A COMPREHENSIVE MANUFACTURERS AND USERS SURVEY OF ELECTRONIC (MONOTONE AND COLOR) PREPRESS EQUIPMENT

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Abstract - During the last decade, there has been a trend toward the automation of prepress technology. Increasingly, prepress production is taking place at remote sites and transmitted by phone modem or satellite. For the most part, each installation is unique and management is unable to easily acquire guidance and information about prepress automation. Electronic prepress has been possible in the past, but was not practical as part of a system before the late 1970's.

Historically, photocomposition did not become a reality before the mid 1950's, satellite and microwave transmission became a reality in the late 1960's, and the 1970's brought color scanning, computer aided masking, laser platemaking, and color page makeup stations, whereas satellite transmission of color separations became a reality in the 1980's.

This paper is the result of a comprehensive survey of 61 companies in the electronic prepress industry. Twenty-six equipment manufacturers answered a survey designed for equipment manufacturers and 35 equipment users answered a survey designed for equipment users. The statistical data in this paper is derived from the study performed in 1984. The purpose of the study was to gather current information that is of value to management.

Profile of Survey Respondents

1984 - Manufacturers and users of electronic prepress equipment from the United States, England, Canada, France, and Switzerland replied to one of two surveys (user or manufacturer). The age, markets serviced, number of employees, 1983 gross sales, and color prepress capabilities of equipment owners are illustrated in figures 1, 2, 3, 4, and 5.

Type of markets serviced	
Color separation	69%
Commercial printing	37%
Total prepress	37%
Typesetting	26%
Publishing	11%
In-plant	11%
Specialty and educational	14%

Figure 1

NUMBER OF EMPLOYEES	
1-5	3%
6-10	11%
11-15	6%
16-25	17%
26-50	17%
51-100	17%
101-200	9%
OVER 200	20%

Figure 2

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YEARS IN BUSINESS

0-3	6%
4-7	8%
8-15	26%
16-25	14%
OVER 25	46%

Figure 3

1983 GROSS SALES

$1-$250,000	3%
$250,001-$500,000	11%
$500,001-$750,000	3%
$750,001-$1,000,000	9%
$1,000,001-$1,500,000	6%
$1,500,001-$3,000,000	9%
$3,000,00 1-$5,000,000	6%
$5,000,001-$8,000,000	9%
$8,000,001-$10,000,000	6%
OVER $10,000,000	29%
Declined to state	9%

Figure 4

COLOR PREPRESS CAPABILITIES

Manual stripping	77%
Color scanner	74%
Separation camera	46%
Color page makeup station	29%
Computer aided masking	17%
Electronic previewer	14%
Separation enlarger	14%

Figure 5

Manufacturers surveyed fall into the categories of electronic prepress equipment manufacturer, computer product manufacturer, electronics manufacturer, and communication equipment manufacturer. They manufacture digital typesetters, digital typesetters with halftone output, monotone page makeup stations, monotone scanners, computer aided photocomposers, color page makeup stations, computer aided masking units, color scanners, micro-projection platemakers, laser platemakers, and laser printers. Specific information concerning research, development, manufacturing, testing, and personnel training for manufacturers is presented throughout this paper.

Equipment Personnel Training and Compensation

1984 - Technology increases productivity if it is economically practical. Outside the laboratory, one problem arises: a shortage of qualified personnel to operate the equipment. Most educational institutions do not have electronic page makeup stations (monotone or color), scanners or digitizers, computer aided masking, laser platemakers, or micro-projection platemakers. This leaves only two sources of training, the manufacturer and plant personnel.

The newest addition to the prepress department is page makeup stations. The source of monotone page makeup station operators of companies surveyed for their most recent hire is shown in figure six. Forty percent of these new hires did not have adequate training at the time of hire and required additional training to meet acceptable standards. Twenty-six percent of the companies surveyed have forcasted the purchase of a new or additional monotone page makeup station between 1985 and 1990.

SOURCE OF MONOTONE PAGE MAKEUP STATION OPERATOR

Another firm	30%
In-house	30%
Trade school	20%
Employment services	20%

Figure 6

Color page makeup station owners surveyed found the available supply of trained operators small and expensive. Seventy-eight percent had to recruit in-house personnel and 22 percent came from another firm. Sources of original operator training are included in figure 7. Annual salaries for color page makeup station operators surveyed range from $30,000 to $52,500. Twenty-nine percent of the equipment owners surveyed have at least one color page makeup station and 57 percent have forcasted purchasing a new or additional color page makeup station between 1985 and 1990. Some equipment owners surveyed have been using a color page makeup station since 1980.

LOCATION OF ORIGINAL TRAINING FOR COLOR PAGE MAKEUP STATION OPERATORS

In-house	60%
Previous employer	20%
Equipment manufacturer	10%
Union	10%

Figure 7

Scanner operators surveyed receive annual compensation of $20,000 to $45,000. Seventy-four percent of the companies surveyed presently own a color scanner and 43 percent have forecasted the purchase of a new or additional color scanner between 1985 and 1990. When an electronic prepress equipment manufacturer sells equipment, the customer normally requests training of its employees to operate the new equipment. Dependending on the circumstances, this training period will last from one half day to four months as shown in figure 8. This training session takes place at the customers location or at the manufacturers training facility. The cost of the training session is included in the equipment purchase price or will be an additional fee. If additional training is needed in the future for a new operator, the customer can arrange this with the manufacturer for a fee (up to several hundred dollars a day for sophisticated color systems). Figure nine shows the employee turnover rate for the last two years for prepress personnel of electronic prepress equipment owners surveyed.

Unless a large amount of funding or equipment donations become available to graphic art educational programs (operator and management) in the immediate future, a shortage of qualified electronic prepres equipment personnel will continue to exist through the end of the decade (1990). Management must train personnel how to operate new equipmnt before its installation if system startup costs are to be

EQUIPMENT	TRAINING PERIOD
Monotone page makeup station	1 week to 1 month
Color page makeup station	2 weeks to 4 months
Color scanner	2 days to 3 weeks
Monotone scanner/digitizer	1/2 day to 1 week
Computer aided masking unit	1 week to 2 weeks
Computer aided photocomposer	1 week

Figure 8

EMPLOYEE TURNOVER RATE FOR LAST TWO YEARS

PERCENT OF COMPANIES	RATE OF TURNOVER
20%	0%
14%	1%-10%
9%	11%-40%
9%	41%-60%
6%	OVER 70%
42%	DECLINED TO STATE

Figure 9

kept at a minimum. In addition, a permanent well defined equipment operator training program should exist to keep operator skills current, train future operators, and train backup operators in case of employee termination, temporary disability, or sickness. Expense incurred from loss of or reduced productivity during training periods, must be forecasted if it is to be recovered in the budgeted hour rate.

The purpose of most industry organizations is to educate and serve its membership through publications, seminars, and training programs. Membership in industry organizatons as reported by survey respondents is shown in figure 10.

(1985 - 1990) Color scanners and monotone page makeup stations will be acquired by a few university programs and some vocational programs. Computer aided masking units, computer aided photocomposers, and color electronic page makeup stations will remain out of the grasp of most educational institutions through 1990. New electronic prepress equipment acquisitions will outpace the available supply of trained operators. Employees with limited training but no proven experience will continue to dominate the electronic prepress field. Companies with major investments and dependency on electronic prepress equipment must implement long term in-house training programs to keep pace with employee attrition (figure 9) and new equipment acquisitons. Color scanner and color page makeup station operators with long term (7 to 10 years) experience can expect annual salaries in excess of $50,000 in top quality companies due to a continued lack of experienced operators.

PERCENT MEMBERSHIP	ORGANIZATION
66%	Printing Industries of America (PIA)
46%	Graphic Arts Technical Foundation (GATF)
34%	National Association of Printers and Lithographers (NAPL)
29%	Technical Association of the Graphic Arts (TAGA)
9%	Graphic Preparatory Association (GPA)
9%	International Association of Photoplatemakers (IAP)
9%	Gravure Technical Association (GTA)
9%	Book Manufacturers' Institute (BMI)
6%	Typographers International Association (TIA)
6%	Magazine Publishers Association (MPA)
6%	Direct Marketing Association (DMA)
3%	Flexographic Technical Association (FTA)
3%	Association of Publication Production Managers (APPM)
3%	Association of American Publishers (AAP)
11%	Various regional printing organizations

Figure 10

(1991 - 2000)Many educational institutions will acquire complete electronic prepress systems due to eqipment donations from companies replacing 10 to 15 year old systems with a new generation of electronic prepress equipment. The availability of highly skilled and experienced (over 10 years) page makeup station operators will begin to keep pace with new equipment acquisitions towards the middle of the decade (1994 - 1996).

Ergonomics

1984 - Ergonomics is the study of engineering conditions needed to interface humans with machines efficiently. Defects in engineering create human stress, loss of profits, and loss of productivity. Many independent and government studies of ergonomics have been done in the past, but no universally accepted conclusion or guidelines (voluntary or mandatory) have been adopted by the graphic arts profession. Presently, most federal and state legislative efforts are in the hearing stage concerning ergonomic factors. Possible ergonomic factors to consider are room lighting levels, work and break periods, determination of and protection from cathode ray tube radiation if any exists, regular eye exams for employees, rights and affects to pregnant workers, cathode ray tube design (color, size, resolution, intensity, contrast, viewing angle, viewing distance, cursor), and physical work space and equipment dimensions.

Of manufacturers surveyed, 58 percent have an adjustable viewing angle on all cathode ray tube workstations they manufacture. In addition, 69 percent of the manufacturers have both adjustable brightness and contrast on monotone cathode ray tube terminals currently offered.

Most workstations manufactured today contain a bit mapped display. A bit mapped screen resolution is measured in horizontal lines per inch (lpi) and each pixel can be individually addressed. Both monotone and color cathode ray tubes in workstations range from under 50 lpi to over 120 lpi. Obviously, the higher the resolution the easier it is to discern images on the screen. None of the manufacturers surveyed manufacture cathode ray tubes in-house. They rely on manufacturers that originate the equipment to produce high resolution cathode ray tubes at an acceptable price.

Throughout the rest of the decade (1985 - 1990), laws concerning ergonomics will be implemented with mandatory compliance by manufacturers and equipment owners. The economic impact is uncertain for the future, but present lack of ergonomic control may be affecting profits through productivity loss, and employee turnover due to stress from ergonomic factors. The results of long term studies (over 10 years) will not be known until the end of the next decade (2000). Laws implemented today are based on short term small sample studies, employee fears, and speculation by experts. Perhaps voluntary ergonomic controls should be implemented until long term studies are concluded that allow fair laws to be written based on verified and accepted facts.

(1985 - 1990) Laws regulating ergonomic factors will be imposed on equipment manufacturers and equipment owners. Laws will be challenged by manufacturers because of increased costs to comply and by equipment owners because of costs to modify working conditons, change equipment, or compensate employees for damages. Legal cases will be heard that set a precedent on interpretations of these new laws. Long term (over 10 years) large sample population studies will begin to ascertain the proper ergonomic factors to be regulated.

(1991 - 2000) The results of long term ergonomic studes will be evaluated and the laws amended based on verifiable study results. Laws throughtout the United States will vary due to the lobbying strength or weakness of regional special interest groups. During the 1990's, the economic impact of ergonomic regulaton will be ascertainable.

Environment

1984 - The environment in which electronic prepress computer equipment is placed affects reliability. Electrical power, temperature, flooring, humidity, and air filtration need to be controlled. A controlled environment is recommended by 69 percent of the equipment manufacturers surveyed, and a mandatory condition of sale or maintenance contract by 12 percent, the others say it is not needed for their equipment. Fifty-four percent of the equipment users surveyed have a controlled environment of some type. Thirty-one percent of the equipment manufacturers surveyed offer design service of a controlled environment to their customers. Figure 11 shows who designed the controlled environment of equipment owners surveyed.

PERCENT	DESIGNER OF CONTROLLED ENVIRONMENT
54	In-house personnel
11	Equipment manufacturer
9	Subcontractor or architect

Figure 11

Seventy-seven percent of the equipment manufacturers surveyed recommend dedicated power lines for electronic prepress equipment. Dedicated is a term that is used loosely in the industry. A power line can only be dedicated to a piece of equipment as far back as it is traced and as far back as controls are placed on it. Equipment owners can trace power back to the street power pole transformer, but typically have control only from the buildings main fuse box to the specific piece of equipment. Before installing equipment, a power audit must be completed. The amperage and voltage available for additional equipment must be determined and monitored over a period of time exceeding one month for voltage deviations exceeding half a cycle (approximately eight milliseconds), noise above 60 hertz, and occurance of total power failure. Some type of weekly power aberration is common. Half of the equipment manufacturers surveyed recommend power supply voltage regulation ranging from two percent to 10 percent. Voltage regulators, noise filters, and uninterruptible power supplies reduce the chance of equipment damage due to power aberrations. Uninterruptible power supplies, supply power for a limited amount of time (a few minutes to a few hours) when power failure occurs. This allows time to store information out to disc and shut down equipment safely until power resumes. Thirty-eight percent of electronic prepress equipment owners surveyed report equipment damage due to power problems. As a result, monotone users surveyed suffer equipment failures of one to ten days and color equipment users surveyed suffer equipment failures of one to five days.

Temperature control of the environment is critical to equipment stability. Thermal drift in analog devices and bit error in digital devices occurs when operating temperatures exceed component temperature parameters. This will cause settings to drift, erratic continuity in circuits, logic errors, or component failure. Fifty-four percent of equipment users surveyed use temperature control systems. Users site target temperatures from 62 degrees fahrenheit to 75 degrees fahrenheit, others range from below 60 degrees fahrenheit to 75 degres fahrenheit. The majority of equipment manufacturers suggest an ideal setting of 68 degrees fahrenheit or 70 degrees fahrenheit, others range from below 60 degrees fahrenheit to 75 degrees fahrenheit. Environment sizes in the survey ranged from 1600 cubic feet to 120,000 cubic feet (cubic feet equals length X width X height).

The air conditioning, filtering, and humidity control system must be able to circulate and control the environments entire volume of air at least twice per hour. Twenty-three percent of the manufacturers surveyed suggest filtering contaminants out of the air. A contaminant between a magnetic disc or tape and its read write head could cause a head crash which can cause permanent damage to the head, tape, or

disc and down time plus data loss. Contaminants also collect on electromechanical contacts (relays, keyboard keys, buttons, rotary switches, and potentiometers) affecting continuity. The most common source of unneeded contaminants and the easiest to eliminate is tobacco smoke, yet 32 percent of those with controlled environments surveyed report employees smoke in the environment. Most atmospheric dust is less than five microns and smoke particles average 0.3 microns. One micron equals 0.000039 inches. Human contaminants are typicaly much larger (human hair 100 microns, blood corpuscles 14 microns). It seems logical that contaminants 0.3 microns or larger should ideally be filtered out. This will typically require filtering with more than one unit. Filtration efficiency levels can be checked by independent clean room testing and certification laboratories.

Humidity must also be monitored to insure proper operation of electronic circuitry. Equipment users surveyed report relative humidity of 40 percent to 60 percent, well within suggested practice by most equipment manuacturers and in the human comfort zone. Relative humidity is the percentage of water vapor in the air relative to the amount of water vapor the air can hold when 100 percent saturated at the same temperature (absolute humidity).

Lastly, a raised flooring of linoleum or electrically grounded carpet is suggested by most manufacturers surveyed with the wiring routed under the raised floor. These flooring materials help to reduce static build up and discharge which can damage circuitry.

Monitoring of environmental conditions should be continuous. Electronic monitoring and warning systems are a convenience, but monitoring by humans can be effectively implemented.

(1985 - 1990) Electronic prepress equipment owners will implement voltage regulation, electrical noise filtration, uninterruptible power supplies, temperature control, humidity control, air particle filtration, and special flooring materials as an integrated environmental control system instead of randomly controlling one or two aspects only.

(1991 - 2000)Vendors selling turnkey environmental control systems (hardware and design service) will specifically target the needs of electonic prepress equipment system owners.

Maintenance and Reliability

1984 - Electronic, electro-mechanical, and electro-optical technology is integrated into prepress with the goal of increased productivity and profits. Maintenance and reliability are important considerations in achieving new standards. Equipment owners surveyed protect their equipment investment with service contracts as shown in figure 12.

SERVICE VENDOR	COLOR EQUIPMENT	MONOTONE EQUIPMENT
Equipment manufacturer	59%	46%
No maintenance contract	22%	31%
Independent service company	4%	15%
In-house personnel	15%	8%

Figure 12

Obtaining parts and complete maintenance and technical information is of prime importance for the 54 percent of monotone equipment owners and 41 percent of color equipment owners surveyed that do not have a service contract with equipment manufacturers. Fifty-four percent of the equipment manufacturers surveyed will not sell parts to independent service companies and 23 percent claim complete maintenance and technical information is not for distribution. Although 65 percent of the manufacturers surveyed will make complete maintenance and technical information available to owners of equipment, only 19 percent of manufacturers surveyed will supply independent service companies with complete maintenance and technical information.

Some electronic prepress equipment manufacturers require that computer hardware problems be serviced by the computer hardware original equipment manufacturer if not manufactured by the prepress equipment manufacturer. This may require a separate contract with the computer manufacturer (IBM, Digital Equipment Corporation, Data General, Hewlett Packard) in addition to the contract with the electronic prepress equipment manufacturer.

Maintenance contract price will be determined by the level of service, past experience, geographic location, a percentage of the original equipment price (one percent to ten percent annually or one percent to 1.15 percent monthly), or any combination. Manufacturers surveyed offer suggestions for electronic prepress equipment maintenance contract provisions and current costs in figure 13. Data for regularly scheduled service, unscheduled service, flat fee or percentage contract cost, and hourly labor charge for equipment owners without a maintenance contract are all included. The data presented is for an annual contract.

The longest individual downtime experience of monotone equipment users surveyed ranges from one day to twelve days. Color equipment owners are not as lucky and have downtime experiences up to three weeks in duration. This is why a pre-planned backup system must exist. Eighty-two percent of color equipment owners surveyed have this downtime on their scanner and 14 percent on their output plotter. The number of service calls normally needed to solve most equipment problems of equipment owners surveyed is listed in figure 14.

Some equipment owners surveyed believe that any downtime or the need for a field service visit is unacceptable. Sixty-three percent of equipment owners surveyed indicate they will buy spare critical circuit boards to have on hand if equipment has built-in user diagnostics. Some equipment manufacturers try to diagnose equipment problems remotely using software and a phone modem. Presently, 81 percent of equipment users surveyed attempt to diagnose electronic prepress equipment problems. Their success rate is illustrated in figure 15.

	Regularly scheduled service calls	Unscheduled service calls	Flat fee	Percentage fee	Hourly cost with no contract
Phototypesetter with halftone output	0-12	0 to unlimited	up to $18,000	8%-9% annually	$41-$100
Network of four monotone page makeup stations	0-4	0 to unlimited	up to $26,000		$51-$175
Computer aided masking unit	4	2	up to $4000		$50-$60
Monotone scanner	0-4	2-6	up to $7000		$51-$225
Color scanner	4	2 to unlimited	up to $10,000		$51-$175
Computerized photocomposer*	1-4	0-3	up to $15,000		$41-$80
Color page makeup station	1-12	0 to unlimited		8%-9% annually	

*includes micro-projection platemakers

Figure 13

NUMBER OF SERVICE CALLS NEEDED	PERCENT OF EQUIPMENT OWNERS
1	67%
2	24%
3	9%

Figure 14

PERCENT OF COMPANIES	SELF DIAGNOSES SUCCESS RATE
19%	NO ATTEMPT
19%	0%-25%
19%	26%-50%
43%	51%-75%

Figure 15

Equipment users surveyed experience response times of up to five days from field service personnel, but 67 percent report same day or next day response times. No equipment user surveyed contributed response time delays of two days or more to their geographic location, but sixty-seven percent of equipment manufacturers surveyed claim a customers geographic location within the continental United States will affect the response time of field service personnel. Perhaps a shortage of repair personnel exists. Sixty-nine percent of the manufacturers surveyed claim a response time of 24 hours or less, and 12 percent respond within 48 hours. Equipment owners wihout a service contract may be refused service by the manufacturer, or serviced when convenient for the field service departent. Only 42 prcent of the manufacturers surveyed will respond within 24 hours to equipment owners without a service contract.

Now that the field service person has arrived to service the eqipment, what is the capability of this person and their backround experience The minimum electronics

experience required by manufacturers surveyed for field service employment is trade school (42%), Associate degree in Electronic Engineering (42%), and some accept military experience while others require a Bachelor of Science degree in Electronic Engineering as a minimum. After gaining emloyment, field service personnel receive further training of two weeks to one year plus continuing on the job training depending on the company. Thirty-five percent surveyed receive three months to one year additional training. Eighty-five percent of field service personnel isolate and replace circuit boards in the field. Trouble shooting of circuit board components is usually done at the factory. Thirty-eight percent of the manufacturers surveyed require that computer hardware problems be serviced by the original equipment manufacturer (IBM, Digital Equipment Corporation, Data General, Hewlett Packard).

The decision by top management to protect the investment in electronic prepress equipment shoud be made before the equipment is purchsed and installed. Preventive maintenance and realistic reliability projections allow advanced knowledge of maintenance costs that must be recovered in the cost center budgeted hour rate.

(1985 - 1990) The need for multiple service contracts on electronic prepess equipment systems will become prevalent due to increased integration of many sophisticated OEM sub-assemblies. In-house service capabilities of electronic prepess equipment system owners will include an electronic engineer or technician on staff. For many, the added salary cost is minimal compared to the equipment cost and benefit of immediate maintenance service. Remote trouble shooting of equipment by use of software and phone modems will increase.

Telecommunication

1984 - The printing and publishing industry has been in the telecommunication age ever since the 1930's when it started using TTS code and punched paper tape. After all this time, the industry is still trying to design and implement acceptable software and hardware standards to electronically transfer typography, color pages, and monotone pages with graphic content between systems and locations. Only 18 percent of electronic prepress equipment owners surveyed use telecommunication capabilities, yet 29 percent desire standards for typography transmission, 23 percent desire standards for color page transmission, and 11 percent desire standards for monotone pages with graphic content. Sixty-nine percent of electronic prepress equipment manufacturers surveyed indicate they would participate in an effort to establish these transmission standards for software. Half of the manufacturers that would refuse to participate in an industry effort to develop standards believe they are competing with computer manufacturers for the electronic prepress equipment market. Electronic prepress equipment owners surveyed were asked if their presently forecasted capital expenditures for new electronic prepress equipment through the end of the decade (1985 - 1990) included telecommunication capability. The response to this question appears in figure 16.

Recently, the Graphic Communication Association (GCA) has adopted GCA Standard 101-1983 Document Markup Metalanguage, GenCode. This is a prop-

FORECASTED PURCHASES 1985 -1990	PERCENT WITH TELECOMMUNICATION
Phototypesetters	33%
Phototypesetters with halftone output	43%
Monotone page makeup station	25%
Color page makeup station	26%

Figure 16

osed American National Standards Institute (ANSI) and International Standards Organization (ISO) standard and was adopted by the United States Department of Defense in 1983. This standard is for typographic markup.

Telecommunication users surveyed use phone modems at 300 baud, 1200 baud, and 4800 baud on a dedicated phone line. Satellite transmission is achieved by C band satellites with a six gigahertz uplink and a four gigahertz downlink. Bit error rates range from 10^{-9} to 10^{-12}. In the past Westar III (91 degrees west longitude, to be replaced by Spacenet III in 1985 a hybrid satellite), Westar IV (98.5 degrees west longitude, launched in 1982), Westar V (119.5 degrees west longitude, launched in 1982), and Satcom IV (83.5 degrees west longitude, launched in 1982) have been used by the printing and publishing industry. A hybrid satellite is capable of both C band and Ku band transmission. Ku band satellites use a 14 gigahertz uplink and a 12 gigahertz downlink. Recently, the Federal Communication Commision (FCC) has reduced satellite spacing to two degrees in the same band to ease the scarcity of orbital slots. Appendix A shows a partial listing of satellite orbital positions, user, band, and launch date.

Locations are transmit only, receive only, or transmit and receive. Most companies surveyed report telecommunication of less than 30 percent of their phototypesetting. Only 12 percent of equipment owners surveyed transmit typography but 18 percent receive typography by telecommunication. Less than six percent of companies transmit or receive monotone pages with graphic content and less than three percent of the companies surveyed use satellite communicaton. As wide band satellite communicaton becomes cheaper its use will increase, allowing expansion into new and foreign markets of printing buyers.

During the last two decades, printing firms have specialized in specific market segments (half width web, color separation service, bindery service, typography service, total prepress service, etc.). Telecommunication is the next logical step to link vendors and customers. Phototypesetters marketed today range in output speed of 50 news lines per minute to 4000 news lines per minute (one news line is eight point type and 11 picas wide, with approximately 30 characters per line, and a word is approximately 4 characters and one space). A keyboard operator can type approximately 12 lines per minute of straight matter. This corresponds to a front end capability of 4 to 330 keyboards per phototypesetter depending on its speed. No company surveyed reported having more than 35 keyboards. Some phototypesetting installations are under using their phototypesetting capabilities and not maximizing profits. Telecommunication allows for increased usage, thereby lowering vari-

able costs. Fixed costs are the same no matter what the equipment usage level is. Sources of telecommuication input to prepress services from remote locations include micro-computers (business and personal), facimile devices, CCD and laser scaners (portable and stationary), electronic filmless cameras, along with trade service vendors and customers. Printing sales outside of a companies geographic manufacturing area is a common practice. Sales and prepress can share the same facility remote from press and finishing facilities. Many of the 2 to 5 million micro-computers in use today have graphic and telecomunication capability. Multiple fonts and graphic design (either original or art library discs) is available to the sophisticated printing buyer, small business, and common person alike. Graphic designers can prepare electronic mechanicals ready for output to plate or film at sophisticated graphic design workstations. Printing buyers are demanding shorter turn around time, increased quality, and sophisticated services as their ability to prepare art for printed reproduction increases in sophistication and quality at a cost savings.

Use of many media by printing buyers is normal. The traditional prepess service is evolving into an image processing service. Art preparation for videodisc, database and information services, videotex, laser printing, ink jet printing, impact printing, holography, lithography, gravure, flexography, and screen printing must be serviced by someone. When the now billion dollar quick print industry was emerging, most traditional firms ignored the quick print industry as a viable competitor. Quick print flourished and is now one of the most profitable sectors of the printing industry. Will the prepress sector of the industry serve the image procesing needs created by new graphic communication technoloy or will new firms develop to serve the changing and expanding needs of printing buyers

Only 13 percent of electronic prepress equipment manufacturers surveyed manufacture telecommunication equipment. Satellite dishes, receivers, low noise amplifiers, and auxillary equipment is supplied and installed by a specialty subcontractor and or satellite communication service. Backup procedures should exist in case of temporary system failure.

(1985 - 1990) Electronic prepress equipment owners surveyed have forecast equipment purchases with telecommunication equipment for 43 percent of phototypesetters with halftone output, 25 percent of monotone page makeup stations, and 26 percent of color page makeup stations during 1985 - 1990. Regional electronic prepress services will adopt their own standards for electronic transfer of typography and graphics (monotone and color) due to a lack of industry wide standards. The trend to remote prepress facilities from manufacturing will continue due to an increase in companies using telecommuication. The rapid acceptance of computerized graphic design workstations will account for the production of many mechanicals. These electronic mechanicals will spur the development of software transmission standards. Software and standards will probably be supplied by non-traditional third party software vendors from other industries (CAD) using the same technology and shortening their return on investment time by servicing many new markets (printing and publishing).

(1991 - 2000) A shortage of satellite orbital slots in the western hemisphere will exist and space debris will pose a threat of temporary damage to commercial satellites. The ability of phone systems in the United States to handle the volume of voice and data transmissions will be at near capacity loads. Authors of periodicals and other timely publications will compose and transmit the majority of text and line drawings to publishers by telecommunication systems.

Management Practices of Equipment Owners

1984 - Management practices greatly affect the manufacturing cost, productivity, and profit margin of a company.

Seventeen percent of scanner owners surveyed program their scanner(s) off line. This is performed at a color preview station. The artwork (reflection or transmission) is evaluated for scaling, color balance, localized retouching, and contrast. The information is entered into a computer that is interfaced to the scanner. Some companies preview the art before scanning even though their scanner cannot be preprogrammed. The information is entered manually from a computer printout generated at the preview station. The purpose of previewing and preprogramming is to maximize scanner productivity time and reduce the need to re-separate poor quality separations. Fourteen percent of scanner owners surveyed use electronic devices to preview art for separation. Eighty-six percent of companies surveyed that preview art have a re-separation rate of 10 percent or less, compared to 57 percent of those that do not preview. Thirteen percent of the companies surveyed that do not preview art for separation need to re-separate 11 percent to 20 percent and 22 percent need to re-separate 21 percent to 30 percent. Equipment owners surveyed report scanner shifts of 7 to 12 hours in duration. Fifteen percent use one shift, 50 percent use two shifts, and 27 percent operate their scanner(s) three shifts. Eighty percent are digital dot scanners, 16 percent use contact screens, and four percent produce continuous tone film. The most predominant resolution is 150 lines per inch by 77 percent of scanner owners surveyed.

Fifty percent of color pagination station owners surveyed substitute electronic airbrushing for manual dot etching 11 percent to 50 percent of the time and 14 percent substitute it 100 percent of the time. As the use of high speed electronic airbrushing with color page makeup stations increases, the need for highly skilled dot etchers will decrease.

Costs from physical storage space, magnetic disc, magnetic tape, filing, and retrieval are all incurred when storing digital data. Forty percent of color page makeup station owners surveyed charge customers for magnetic storage space on disc or tape of color pages. Presently, optical laser disc technology is in use in the audio industry (read only compact disc), and video industry (read only, and write once). Optical disc technology for computer use is available for limited applications in many non-compatible formats in test markets. Read write optical discs for computer use have the capability of storing many gigabytes (billions) of data on one disc. However, storage capacity of same size discs from two different systems will vary due to different data redundency schemes used to compensate for bit error rates.

Thirty-eight percent of electronic prepress equipment manufacturers surveyed are considering future integration of optical discs in their systems. Twenty-six percent surveyed are putting increased emphasis on data compression techniques. Although color pages stored on 300 megabyte hard discs (two to three A4 pages per disc) can be backed up on low cost sequential access magnetic tape, the audio industry has discovered magnetic tape is not an archival medium and data loss may occur over a period of time even with redundency schemes. Film is still the only archival storage medium.

(1985 - 1990) There will be an increase in the use of electronic previewing of art for color scanning and preprogramming of scanners will increase due to the need for productivity of quality work. A decrease in the demand for dot etchers will be apparent due to the continued use of electronic airbrushing on some color page makeup stations. The majority of color page makeup station owners will charge customers for magnetic storage of pages. The publishing industry will begin to accept soft copy proofing by telecommunication thereby shortening lead times.

(1991 - 2000) Electronic prepress equipment manufacturers will begin to integrate optical disc storage technology into systems. These storage systems will have the capability to read and write to disc unlike the read only compact disc (CD-ROM) format that is likely to appear in the micro-computer market in 1985. The majority of all art to be reproduced will be electronically created or enhanced by the year 2000.

Computer Hardware and Software

1984 - Beginning with the UNIVAC I, the first computer installation in the United States in 1951, at the United States Bureau of Census and the marketing of the UNIVAC machine by Remington Rand in 1954, both software and hardware has evolved.

The majority of hardware and software is supplied to electronic prepress equipment manufacturers from subcontractors and vendors. Thirty-one percent of the electronic prepress equipment manufacturers surveyed have in-house manufacturing or assembly for one or more pieces of computer hardware (lasers, monotone cathode ray tubes, central processing units (8 bit, 16 bit, 32 bit), floppy disc drives (8 inch, 5.25 inch, 3.5 inch), hard disc drives, magnetic tape transport systems, and keyboards). Fifty-eight percent of electronic prepress equipment manufacturers surveyed have developed software in-house for monotone page makeup stations, color page makeup stations, and or digital phototypesetters.

Electronic prepress equipment sales are in 100's of units per model over many years, this does not allow manufacturers a recoverable return on investment for in-house research, development, and manufacturing of sophisticated hardware sub-assemblies unless they, their parent company, or a subsidiary company markets the hardware to many market segments. The parent company and or subsidiary company of manufacturers surveyed are shown in figure 17.

Classification of Parent or Subsidiary	Percent of Companies
Computer product manufacturer	15%
Electronics manufacturer	12%
Communication equipment manufacturer	6%

Figure 17

Keyboarding of text and system commands is the dominant method in use today. The QWERTY keyboard is the standard against which other methods are measured. Since the first computer system in 1951, various attempts at increasing character capture rate and user friendliness have been marketed. Keyboard designs are for text entry, system command entry, or both. The Dvorak keyboard layout is offered by only a few electronic prepress equipment manufacturers and is supposed to allow an increase in character capture rate over the QWERTY layout. Twenty-three percent of equipment users surveyed expressed an interest in a keyboard layout that would allow increased character capture rate over the QWERTY layout. Seventy-five percent of these users are looking for an increase in speed of 11 percent to 40 percent, and 88 percent of those interested in a speed increase will accept a maximum keyboard operator retraining period of one to four weeks. No electronic prepress equipment manufacturer surveyed is engaged in research and development of such a keyboard. As long as the ASCII character set is supported, any layout is possible. In an attempt to increase user friendliness by simplified entry of system commands, many devices (keyboards, mice, digitizing tablets, touch pens, selectors, and touch sensitive screens) have been incorporated into computer systems with supporting software. These devices make possible interactive systems. Keyboard function keys are slow to use and have limited capability because the increased number of keys on the keyboard increases operator confusion and keyboard size. The popular mouse has one or more function buttons and is used in conjunction with software menus, software windows, and or digitizing tablets. Touch pens and selectors have seen limited use and are used in conjunction with with the cathode ray tube screen and or digitizing tablets. Touch sensor cathode ray tube screens have seen limited use in the educational and video field along with joysticks and trackball devices. Mice, digitizing tablets, and the supporting software allows graphic manipulation to mainframe and micro-computer users alike.

The ability to manipulate monotone and color graphics can be handled by modern high speed (8 Mhz and above) multitasking multiuser micro-computer systems. Old 8 bit (6502, 6800, Z80) processors could only access 64 kilobytes of random access memory. Newer 16 bit (8086, 68000, 16032, Z8000) processors can access up to 16 megabytes of random access memory. Thirty-two bit processors are now entering the marketplace. As larger RAM chips (512 kilobit, 1 megabit) become available at low cost, micro-computer graphic manipulation capabilities will increase. Micro-processor classifications (8 bit, 16 bit, 8/16 bit, 16/32 bit, 32 bit) are confusing to many potential electronic prepress equipment owners. The Motorola 68000 has a 32 bit address bus but a 16 bit data bus. Thus the many classifications (16 bit, 32 bit, 16/32 bit) people attach to the Motorola 68000 micro-processor. The Intel 8088 has a 16 bit address bus and and 8 bit data bus. Is it an 8 bit, 16 bit, or 8/16

bit If vague definitions of electronic prepess terminology is replaced with precise definitions that are universally accepted throughout the prepress industry, potential electronic prepress system owners will be able to make intelligent purcasing decisions based on a clear understanding of how to effectively apply new prepress technology to their company needs in a minimum amount of time at a profit.

Excluding th rapidly expanding software available from third party vendors, manuacturers of electonc prepress equipment surveyed report implementation of machine language, low level language (convert source code to object code), and high level languages (BASIC, Fortran, C) on equipment. UNIX, C, Fortran, BASIC, Pascal, Machine, OSRT, RSX-11M, IBM-PRS, Assembly, and VAX VMS are all reported in use by equipment manufacturers surveyed. Assembling a complete prepress system from different manufacturers or communcating with equipment at a remote location may require sophistcated and expensive software to interface the equipment.

(1985 - 1990) Computer manufacturers will service a larger section of the electronic prepress market directly and traditional printing equipment manufacturers will direct their efforts to enhancements of hardware of software. At the same time third party software companies will attempt to enter the prepress market. Software enhancements and peripherals (mice, touch pens, digitizing pads) will reduce the need to memorize and keyboard in many system codes. Page makeup stations will gain greater image enhancement capabilities due to increased interest in color reduction separation techniques (achromatic).

(1991 - 2000) Thirty-two bit micro-processors will be dominant in electronic prepress equipment due to their massive processing capabilities. Emerging technology in the field of mass data storage might reduce the cost of digital data storage to a few pennies per megabyte. Electronic prepress system software will become available at a rate that exceeds the capacity for the average equipment owner to evaluate the benefts of each new software package available.

Reproduction Processes

1984 - Reproduction processes employed by electronic prepress equipment owners surveyed are sheet-fed offset lithography, web offset lithography, gravure, letterpress, flexography, ink jet, and impact.

Forty-six percent of those surveyed produce plates with traditional high wattage lamp platemakers. Twenty percent use a computerized photocomposer for over 20 percent of their plate production. Laser platemaking devices are in minimal use. Historically, laser and plate compatibility has been a problem that limited the use of laser platemakers. Imaging directly to 70 millimeter film from a phototypesetter for use with a micro-projection platemaker is another emerging method of automated platemaking that is in limited use. Integrating page makeup stations (monotone and color) with the ability to output to film, hard proof, and plate from the same database is a developing trend. Plate is a term that should be redefined for electronic prepress.

Depending on the reproduction process, plate could mean cylinder (gravure), screen, plate (lithography, flexography, letterpress), or magnetic storage (impact, non-impact). The common database trend in future pagination systems (1985 - 1989) is likely to include business application software for management information needs as an optional software package. Fifteen percent of the electronic prepress equipment manufacturers surveyed have forecasted the marketing of monotone computer-to-plate systems that can input and merge electronically typography, halftones, and line drawings and output to film, hard proof, and plate between 1985 and 1989. Twelve percent have forecast marketing color systems between 1986 and 1989 with the capability of inputting and merging electronically typography, color separations, and line drawings and outputting to film, hardproof, and plate. Of the electronic prepress equipment owners surveyed, 68 percent produce monotone jobs and 89 percent produce process color jobs. For 52 percent of those involved in color prepress, 90 percent to 100 percent of their prepress work is process color.

Radio, television, videodiscs, electronic imaging still cameras, magnetic disc and tape, impact and non-impact printers, electronic mail, teletext, videotex, database/information networks, teleconferencing, instant films, holograms, and computer image recorders provide competition to the conventionally printed page. Fifty-six percent of the electronic prepress equipment owners surveyed project new competition directly from electronic storage/transmission/retrieval systems in the markets they now service (typesetting, color separation, prepress service, publishing, commercial printing, in-plant) beginning between 1985 and 1994. This places increased emphasis on long term marketing and sales planning for these companies if they are to co-exist with these emerging electronic imaging technologies in the graphic communication industry. Fourteen percent of the electronic prepress equipment owners surveyed report that they, their parent company, or a subsidiary company are in the field of network television, computer service/database networks, or videodisc production.

(1985 - 1990) Traditional printing processes will be used mainly for process color reproduction. New electronic technologies will dominate the monotone graphic communication market. Non-traditional monotone reproduction methods will define their market niche during this period. Technological gains in process color flexography and halftone gravure will compete in previously untouched markets. Plate producton will remain dominated by standard lightsource platemakers. Automated platemaking outside the newspaper field will be dominated by computer controlled photocomposers and micro-projection platemakers. Laser platemaking systems will still be trying to prove their viability. The videodisc industry will begin to define its market niche in areas previously dominated by traditional printing.

(1991 - 2000) By this period of time, the market niche to be served by traditional printing processes and the niche to be served by emerging electronic storage/transmisson/retrieval systems will be well defined. Laser platemaking will have had a chance to develop laser/plate compatibility technology. Monotone electronic copying machines capable of 6000 to 8000 sheets per hour of two sided copy will compete with small offset duplicators causing a continuing downward sales trend of

small offset duplicators. Process color electronic copying systems will be used for low quality reproduction requiring less than 500 copies per form.

Conclusion

Monotone reproduction technology is developed to the point that it is a tool for the person needing short-run text and line copy. No longer are successful results only achievable by highly skilled professionals on specialized equipment. In the future, graphic art professionals will service the monotone reproduction market for continuous tone reproduction, long runs, electronic image enhancement, and will provide the technology to print on many substrates besides paper. Process color reproduction methods and equipment will remain the domain of graphic art professionals into the next century. Telecommunication, computer image processing, emerging reproduction methods (flexography, gravure, screen), and the technology to reproduce process color on almost any substrate keeps the process color reproduction market dynamic for the graphic art professional. The high initial cost of color electronic prepress systems necessitates an established customer base for equipment owners so that accurate marketing studies can be made before equipment acquisitions. This high initial cost to enter the market limits young companies (one to seven years old) from entering the market competitively unless they are composed of highly professional management and marketing people and have a large financial backing and a previous customer following on which to draw on in their new endeavor.

Ignorance of the practical application of new technology and the lack of professional long range marketing studies and planning by some graphic art executives in the 1970's sparked talk of the Decline of Print and the Paperless Society. Those ideas have no validity for the printed word. While some markets are shrinking or dissappearing, new markets are emerging everyday. Halftone gravure, process color flexography, and high speed process color web fed screen presses are allowing graphic art professionals to service new markets. The investment in developing this new technology by equipment manufacturers and the acceptance by equipment owners, shows that the printed word is alive and well and will remain so as long as the equipment owners properly identify the needs of the market niche they choose to service now and in the future.

Subjects for Further Study

A) Communication methods (phone, satellite, microwave, cable) in use for data handling suffer temporary failure. Satellite damage from space debri, microwave dish damage from acts of nature, and cable breaks all pose threats. These data communication systems have a finite data handling load. The United States phone system will be strained to near capacity loads of voice and data transmission before the end of the century if new technology is not implemented. Telecommunication is a profitable new tool for the prepress industry. An investigation of transmission system reliability statistics, backup procedures, and possible insurance coverage for eco-

nomic loss due to transmission system temporary failure needs to be performed.

B) The educational needs (current, short term, long term) of the graphic communication profession needs to be assessed. Technology in the graphic arts is changing at an exponential rate that exceeds the capabilities of educational institutions and those in the workforce (workers, managers, executives) to stay current. The escalating price of new equipment and its proper application mandates that a companies employees stay current with technology if the business is going to have an acceptable return on investment. The availability of information, volume of students and employees in educational programs, and a skills inventory of industry needs versus the skills of people in the industry and those about to enter from educational programs should all be addressed.

C) Electronic prepress technology has its own vocabulary of terms and acronyms. Unfortunately, some definitions and terminology is not universal throughout the industry. The electronic prepress industry needs to publish industry wide conventions on terminology and definitions.

Appendix A

WESTERN HEMISPHERE SATELLITES

ORBITAL POSITION (DEGREES WEST LONGITUDE)	BAND	USER	LAUNCH DATE
175	KU	US	—
166	—	US	—
157	—	US	—
148	—	US	—
143	C	SATCOM V	1982
141	C	UNASSIGNED	—
139	C	SATCOM 1R	1983
138	—	CANADA	—
137	C	UNASSIGNED	—
136	—	MEXICO	—
134	C	GALAXY 1	1983
132	KU	RAINBOW	PROPOSED
131	C	SATCOM 3R	1981
130	KU	ABCI	PROPOSED
129	—	CANADA	—
128	C,KU	AMSAT 1	PROPOSED
127.5	C	COMSTAR D4	1981
127	—	MEXICO	—
126	KU	RCA	PROPOSED
125	C	TELSTAR 4	PROPOSED
124	KU	SBS5	PROPOSED
122	C,KU	SPACENET 1	1984
120	KU	USSSI	PROPOSED
—119.5	C	WESTAR V	1982
119	C	SATCOM 2	1976
117.5	KU	ANIK C3	1982
116.5	C,KU	MEXICO	PROPOSED
114	C	ANIK A3	1975
113.5	C,KU	MEXICO	PROPOSED
112.5	KU	ANIK C2	1983
111.5	C	CANADA	—
110	—	ANIK D2	1984
109	C,KU	ANIK B	1978
108	C	ANIK D3	PROPOSED

107.5	KU	ANIK C	1984
105	KU	G STAR 2	1984
104.5	C	ANIK D1	1982
103	KU	G STAR 1	1984
101	C,KU	UNASSIGNED	—
99	KU	SBS 1	1980
—98.5	C	WESTAR IV	1982
97	KU	SBS 2	1981
96	C	TELSTAR 1	1983
95	KU	SBS 3	1982
93.5	C	GALAXY 3	1984
93	KU	UNASSIGNED	—
—91	C	WESTAR III	—
89	KU	SBS 4	1984
88.5	C	TELSTAR 3	PROPOSED
87	C	COMSTAR D3	1978
86	C	WESTAR	1984
85	KU	USSSI	PROPOSED
—83.5	C	SATCOM IV	1982
83	KU	ABCI	PROPOSED
82	—	CANADA	—
81	C,KU	AMSAT 2	PROPOSED
79	KU	RAINBOW	PROPOSED
78.5	C	WESTAR II	1974
77	KU	RCA	PROPOSED
76	C	TELSTAR II	1984
75	KU	UNASSIGNED	—
74	C	GALAXY II	1983
73	KU	UNASSIGNED	—
72	C	SATCOM 2R	1983
71	KU	UNASSIGNED	—
70.5	—	CANADA	—
69	C,KU	SPACENET II	1984
67	C	SATCOM 6	PROPOSED
61.5	—	USA	—

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