Progress in Electronic Prepress Systems (EPS)

S. Thomas Dunn, Ph.D., President
Barry V. Harris, Vice President

Abstract

The advent of electronic prepress systems presents the printing industry with the opportunity to fully automate, or rationalize, the historic skills and crafts involved in creating information in the form of printed images.

Of equal importance to automation are the new opportunities created by all-electronic prepress systems. These new opportunities will create new business areas for the astute printing manager, while forcing the less astute out of business.

At the same time, electronic prepress systems offer significant threats to the printing industry; these threats range from that of the automated office, using computer-to-press cylinder technology to print pages with halftones in place, to the threat of the video magazine and advertising catalog.

The forward-thinking printer will find these threats to be true opportunities to expand his business.

As increasing numbers of printers consider moving into electronic technology, it is important to remember the basic purpose of the printing business: the business printers are in is the production of images. These images contain type, line art and pictures that convey information for the use and profit of our customers.

Dr. Dunn and Mr. Harris are principals at Dunn Technology, Inc., a consulting firm active in electronic prepress.

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Background

Construction of these images has remained manual throughout five hundred years of printing; however, all of this is now changing, at an increasing rate, to electronic image assembly.

During the 1960s, the industry began automation of typesetting (the conversion of words to type); in the 1970s, the industry started to accept electronic color separation and electronic halftone screening; and, towards the end of the last decade, total electronic systems were being offered with the promised capability of composing pages of information incusive of type, line art, and process color pictures.

Today, most of these systems are still evolving to try to meet the early promises. Electronic prepress systems (EPS) are being developed for all segments of printing, from forms to directories to magazines, inclusive of monotone and process color pages.

Aside from the specific operational aspects of these electronic prepress systems, the industry needs to recognize and fully understand that its business is converting

"Information into Images" (TM)

Automation in the prepress area simply means the creation of final pages in an automated fashion. When the printing industry recognizes this simple statement of purpose, it is much easier to recognize the threats and opportunities afforded by new technology and/or newly encroaching industries.

The graphic arts industry has printed most of the information that constitutes our collective intellectual resource. Now one unanswered question that offers great reward to those who answer it is whether and how this information can be re-marketed to capitalize on new delivery vehicles, once the major costs associated with capture and formatting are out of the way.

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Information Into Images

The principal electronic automation of prepress has developed along two distinct lines (1960-1980):

- Automated Typesetting
- Electronic Color Separation and Halftone Generation

These two developments have been very profitable to the printing industry, but unfortunately, they have progressed along totally separate paths, resulting in highly optimized CRT typesetters that are inefficient and quality limited for electronic screening of pictures, and color scanners that are inefficient, and in some cases quality limited, in the processing of type and line art.

Not only have technology considerations driven the equipment development along separate paths, but users have tended to segment themselves into the specialties either of typesetting or of electronic color separation, based on historical evolution as well as on the differences in required skills.

Thus, we reached the 1980s with a myriad of electronic prepress equipment being developed, requiring user skills in typesetting and color separation, as well as page composition. In general, only the very large vertically integrated printer possesses both kinds of skills within his organization, although even these organizations separate the functions along departmental lines.

In fact, historically, it is only at the stripping table where composed type, line art and pictures are merged into the information element to be printed. Emerging electronic systems pose the opportunity for this merger to take place at video terminals. Figure 1 postulates the emerging electronic prepress system framework within which this can take place.

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The parallel but separate development paths for type and pictures caused both technical equipment and user assimilation problems with the new electronic prepress systems. These are not easily or quickly solved. They have, and will continue, to require the dedication, patience, financial commitment, and resolve of supplier and user alike to reach the end objective of maximizing cost-effective electronic prepress automation.

Prepress Focus

During the 1980s, the main focus of prepress equipment and consumables suppliers will be on automating and streamlining the prepress components of printing, all toward the goal of

higher productivity, lower cost, faster turn-around time, and improved quality.

From an equipment viewpoint, this automation will take two generally separate paths:

- Automated conventional equipment and processes
- All-electronic systems

Automated conventional equipment for step-and-repeat and signature makeup is represented at the up-end by OptiCopy, Misomex, Klimsch, and Ruthographics. For electronic stripping systems, the automated conventional process is similarly represented by Gerber, Toppan, DS America, and others.

The all-electronic prepress systems are represented by a wide array of developing monotone and color page make-up systems, where all the components of a page are assembled, color corrected, and output as a page unit(s). Vendor developments, particularly in monotone, are proceeding at a feverish pace, with no less than six startup companies entering the business in the past year, in addition to ongoing improvements by traditional suppliers.

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The emphasis of this paper is on the evolution into the all-electronic prepress world.

Despite this emphasis, it should be strongly pointed out that automated conventional equipment and processes that optimize prepress production will be required for many years, even with the use of the new all-electronic systems.

For instance, in today's electronic prepress world it remains most cost-effective to electronically produce one (or two) page unit(s) and to strip to plate-ready film (or imaged plate) using automated conventional equipment. Further along this same line of thought, current electronic stripping systems are potentially compatible with today's electronic prepress systems, in that they are performing the same layout functions as the developing stand-alone layout terminals for the electronic prepress systems.

EPS Systems

What to call the electronic prepress system? Many names are bandied about; perhaps the simplest is EPS, for Electronic Prepress System. Since this technology is in an evolutionary state, one must also anticipate generations of EPS systems. Furthermore one must, for at least the next five years, clearly distinguish between monotone systems (MEPS) and color systems (CEPS). At some point in time, the processing of color versus monotone prepress data will not substantially differ in cost, and the systems will merge. But for the short term, they are distinctly different and require separate treatment.

As vendors and users struggle to adopt EPS systems, it is important to recognize that, for the first time, prepress managers are required to perform a detailed and comprehensive analysis of our total prepress activities. In justifying and purchasing an EPS system, one is hoping to replace a large array of conventional

processes with an all-electronic system. These processes can include layout, type composition, page imposition, color/tone adjustments, geometric art, proofing, page correction, edit, etc.

Prior to this time, the prepress manager has been able to select new equipment for specific production steps by comparing the old and the new. EPS on the other hand requires that the entire process be analyzed, and that the proposed EPS system be vetted to ensure that all required steps are performed cost-effectively. New analyticalquestions are needed: for example, when was the last time you asked stripping "How often and by how much do you rotate scanner output filmin page makeup?"

Manual rotation is a given in conventional operations, and one that is highly efficient when compared to electronic rotation.

Suffice it to say, many a current EPS user has been burned by assumptions concerning the nature and volumes of prepress work his shop requires, versus the actual capability of a given EPS system. The bottom line is that a lot of homework is required and will pay off. Any prepress activity of 30 or more people should begin this homework now.

This same issue of duplicating all prepress functions causes an array of development problems to the EPS vendors. Which function should he implement next? The solution to this problem is often the "squeaky wheel". That is, the customer who won't order or won't pay until the specific function is satisfied. It will take years for maturity of software and hardware able to perform most of the required functions. The situation will not fully stabilize during our lifetime, because as users become aware of the new possibilities with EPS equipment, they will be provided, only to be replaced by requirements for additional capabilities.

In addition to the "which function next" problem, the vendors are faced with a broad-ranging technological challenge. For, in order to implement an EPS, they must go well beyond the computer manipulation of the page. A whole new class of computer peripherals is under development: input scanners, output scanners, direct digital proofers, plate imaging devices, low resolution proofers, and memory systems to satisfy the needs of EPS.

Unfortunately, many of these new systems require compatibility with consumables; that is, laser imaged printing plates, film, and proofs. This can complicate the equipment vendor's life a great deal, since he has no control over (and little technology in) the area of consumables materials.

Thus, the development of electronic prepress systems requires vendors not only with prepress knowledge, but with a broad base of technology ranging from input scanning, typesetting, image processing, specialized hardware architecture, color phosphors, and output scanning, to the imaging of various output materials.

Also unfortunately, no one graphic arts vendor possesses all these skills. Thus in 1977 Dunn Technology projected that the implementation of EPS would require a wide array of inter-company cooperations - joint ventures, acquisitions, mergers, etc. - to bring together the requisite skills.

A Restructuring of the Industry

A simple case in point is the setting of type by EPS systems. Here the MEPS systems have evolved from typesetting companies who have added line art and pictures to the typesetter (most notably III, Monotype, and Autologic). On the CEPS side, the systems developed as picture systems to which typesetters are/were added during 1982-1983. All of this has caused a lot of cooperation (Table I) as well as creating a whole new market for digital type.

Hastech/Monotype	Atex/Scitex
EOCOM/Compugraphic	Scitex/Bitstream
Crosfield/III	Autologic/3M
Xenotron/ECRM-7000	

Table 1: Industry Cooperation

Similarly, the output materials are critical and we see an array of joint ventures and acquisitions here also, and we can continue to anticipate a restructuring of the industry through joint ventures and acquisitions (Table 2) as electronic prepress systems come together.

Hoechst/EOCOM	Autologic/Raytheon
Crosfield/LogEscan	Kodak/Atex
Chemco/Dow Jones	Agfa Gevaert/Compugraphic

Table 2: Recent Joint Ventures and Acquisitions

The money force may well come from the consumables suppliers, who have the most at risk in the automated prepress world. The driving force for the consumables suppliers is an effort to influence the development of output imaging systems to be compatible with new (and hopefully proprietary) consumables with high profit margins.

As this restructuring proceeds, we should get closer to the full EPS as the vendor side becomes capable of handling all of the prepress requirements.

At the same time that we are witnessing a restructuring of the supply side, we notice some of the once-powerful vendors subsiding (such as Mergenthaler and Harris). Here, the problem appears to be an inability (or unwillingness) of the parent corporation to come to grips with the new trends in the graphic arts and make

the right ventures and investments. In both of these cases, our hardware market may be too small and too complicated to attract the parent's resources.

"Information into Images" Electronically

Historically, the industry has used "Words into Type" to indicate a form of automation. This is obsolete, and this continued thinking by some segments of the industry should put their existence at risk as the printing world changes. It is time to recognize the true business of printing: Conveying Information through Images.

"A picture is worth a thousand words" is an old saying. What does this mean digitally for EPS systems? For comparison, we assume the existence of a digital typeface library and the use of a standard USA weekly news magazine format (10 point type and 133 line screen (52/cm) process color).

Unfortunately, the quote does not specify the size of the picture required to represent the thousand words.

1000 words = 52 sq. in. or 6.4K bytes of storage

= 123 bytes/sq. in.

133 line screen Process Color = 283K bytes/sq. in.

Table 3: A Picture is worth 2300 Words

From Table 3, it is apparent that one square inch of 133 line process color requires 2300 times as much storage as does one square inch of 10 point type. That is, process color pictures on a one to one area basis with type represent about two thousand times the storage requirements for type. However, it is also clear that smaller pictures can represent larger bodies

of text. This form of information theory is left to others, but it is interesting that the old saying is not far off from the digital world.

It should also be appropriately noted that digital typesetting depends on a permanently stored digital type library (which in itself may be several megabytes). This digital type library is a one time expense. Process color pictures are of course every time an original, and cannot depend on library elements for basic construction of the picture elements.

Another point along the same line is that picture storage costs increase geometrically with line screen ruling (Table 4). With today's limited data storage options, this costs time and money.

Screen Ruling	Memory Storage
65	x
100	2.4x
120	3.4x
133	4.2x
150	5.3z
200	9.5x

Table 4: Line Screen Influence on Picture Storage Requirements

With the fixed limited digital storage available today, the implications of producing a job at 100 line screen or at 150 line screen can significantly affect production flow (processing speeds), and require user attention to these digital details. Further, the user is required to

- Track developments in data compression, which will save digital storage space at some probable (but unpredictable) loss in picture quality;

- Track developments in new memory systems for projecting future investments in peripherals;

- Ascertain whether carefully generated digital halftones, at lower screen ruling, will indeed satisfy customer requirements for the printed result.

The above just scratches the surface of the prepress automation of "Information into Images", and indicates a large requirement for printing industry management to broaden their horizons and awareness of both the capabilities and limitations of evolving electronic prepress techniques.

Forming "Information into Images" electronically will significantly increase the required capital investment in the prepress area, making prepress equipment decisions much more important than ever before. Further, combining typesetting, composition, and color picture processing in one system puts significant new requirements on the management and control of this system.

Office Encroachment

Already several trends are clear in the developing office of the future. These trends clearly indicate that major office equipment suppliers are planning systems that will compete with the printing process.

Word processor-to-typesetter interfaces are already in place, a step impacting the traditional type shop. Also, in the same vein, the print quality of matrix printers is being significantly improved by higher resolution devices, and by the addition of better typographic designs, including proportional spacing and kerning.

IBM has demonstrated an ink jet printer with the resolution and potential quality to do color proofing, and has announced a 600 lpi typesetting peripheral (the 4250) with a complete typographic library.

Xerox, with their X700 laser-based non-impact printer equipment is already (through its users) heavily into the demand printing market.

Most dramatic is the development of low-cost Non-Impact Printing (NIP) systems. Here the office equipment indus-try is starting to use electrophotographic office copier technology as a basis for new forms of printers. Already Agfa-Gevaert, IBM, Xerox, Ricoh (and others) have shown high resolution (300+ lpi) NIPs with type-faces of typographic quality, plus line art and half-tone imaging capabilities, and some with integral document scanners.

In fact, some 50-plus companies are in the process of adopting non-impact printing to replace line printers and daisywheel printers, with the non-impact printers offering line printer speeds and Near Typeset Quality (NTQ). In fact, these NIP systems are the computer-to-press cylinder technology of today. With slightly improved text quality and the addition of line art and halftones, they will begin to take a stronger share of the short run (to 5000) monotone printing business.

In the next few years these non-impact printers will be priced in the $10,000 to $20,000 range complete with image drivers and paper handling subsystems, and provide speeds in the range of 10 to 40 A4 pages per minute. Already Canon is offering in Japan a laser-driven Personal Copier (PC-20) with resolution of 300 x 300 dpi at 8 pages per minute and a reported price under $1500.

Further, it can be anticipated that these NIP devices will improve dramatically in quality (400 to 600 lpi) and become competitive with offset printing. Thus, the office replacement for the typewriter will in the five year time frame be comparable to offset quality for type and line art, and will have a capability of approximately 65 line monotone screen with 30 to 50 distinct gray levels.

At 60 A4 pages per minutes, the result of this technology is "computer-to-press-cylinder" where every copy
- is an original
- can be totally new or the same, in any mixture

and is produced at the rate of 3600 copies per hour. Combined with a collator (or computer collation) and binder, as is already common with high-speed office copiers, and you have a complete printing system as a peripheral to the office automation system. Table 5 shows very clear trends in this direction.

- Agfa-Gevaert buys Compugraphic and shows NIP and electrophotographic printing plate (NIP with typefaces, line art, and halftones)

- IBM announces a 600 lpi printer (the 4250) with high quality typefaces, line art, and halftones

- Xerox buys typefaces from Mergenthaler and announces graphics digitizers

- Kodak buys Atex

- DEC and Wang offer OEM non-impact printers from Xerox

Table 5: Industry Developments

These are only a few of the major events by office equipment suppliers during the past 12-18 months.

Already the technical document community is utilizing NIP technology as an alternative to typesetting output. Software is available for the Xerox 9700 to set type with the character spacing of the Autologic and III typesetters, thus further accommodating the interchangeable use of NIP with typesetting, and providing low cost plain paper proofs for "what you see is what you get".

Interfaces are also being provided between Computer Aided Design (CAD) systems and typesetters, as well as NIP printers.

Evolving EPS

The evolving electronic prepress system should be viewed as the product data base of the company. With time, a myriad of interfaces is likely to develop to improve the potential profitability of these electronic prepress systems in combination with the data base.

Today the basic interfaces are

- Color Scanner Interface: for inputting Monotone and color data
- Archiving Interface: for building digital archives
- Color Recorder Interface: for output to film

Under development at this time are interfaces for

- Typesetting: for inputting (or internally generating) digital type
- High Speed Scanner Input: for text and line art
- Direct Digital Proofing: to provide color proofs directly from the data base (without film)
- Remote Communications: for displaying pictures and pages at customer site
- Ability to Acquire Video Pictures: for manipulation and printing

In addition to these ongoing interfaces, several additional interfaces should be considered:

- High Speed Color Scanner: for input of picture data, with a faster Monotone picture input speed

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- System-to-System Communication: for offsite transmission of data between systems of the same manufacturer
- Viable Printing Plate Recorder: for the direct imaging of printing plates
- System-to-Foreign System Communications: for transferring data between systems of different manufacturers
- Ability to Provide Data to Video: for direct TV use
- Generalized Facsimile Interface: between various equipment
- Two-Way Communication with Customer: for Corrections
- Customer Site Direct Digital Proof
- Interface to NIP Systems: for high speed medium quality cheap positional proof
- Ability to Accept News Wire Photos
- Interfaces for CCD and MOS Array still (and frame capture) digital pictures

While discussing the external interfaces for electronic prepress, one cannot ignore areas of significant improvement required within the system.

- Data Compression
- Monotone or pseudo color representation of pictures on page layout terminals
- Cost effective soft proofing while scanning
- Networking amongst the four or more computers

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- Viable archiving software
- Systems management software
- More sophisticated sizing software
- Better "ink on paper" direct digital proofs
- Availability of cost-effective creative ad composition terminals
- Better Soft Proofing (i.e ink on paper)
- Automatic signature imposition control

Each of these capabilities and interfaces will eventually come about. However, the user community has no coordinated activity to influence their optimum development. Therefore, it is being left to the manufacturers to provide the required features in response to specific customer needs, rather than in response to clearly articulated industry-wide requirements. Note that this haphazard development schedule could prove a fatal flaw as the printing industry competes with other industry segments for the various markets requiring the conversation of "Images into Information".

For instance, the simple communication of data between competitive electronic prepress systems is a must for ultimate success. This is routinely achieved amongst competitive computers and, in the area of digital images, is routinely achieved amongst competitive Computer Aided Design systems, and digital imaging data format standards are being finalized.

Vendors of electronic prepress equipment do not wish to offer this capability for obvious parochial reasons. The printing industry needs to band together in the form of groups that specifically focus on standards, system requirements, and the like.

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Currently, a customer can move film or pages from vendor to vendor as his requirements change. For the future, the customer must be able to move his digital archive from one supplier to another supplier (at some appropriate cost) independent of the specific EPS system in use by either supplier.

Another customer will need to move data from a central prepress supplier to selected printing plants, again without regard to the specific EPS in use.

And yet another customer will have a soft proof terminal capability and want to deal with multiple suppliers without regard to their specific EPS system.

If there were no outside threats to the printing industry, then the haphazard development of electronic prepress could proceed as typesetting did, and only limit the flexibility and capability of individual competitive companies within the traditional printing industry. But since we anticipate strong competition from other industries in converting "Information into Images", the result of a traditional printing industry development process may be

- The overwhelming of our current vendors by a new class of vendors from outside the industry (office automation and computer system vendors)

- The strong competition with current printing companies by a new class of competitors in "Information into Images"

Fortunately, it is generally true that the average buyer of print is not sophisticated and therefore, may be slow to realize the new technological possibilities and realities. On the other hand, it can be anticipated that massive educational programs by competitors outside the industry will attempt to draw away the traditional print buyer in a variety of ways.

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Printing Industry

The printing industry has become very skilled in providing images with a maximum of esthetics and information content. These skills range over

- Design of characters within a typeface
- Spacing of characters for maximum readibility
- Balancing of page components for information transfer
- Optimizing picture reproduction techniques consistent with mechanical printing processes.

All this has grown out of centuries of trial and error, with little or no theoretical basis. Yet, the electronic-digital automation of these basic arts and crafts is the critical path for the printing industry. This automation must be achieved while maintaining or improving quality levels. Some are quick to point out that hot metal still produces the best type, and only recent innovations in high resolution laser imaging have approached this original quality standard.

It is this skill (quality and form of information presentation) that the printing industry brings to the "information" market. Even though printing is the oldest mechanized industry possessing this skill, many other industries are coming to realize the needs to optimize the "Information into Images" transfer. This ranges from a host of new products for the television industry, to efforts by computer peripheral suppliers to provide typography and halftones. To the extent that certain prepress crafts can be automated, as is already being shown by in-plant technical publishers, the future poses serious threats to certain specialized industry segments.

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Now is the time for the printing industry to take the lead in optimizing the "Information into Images" transfer and provide services to a broader share of the information market, as well as protect current continuing markets.

What are some of the real threats?

- Checks can be printed, at sufficient production rates, by the combination of a word processor and a specially-designed NIP.

- The same can be said for forms, with the addition of a business graphics package to word processors.

- In fact, both of the above could be good candidates for franchising in the USA - like copy shops.

- Real estate directories are a candidate for NIP.

- Technical documents are already moving to NIP and will move much more strongly when improved resolution and halftone capabilities are offered.

- Financial printing is yet another candidate for NIP and franchising.

The above markets are all monotone in nature, short run, with moderate quality requirements. This would begin to imply that traditional printing may get pushed primarily into process color markets.

Centralized Prepress

A variety of converging technologies and facts are placing emphasis on centralized prepress facilities.

- Capital costs of electronic prepress

- Complexities of digital archiving

- Distribution costs of printed matter

- Relative ease of digital data communication from centralized prepress to printing plant

- Training of operators

This holds true for the vertically integrated printer, as well as the trade shop serving multiple printers. Today this is practiced only by the vertically integrated printer, for many of the reasons already pointed out.

The centralized electronic prepress system with archived data bases should be looked at as the company's product potential.

Here again achiving raises some strategy questions not really addressed by the printing industry. Even if we assume the availability of optimized memory systems and archiving software (not currently true), there are several critical issues to address. For instance, what is the maximum size and highest resolution (line screen) you will want to use for an archived picture? This affects

- Memory storage
- Data compression
- Digital sizing
- Picture quality

For example, assume you scan a 35 mm slide to print at 4" x 5" at a 100 line screen, but you wish to archive the picture for later use at a 150 line screen and 12" x 15". Today the conventional way to handle this would be to

- Archive at 12 x 15" and 150 line screen, requiring approximately 65 megabytes of storage (or half a mag tape or one fourth of a disk pack).

- Process the data for current use at 4 x 5" at 100 line screen by a combination of sizing and averaging the data. This requires (conventionally) 3.2 megabytes or 1/20 of the space of the archived picture.

The implications are clear, and the need for digital data compression and effective picture sizing apparent. But what quality reduction will the industry accept in order to retrieve data from a digital archive for later use? Both data compression and picture sizing affect picture quality. To date, very little emprical experience exists to understand ramifications of these techniques.

Yet the development of full archiving systems that allow multiple uses of the data probably depends as much on these issues (quality results from data compression and sizing) as on new memory systems.

Summary

"Information into Images" should become the slogan of the printing industry as the automation of prepress moves forward. These observations are offered:

- Users should make their needs clear, to reduce development time by manufacturers and eliminate duplication of effort.

- Suppliers and users alike must watch for significant competition from outside the current industry.

- EPS systems are necessary, but will require major industry commitments to fully develop.

- Standards in data storage and intersystem communication are a must.

The decade of the 80's should prove to be exciting and challenging to all involved in the prepress arena.

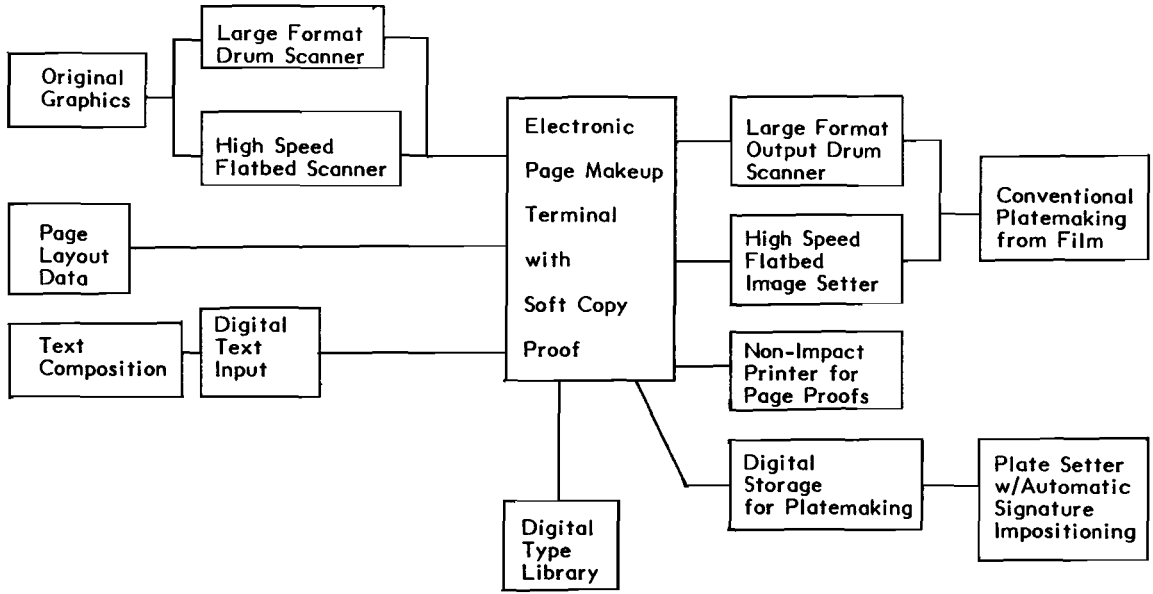

Figure 1: Postulated Electronic Prepress System