planned.

AUTOMATIC WEB LEAD-IN

Some Japanese presses are equipped with web lead-in tapes which pull the paper through the press all the way from the roll to the top of the folder. This feature was attainable in Japan but not in the U.S., not because of technology differences, but because Japanese papers have many fewer pages - typically 24 to 32 - and therefore the papers do not have the variety of sections like U.S. papers. This means that web paths are fixed, whereas such a system in a U.S. installation would require many complex switching mechanisms. These Japanese units are reportedly very effective. As a point of interest, the information content of a Japanese newspaper page is about equal to three U.S. pages, due to the nature of the Kanju character set.

BUNDLE LABELLING AND SCANNING

Some Japanese mailrooms reportedly have implemented closed-loop bundle distribution by printing labels on each bundle and scanning these labels in the delivery carts before dropping them at the truck loaders.

INK ADJUSTING FEED-BACK POTENTIOMETERS

Some manufacturers have incorporated position feedback potentiometers on their ink-feed adjusting mechanisms. This allows determination if a mechanism fails to move when commanded, but does not provide a closed-loop ink system, since the ink transfer to paper is not monitored.

NEXT-GENERATION SYSTEMS

What features and functions will the next generation of newspaper production control and information system offer? It is this author's belief that new features will be evolutionary in nature. This will be partially due to the fact that well-structured and modular systems currently installed and being installed were designed with this in mind. It will be both technically and economically feasible to incorporate new features when both supplier and user determine that identified needs can be met cost effectively. Another reason is that the technology in sensors, which will be the foundation of many new features, will also evolve (6). One other reason is that different users perceive needs differently and, therefore, new features often start as customized specials, not as industry standards.

The features discussed below are presented from the viewpoint of current Goss systems and it's quite possible that another supplier may already offer some particular feature or some users may have implemented some of these or other features themselves.

EXTENDED PRESS MONITORING

A natural extension of current monitoring systems is to add additional monitor inputs. Some possibilities are:

- Web break details - first and subsequent breaks.
- Paper roll identification data.
- Press crew identification.
- Web tension data.
- Tension preset based on paper being run and other printing variables.
- Print quality sensing (not on-press densitometers.
- ID of plates changed due to plate problems.
- Paper defect detection and recording.
- Press unit sound signature anomalies.
- And so forth.

MORE CLOSED-LOOP CONTROLS

The continued advancement of microprocessor and largescale integrated circuit technology along with sensor technology advances will make additional closed-loop controls feasible. Robotics technology research and development is causing much additional resources to be applied to both of these areas.

CUT-OFF REGISTER

Already rather common on commerical web presses [7], miniaturization and cost-reduction will make closed-loop cut-off controls feasible for newspaper presses. The cost due to the sheer number of sensors required because of the multiple webs in newspaper presses has been the big drawback to date.

COLOR REGISTER

As newspapers continue to print more process color, closed-loop color register will make its debut. Again, the cost must come down significantly in order for that to happen. This will only occur after such controls become standard on commerical web presses.

INKING AND DAMPENING

On-press densitometers are beginning to be applied on sheetfed and commercial web offset presses (2)(8). In a manner similar to the register controls discussed above, closed-loop inking will find application in newspaper plants only after commercial development makes them available at lower cost. Dampening sensors now exist for laboratory research. Closed-loop dampening control may be required in order for closed-loop inking to be effective. This author feels that closed-loop dampening will be very slow to be implemented.

WEB PATH SENSORS

If web leads were always manually pulled over the correct side of all rollers, the path length would be known and open-loop cutoff presetting would be reasonably accurate. Sensors with audible or visual feedback could prompt crews to pull them properly, making cutoff register presetting more effective.

MULTI-VARIABLE CONTROLS

It is well known that printing is a very complex process and many input variables and output criteria are involved (9). Due to this complexity, most efforts to date have been directed at controlling single variables - those with the greatest influence upon the output. As the process becomes better understood, it is expected that multiple variables will be treated as inputs to much more complex control algorithms. Such combinations as tension, register and ink tack will be candidates.

VOICE RECOGNITION/SYNTHESIS

Voice recognition/synthesis (VR/S) technology offers the possibility of developing subsystems capable of providing a new dimension in improving productivity. Physical handling of printed products and paging through to inspect the quality level is the pacing function in achieving acceptable quality at start-up. The key attribute of control systems employing VR/S is that an operator's hands and eyes are freed for more important functions.

With both hands free to handle the printed product and with the ability to control the equipment by voice, equipment operators should be able to make many more control changes in the same amount of time as required without VR/S. Voice-synthesized prompts and verifications will allow for complete system optimization, including the operator as part of the system.

ADAPTIVE CONTROLS

One of the key attributes of next-generation controls should be self-adaptation. Humans operate in this mode continously. For a simple example, you may have a standard route which you drive to work, but you adapt to traffic jams, weather conditions and other factors as they arise to maximize your satisfaction. Adaptive controls, in my opinion, will add benefit leverage in systems by allowing less stringent tolerances in manufacturing and reduction of both waste and maintenance in the production plant while improving productivity and efficiency. Adaptive controls have already been applied in some process control systems and make the controls self-optimizing in the initial start-up [10]. Probably more important, though, is the potential for control systems to self-optimize on a continuing basis through adaptation, thereby enhancing quality and productivity. Application in inking, dampening, register and tension control are expected.

SMART SENSORS

One of the hindrances to adding a great number of sensors in the newspaper production environment is the mass of wiring and low-level, noise-sensitive signals involved. Smart sensors which will process the raw data and transmit only pertinent exception data in digital form will overcome both barriers. However, a high volume of standard programmable sensors will be required to make them practical for users . The development of sensors for robotics should produce the technology for application in this area also.

MULTI-FUNCTION SENSORS

Alternatives to low-cost single-function sensors are more complex, more costly multi-function sensors. Continuing developments in optics, LSI and microprocessors should make multi-function sensors practical in some areas at less cost per function, and with increased reliability and reduced maintenance.

LEARNING SYSTEMS

Learning systems are different in concept from adaptive controls. My thoughts about a learning system foresee applications such as the following, as an example. Considering paper, identifiying data would be kept in a database about all the paper that is used. With software programs to analyze the results obtained - web breaks, register problems, printing problems, net productivity, etc. - the system could "learn" that when certain combinations of job type and paper (possibly other supplies) were to be run, tension and operating speed should be at particular values for optimum performance. Pressmen do this to a limited extent, but primarily by intuition and subconscious logic - we call it craftsmanship.

EXPERT SYSTEMS

Perhaps the concept of expert systems is only an extension of learning systems, but such systems incorporate the experience and knowledge of human experts. The computer is programmed to develop the same responses that an expert would in reply to the input of symptoms. The computer will also ask questions in a logical, diagnostic sequence, as an expert would, to prompt the input of additional symptoms. Such systems are under development in the medical profession, oil exploration, computer system configuration and other fields. Applications to production planning/scheduling, print quality and on-site maintenance could be promising.

ROBOTICS

Robotics is one of the most talked about technologies in the world today [11]. Applications in hostile environments, repetitive/boring jobs and for major improvements in productivity are growing rapidly. Applications in the printing industry have already been made in stacking and de-stacking of printed products on skids. Automated roll-loading subsystems can also be considered robotic. Goss has developed and installed an automated roll loading (ARL) subsystem. This subsystem is in essence a robot, operating under control of a local microprocessor on-line to the central material handling computer via a dual-microprocessor, dual-channel communications multiplexor, as shown schematically in Figures 15 and 16. Figures 17 through 21 illustrate the ARL removing the core of the previous paper roll and loading in a new roll, all under computer control. The new roll is spliced to the expiring running roll at speeds up to 2500 feet/minute. The only manual actions required are to remove the roll wrapper and prepare the paste pattern on the new roll. Many other opportunities exist in the material handling aspects of print manufacturing.

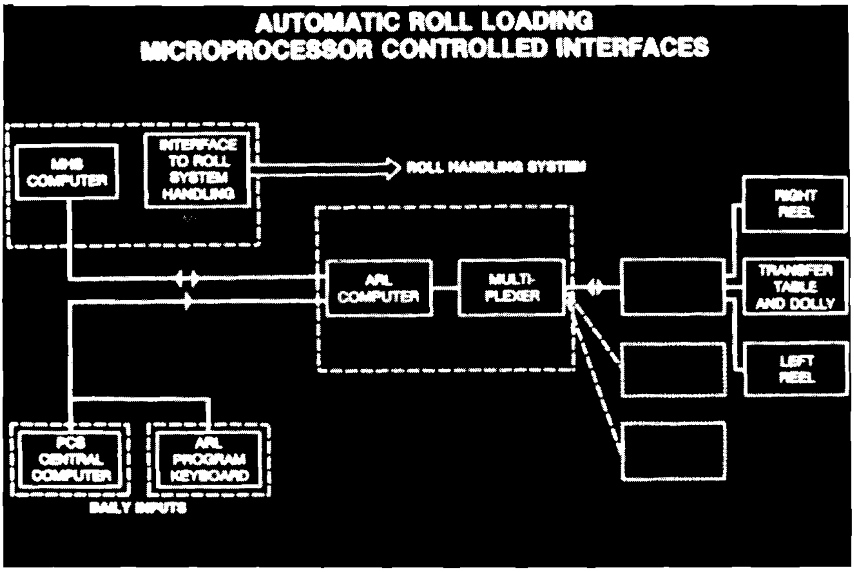

FIGURE 15

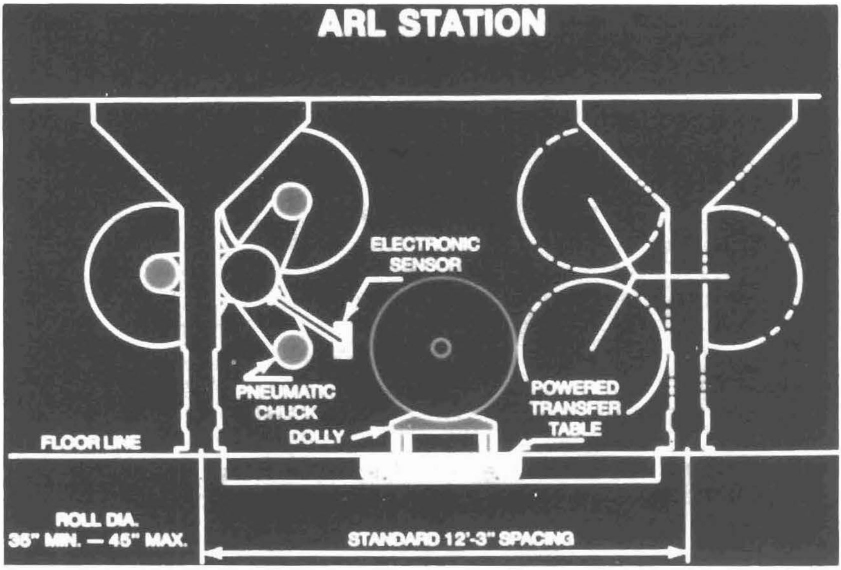

FIGURE 16

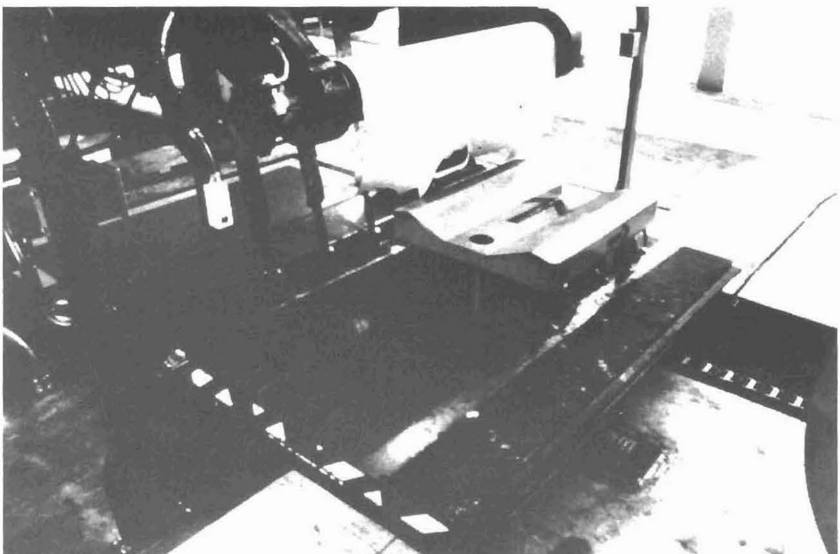

FIGURE 17 - Positioning of Dolly

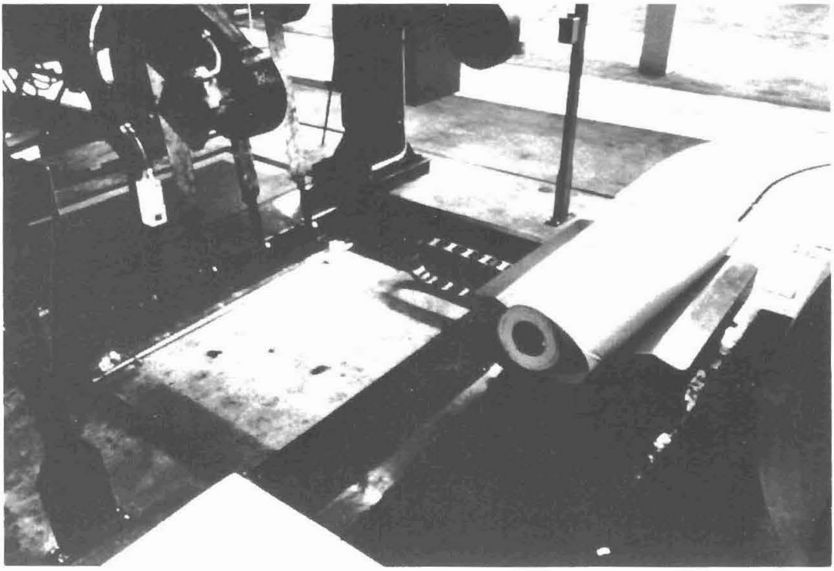

FIGURE 18 - Removing Previous Roll Core

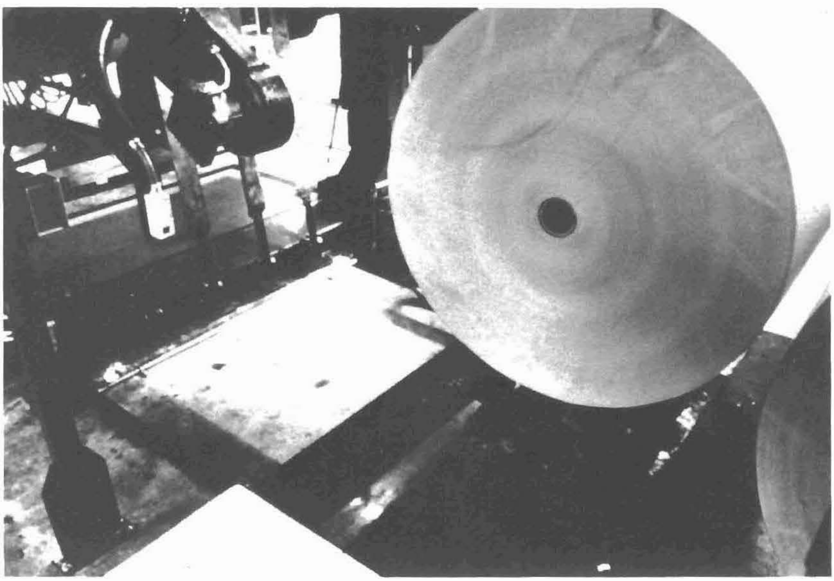

FIGURE 19 - Bringing New Roll In

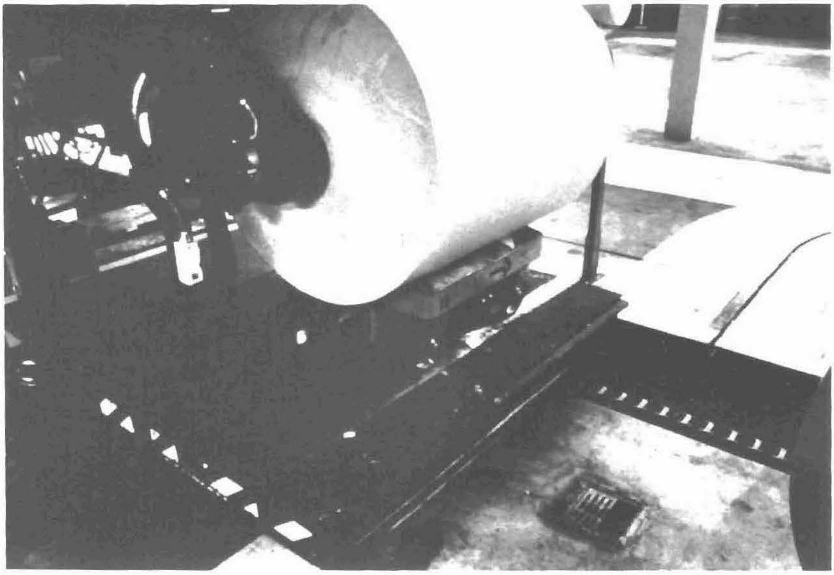

FIGURE 20 - Positioning New Roll

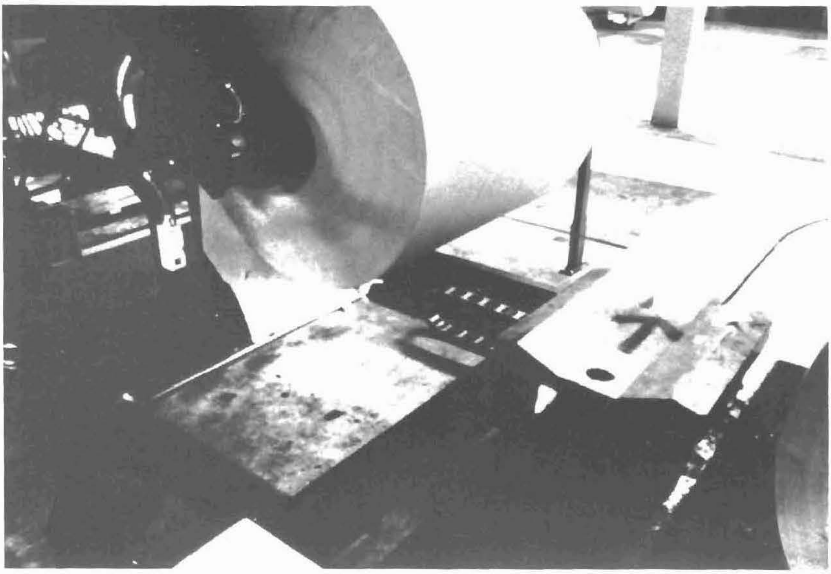

FIGURE 21
New Roll Loaded and Pneumatically Chucked

ARTIFICIAL INTELLIGENCE (AI)

The next generation of computers are projected to possess AI. This simply means that they will operate more like humans do, cross-correlating many factors very rapidly and proceeding based upon a degree of "judgment". The Japanese have set a national goal of being the technological leader in "fifth-generation" computers with AI. Military systems will undoubtedly be developed with AI to improve the speed and quality of decision making. AI is considered to be a vital capability for the fullest development of robotics. Printing production should benefit significantly from the fallout of AI applications in other industries.

INCREASE IN COMPUTER UTILIZATION

The utilization of computers in newspaper production systems has increased dramatically. As shown in Figure 22, this trend is expected to continue.

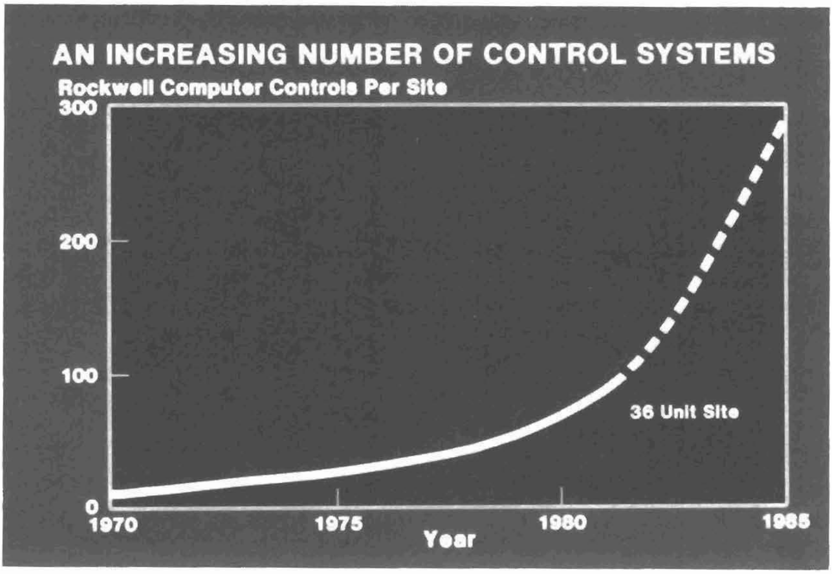

FIGURE 22

COUNTER TRENDS

Everything isn't necessarily moving in the direction of ever-increasing complexity in mechanisms. In fact, there is always beauty in simplicity and presently a groundswell of interest exists for simplifying the transfer of ink to paper in newspaper and commerical printing. The generic description of the process change envisioned is "keyless inking". This isn't really a new concept at all, except for letterpress and offset, and even there the concepts go back more than a decade. Gravure printing is keyless certainly, but the control must be all accomplished up front in the color separations and engraving of the printing cylinders. Flexographic printing is keyless, but the control must be accomplished in color separations, plate uniformity, celled anilox rolls, ink viscosity and critical impression settings. Great interest and considerable development is under way to transfer the ink-metering principles of flexography to offset printing and to use true flexography with water-base inks for newspaper and commerical work.

To the extent that these developments are successful, the complexity of control in inking will decrease. Closed-loop inking press-to-paper could be accomplished simpler and sooner. Goss has just announced an agreement with the Washington Post and Paper Converting Machinery Company to modify one of the Post's letterpress presses for testing of flexographic printing of newspapers using water-base ink and photopolymer plates.

Several other equipment suppliers are also working on the development of flexographic newspaper printing units. A few pioneers experimenting with single units printing black only must be credited with creating most of this interest.

Many challenges and opportunities are involved and it remains to be seen how successful these industry efforts will be.

CONCLUSIONS

A new threshold has been reached in technologies which will fuel a rapid growth in automation in the manufacturing aspects of printing production. The cost of components and the performance capability of microprocessors and memory will not limit applications. Software development will continue to be a key factor, but significant progress has been made over the last decade in organization, structure, modularity and management of software. Commercial printing should be the area of pioneering in technology applications in the 80's.

Sensor technology will be driven by robotics, and the fallout should offer great opportunities in the printing industries. Optical sensors, fiber optic signal/data transmission and infrared and laser diode light sources will make possible on-press, in-the-mailroom, in-the-bindery systems that we would have trouble imagining today.

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