

GC20-1775-0

Systems

**Concepts of the IBM 3800
Printing Subsystem**

IBM

Systems

Concepts of the IBM 3800 Printing Subsystem

This manual is intended as a first reader for those users of printers who wish to take a quick look at the non-impact IBM 3800 Printing Subsystem, at its basic concepts, and at how these concepts lead to new functions that may offer different options in planning and operations.

The IBM logo, consisting of the letters "IBM" in a bold, sans-serif font with a double outline.

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This publication will be updated periodically, but at any one time it may not reflect the latest versions of options, equipment, or programming support. The authoritative sources of information on the components of this system are the Systems Library publications issued on the units of this system and its programming support.

Requests for copies of this and other IBM publications should be made to your IBM representative or to the IBM branch office serving your locality.

First Edition (March 1975)

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A. INTRODUCTION

A1. The IBM 3800 Printing Subsystem is a high-speed, general purpose, non-impact printer using electrophotographic and laser technology to achieve effective printing speeds as high as 13,360 lines per minute at a constant paper feed rate of approximately 1840 inches per minute (10,000 eleven-inch forms per hour). Vertical spacing of the printed lines can be 6 lines per inch or 8 lines per inch, and can be intermixed on the same page. Characters can be printed 10 to the inch (max. 136 characters/line), 12 to the inch (max. 163 characters/line), or 15 to the inch (max. 204 characters/line), and can be intermixed on the same line. Characters are stored internally in sets of 64 each; up to four sets can be combined at a time into character arrangements that can be used to print a maximum of 255 graphics without reducing throughput. Programmed on-line functions allow the 3800 to select the character sets desired and to print the number of copies required (up to 255 at one time), without operator intervention. Simple forms can be generated from internally stored graphic characters. More complicated forms can be projected optically and printed under program control on all or on selected copies.

A2. The availability of these and other functions and capabilities in one unit makes it necessary to think of the IBM 3800 not as another output printer but rather as a printing subsystem that can reduce the time interval between processing and the delivery of printed output to the ultimate user. The exact effect of the subsystem on costs, quality, and time will vary from installation to installation, from application to application, and from one time to another; some items to be considered when making comparisons with an impact printer are given in Section I.

A3. In the pages that follow we will describe, briefly, how the IBM 3800 operates, and then we will discuss how to make use of some of the capabilities and functions of the subsystem. If the operating details are not of immediate concern or interest, you may wish to turn directly to "C. Capabilities and Limitations" on page 6. The latest authoritative detailed information on this system is available in GC26-3829, "Introducing the IBM 3800 Printing Subsystem and its Programming" and in the associated publications referred to in that manual.

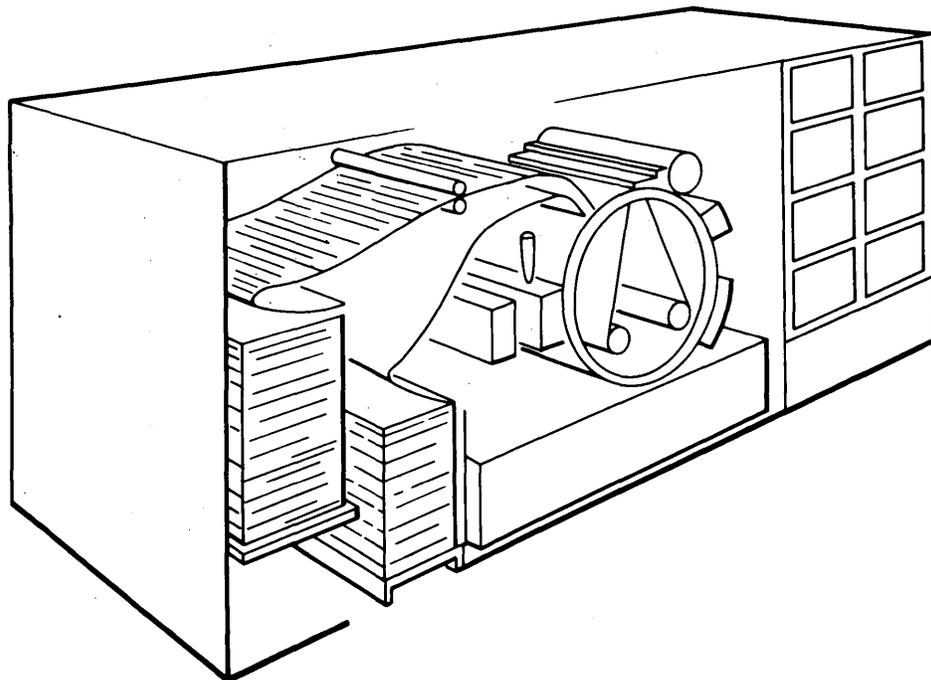


Figure A. Overview of the IBM 3800 Printing Subsystem

B. OPERATION

B1. OPERATING PRINCIPLES.

B1a. In an impact printer a character is generated by using mechanical pressure to transfer "ink" from a ribbon to paper. In the "back-to-front" printers a hammer strikes the paper against a ribbon coated with "carbon", which then strikes a metal slug on which the character has been permanently cast. The pressure between slug and hammer causes some of the carbon to be transferred from the ribbon to the paper. In "front-to-back" printers, the slug strikes the ribbon against the paper.

B1b. Electrophotographic printing is a process that uses a special surface on which the shape of a character that is to be printed is formed by light. Black plastic particles are attracted to those places on the special surface that have been exposed to light. The particles are then transferred to paper and fused into the fibers of the paper to create the printed output.

B1c. In the IBM 3800, a character exists as a dot raster pattern described by bit configurations stored on an internal disk. Three basic dot rasters are used, one that is formed of 24 parallel rows with 18 dots per row for generating characters that are equally spaced horizontally 10 to the inch, a second that has 24 rows with 15 dots each for generating characters spaced 12 to the inch, and a third which is formed of 24 rows with 12 dots per row for generating characters spaced 15 to the inch.

B1d. Input data is translated from an intermediate buffer and is stored, input line by input line, in the page buffer. When a page is complete in the buffer, the dot rasters are scanned raster line by raster line, and the resulting bit patterns are used as impulses that modulate a laser beam that is directed, through an optical system, at the photoconducting surface. In places where the raster pattern indicates the need for a dot, the laser beam is allowed to reach the photoconductor (PC); there the electrical potential of the spot on the surface of the PC is changed. Plastic particles are attracted to the spots on the PC that have been exposed to the laser light. The particles are then transferred to paper and heated so that they are bonded in place. The paper starts and stops in synchronism with page images formed on the photoconductor. The photoconductor surface is cleaned and recharged, and the process continues.

B2. OPERATING DETAILS

B2a. Generating and Storing Characters.

B2a1. As mentioned above in B1c, a character is represented by the bit configuration of a 24 by 18, 24 by 15, or 24 by 12 matrix. Any character can be printed if it can be represented by such a bit configuration. Taking a large (10-pitch) character as an example, the bit configuration could be as shown in Figure B2a. Note that the matrix includes blank rows and blank columns used to separate characters from each other.

B2a2. This bit configuration can be identified by linking it with an appropriate code, for example the hex 05, and then the configuration and the identifier can be stored on the internal disk in the IBM 3800. A set of 64 such bit patterns and identifiers constitute a character set; up to four of these sets, each with its own identifier, can be used at one time. Some character sets available at this time are shown in Section C of this manual.

B2a3. At the time a printing job is started, each designated character set is copied into a portion of storage called Writable Character Generation Storage. Two of these storage areas, one with 128 positions and the other with 127, can be in use at any one time; therefore up to four character sets (255 bit configurations) can be active. EBCDIC or other 8-bit assignment to graphic characters is made through 256-position translate tables.

B2a4. Write commands cause the transfer of data from the system to the IBM 3800. Each write command transfers one print line into an intermediate storage buffer where each character of input data is translated against the appropriate translate table. The code resulting from the translation is placed into a page buffer where enough input lines are accumulated to form a page of output. When it is time to print the page, the codes in the page buffer are transferred, a line at a time, to a print line buffer where the codes are scanned character-by-character and one raster line at a time, into the bit configurations stored in the Writable Character Generation Storage. The codes are thus changed, bit-by-bit and line-for-line, into a series of dots of light that are applied to the surface of the photoconductor.

B2b. Laser, Laser Modulator, and Laser Optics.

B2b1. A low-power helium neon laser assembly (Figure B2b) is the source of a continuous beam of coherent light that passes through the laser modulator which deflects the laser beam in

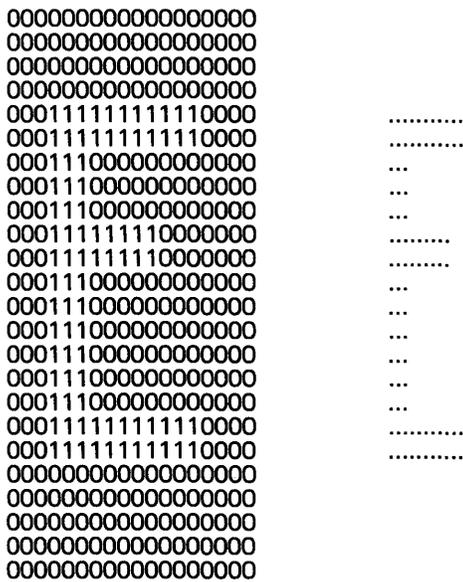


Figure B2a. Example of Dot Raster Pattern and Corresponding Bit Configuration

response to a modulating signal. When the light is deflected, the light output from the laser assembly passes through the optical system and the mirrors to reach the surface of the photoconductor; a black spot will then appear in the corresponding position on the printed paper.

B2b2. The modulating signal creates the dot pattern of the character being printed. The laser beam moves "horizontally" across the width of the photoconductor, while the rotation of the drum provides the "vertical" displacement. The result of the two motions produces a vertical raster of 144 lines per inch; this, combined with the basic 18 dots per character width of the 10 characters per inch set, gives an image resolution of 144 x 180 dots per square inch.

B2c. Image and Image Development

B2c1. As described above, the laser beam is directed at the surface of the photoconductor, which is a thin flexible coating of complex organic material. Because this coating has a limited life, the photoconductor must be advanced (replenished) when the surface in use reaches end of life. A roll of photoconductor is mounted on a feed roll inside the drum of the IBM 3800. The photoconductor passes through a sealed slot in the drum surface, then around the drum, and is returned through the gap to a takeup spool which is also inside the drum. The operator may advance the photoconductor to renew the surface after the specified usage has been reached.

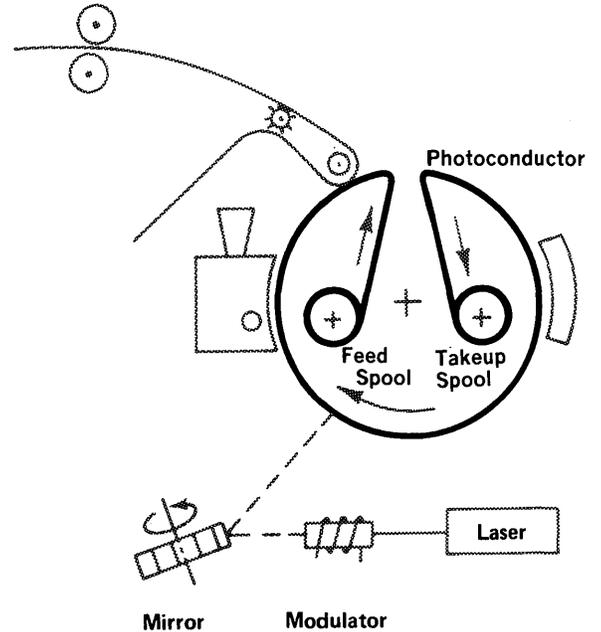


Figure B2b. Photoconductor and Laser

B2c2. As the drum turns (clockwise), the photoconductor passes by the various stations of the continuous process operation. At the cleaning station (Figure B2c2) the surface of the photoconductor is flooded with light, the residual toner (very fine black powder) is loosened by the preclean corona, and the surface is wiped by the rotating cleaner brush to remove traces of toner. The toner removed from the photoconductor

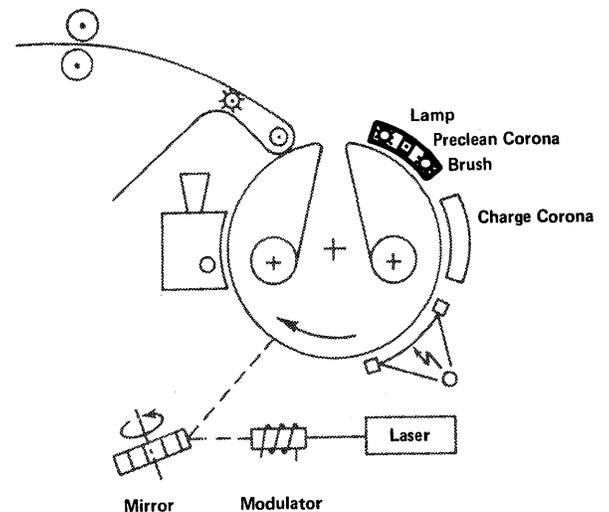


Figure B2c2. Cleaning and Charging the Photoconductor.

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surface and from the brush is guided by a stream of air into a cyclone precipitator, from which the toner particles are allowed to settle into the toner collector. Any particles remaining in the air stream are removed by a filter bag.

B2c3. The charge corona supplies negative ions to charge the surface of the photoconductor. The corona unit equalizes the ion flow and creates a constant and uniform voltage distribution across the width of the surface.

B2c4. The photoconductor next passes under the image holder of the image form overlay (Figure B2c4). This device can project an image onto the photoconductor by use of light that passes through a film negative mounted in a frame. Exposure of the image is accomplished by a single flash which is initiated under program control and, therefore, can be used to project the image selectively on particular copies of a paper or report. The image can be that of anything that can be drawn in black-and-white, such as graphs, curves, borders, grids, cartoons, logos, etc., with certain limitations on line widths.

B2c5. The modulated laser beam scans the photoconductor surface and selectively discharges spots where elements of the characters are to appear in print. The scanning takes place just ahead of the developer unit (Figure B2c5). The developer is circulated by the developer unit across the surface of the photoconductor. The developer consists of the carrier and the toner. The carrier is iron shot which has a coating that

attracts the particles of the toner. The toner is a black thermoplastic powder that forms the printed images. As the developer runs across the surface of the photoconductor, the toner is captured in the image areas formed by the laser beam and/or the form overlay. The developer mixture gives up toner to the images on the surface of the photoconductor, but the toner is replenished by the toner feed unit. Uniformity of print density is maintained by the toner control system that measures the reflectance of a standard mark printed on each page of output; the toner control sensing unit sends appropriate information to the circuits that control the toner feed unit where the proper ratio of toner to carrier is maintained automatically.

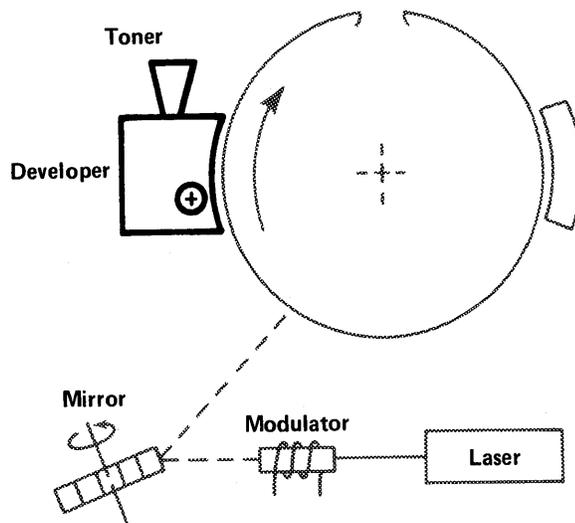


Figure B2c5. Developer and Toner.

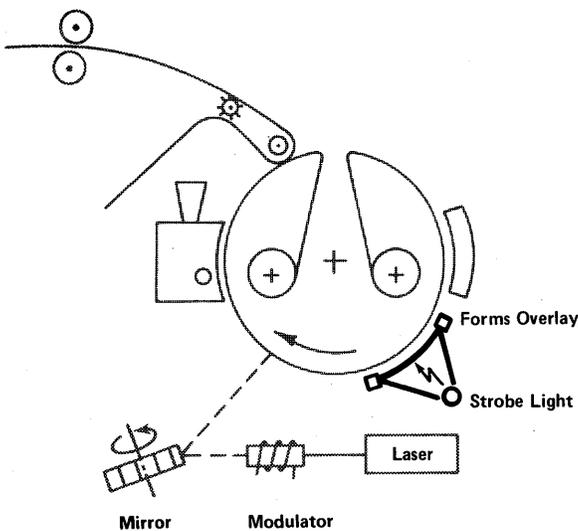


Figure B2c4. Forms Overlay.

B2d. Image Transfer and Fusing

B2d1. The transfer corona supplies positive ions to the back of the paper at the transfer station (Figure B2d). The positive ions attract the negatively charged toner from the surface of the photoconductor and onto the paper web.

B2d2. The toner, and therefore the image, is fused into the paper by heat from a pre-heat platen, and by heat and pressure from a hot roller.

B2e. Paper Transport

B2e1. Continuous form paper (Figure B2e) is loaded by the operator at the input station. As with impact printers, only one paper size can be used in the same run. The paper is guided over the splicing station, a location where the trailing edge of the paper stops when the end of forms is

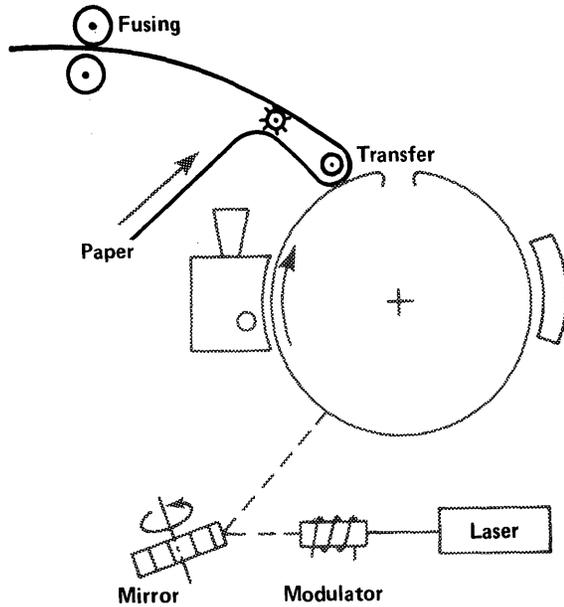


Figure B2d. Transfer of Image.

sensed. At the splicing station a set of fixed pins can be raised, and the leading edge of the first sheet of a new stack of paper can be placed adjacent to the trailing edge of the last sheet in the printer. A perforated sticky tape is used to

join the two sheets, the fixed pins are lowered, and the printer is ready to continue operation. When the size of the paper is to be changed in either length or width, rethreading is required.

B2e2. Paper from the splicing station is guided and driven by transfer station carriage tractors. The tractor pins engage the holes punched along both edges of the paper. The tractor along the edge of the printer nearest to the operator is fixed in lateral position, while the other one is adjustable to the width of the paper being used. From the image transfer station the paper passes over a pre-heat platen and is then subjected to heat from a hot roller at the fuser station and to pressure between the hot roller and an opposing pressure roller. Vacuum applied to perforated holes at the leading edge of the pre-heat platen smooths the paper for uniform heating and feeding into the hot roll. From the hot roll, the paper passes through a set of friction drive rolls and under a set of moving chains which cause the web to refold along the transverse perforations at spacings of 7, 8-1/2, or 11 inches. The paper accumulates on top of an output stack as it is folded. As the height of the stack increases, the supporting table descends until the folding ceases or the stack height reaches 16 inches, at which time folding will stop automatically and "Table

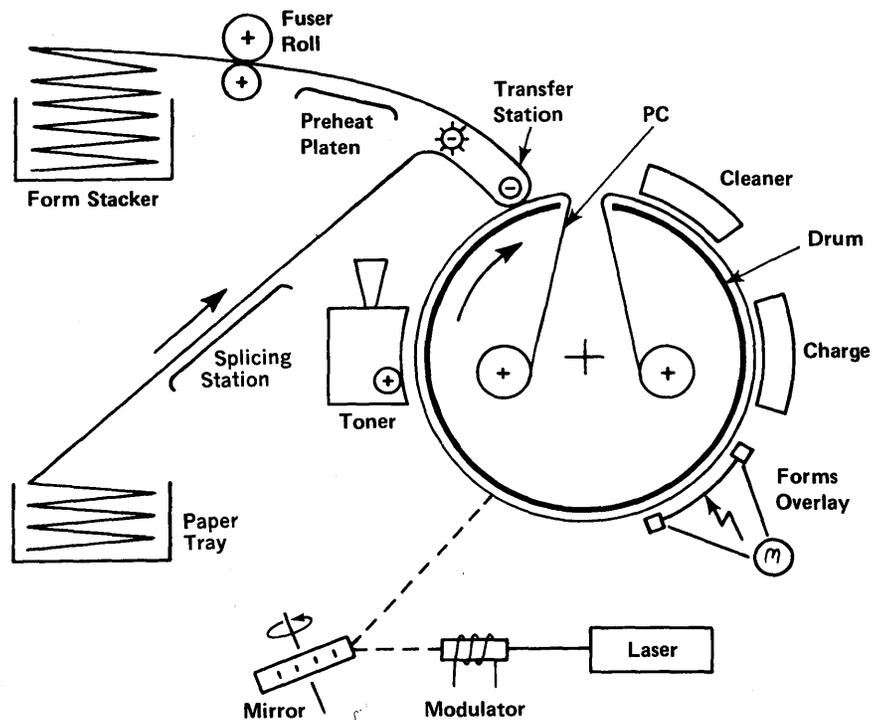


Figure B2e. Path of Paper Forms Through the Printer

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Full'' will be indicated on the operator's panel. The operator may then remove the stack, and the platform can be repositioned automatically.

B2e3. Motion of the paper through the printer is synchronized with the motion of the electrophotographic drum; this makes it possible to position images accurately on the paper. During printing operations, the drum will be rotating continuously and the paper will be moving at a constant rate through the paper transport mechanism for as long as printing is in process. If images are not being created the paper comes to rest so that the bottom of the perforation of the previously printed page is located at the transfer station. The paper is started and stopped to accommodate any intermittent paper motion through the transfer station. A loop of paper is maintained between the carriage and the pre-heat platen. If the rolls must be stopped for more than a few seconds, they separate to avoid scorching the paper; the paper will stop at a perforation between forms.

C. CAPABILITIES AND LIMITATIONS

C1. The standard operations associated with creating printed output consist of moving paper to the printer, adjusting and starting the printer, removing the output and, in some cases, moving the output to another location for bursting and/or deleafing, addressing the various copies, and finally forwarding the output to the user who may choose to file the paper in a binder. When using multi-ply forms on impact printers the carbon paper is normally removed and the output separated into sets, an operation usually performed by a machine called a deleaf. Multi-ply forms are not used on the IBM 3800, and this operation is not needed.

C2. In what follows we discuss this and other differences that affect such factors as:

- *Capabilities and limitations* significantly different or not previously available;
- *Time interval* between start of printing cycle and the time the output is in the hands of the user;
- *Quality* of the printed output, with respect to appearance factors such as legibility, registration, etc.;
- *Convenience* factors that concern the computer operator and the user of the printed output;
- *Security*
- *Programming Support*
- *Cost* of the total printing operation, including paper, paper storage, labor, rentals, etc.

C3. Character Sets and Character Sizes

C3a. A page can be printed with lines spaced either 6 or 8-to the inch, or the line spacing can be intermixed. A maximum of 10 inches (60 lines or 80 lines) can be printed on paper 11 inches deep because the printer needs half an inch on all forms, both top and bottom, for spacing. We have seen in B2a how individual characters are defined as bit patterns which are then stored on a disk cartridge internal to the IBM 3800. A

maximum of 64 of these characters make up a character set. It is possible to store 18 sets of characters on the internal disk, but only a maximum of four of these sets (64, 128, 192, or 255 individual characters) can be used during the printing of any one data set. The speed of printing is independent of the number of character sets being used. A user can design his own characters and can use them interchangeably with those in a standard set.

C3b. The Gothic-10 character set consists of the 64 "Gothic" characters and contains the characters used on chains/trains like the PN train of the 1403 or the 3211 printers. In this set the characters are spaced ten to the inch, with a maximum of 136 characters in a line. A similar but narrower set of characters is the Gothic-12; it prints 12 characters to the inch for a maximum of 163 characters in one line.

C3c. The Gothic-15 character set will allow printing of 15 characters to the inch for a maximum line length of 204 characters. At 8 lines to the inch, this type face is at least as legible as the 10-pitch type printed 6 lines to the inch on an impact printer using a cloth ribbon. Gothic-15 is very useful when tables of many columns must be printed on 14 7/8-inch paper. Perhaps the most useful feature of this character set is the ability to print a 150-character line in a width of 10 inches; when using paper 11 inches wide and 8 1/2 inches long, this allows many reports to be filed in standard 8 1/2x11 three-ring binders, thus making for greater convenience in handling, and for savings in storage and paper costs.

C3d. The alphabetic characters in the three Gothic sets are all upper-case, but some text needs to be printed with both upper and lower case letters. TEXT1 is a set similar to the Gothic in that it contains only upper case letters; the corresponding lower case letters are part of TEXT2. These two sets together contain the graphics used in such trains as the TN train on the 1403 printer, and can be used to print such things as booklets, conference reports, inter-office memoes, etc. Other character sets are available, some of which are shown in Figure C3.

C3e. Underscoring (or underlining) is a means of creating contrast when using only one type face. If data has already been created with the requirement that certain characters or strings of characters be underlined, the IBM 3800 may print an underscore automatically anytime an attempt is made to print two characters in one position, if one of these is the underscore character. Another way in which the equivalent effect can be

achieved on the IBM 3800 is through the use of character sets in which each character incorporates the underscore in the character itself. The use of different character sets can be made to provide contrast in new data created for output on the IBM 3800.

C4. Forms, generated or preprinted

C4a. In this section C4 we reserve the words "form" and "forms" to designate images or outlines within which or over which the data is printed using the standard alphameric characters. The forms can be pre-printed on the paper that is to be fed into the IBM 3800, or the forms can be printed by the IBM 3800 itself. The IBM 3800 can generate forms by using the FORMAT-10, FORMAT-12, FORMAT-15, or other characters available in the sets stored on the internal disk. (As mentioned in C3, the user can design his own set of characters and can store them in the SYS1.IMAGELIBrary.) The IBM 3800 can also print forms by using the forms overlay as explained in B2c4.

C4b. The use of internally generated forms prevents such simple errors as the feeding of the wrong preprinted form, or such delays as can be caused by running out of a particular form in the middle of a job. The details and the use of the form are under the control of the programmer and require no operator or other outside intervention. In addition to this flexibility, the use of internally generated forms can result in significant savings in costs that are now incurred by the pre-printing, storing, handling, etc. of many special forms.

C4c. When using the forms overlay the operator needs to insert the proper overlay frame into the film holder. He could use the wrong frame, but such a mistake is easier to correct than to load another box of forms into an impact printer. Savings in initial printing costs, storage, inventory, obsolescence, etc. can be significant, and availability of forms may be important. (There is only one lead time, the time the film negative is first prepared; after that you can't run out of the form unless you run out of paper.) Negatives are prepared as explained in GA26-1633.

C5. Printing Speeds

C5a. When discussing printing speeds, it is helpful to agree on a unit of measure, and to make all comparisons in this unit. Such a unit can be the number of characters printed in a unit of time, or the number of lines printed in a unit of time, or the number of pages printed in a unit of

James A. Smith
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 San Jose Ca 95126

				DATE
CHECKS AND OTHER DEBITS	DEPOSIT	DATE	BALANCE	
Checking A/C 012-9876				
Opening balance as of			12/31	675.43
15.00			01/02	660.43
27.37	10.00	9.72	01/06	613.34
25.00	100.00		01/10	488.34
3.51	310.62		500.00 01/13	674.21
50.00			01/14	624.21
37.42	12.17	5.00	01/15	569.62
117.00	41.97		01/17	410.65
			12.15 01/20	422.80
10.00	7.50		01/21	405.30
74.82			01/22	330.48
175.00	10.00	25.00	01/23	120.48
50.00			01/23	70.48
21.71	36.35		01/24	12.42
			500.00 01/27	512.42
100.00			01/28	412.42
Closing balance as of			01/31	412.42

Items enclosed 27

Thank you

TRANSACTION DESCRIPTION	AMOUNT	DATE	BALANCE
Simple sav A/C		12/31	
Withdrawal		01/10	
Interest			
Withdrawal			
Deposit			

Figure C4a1. Example of Form Generated Using FORMAT-15 for Rules, GOTHIC-15 for Column Heads, and TEXT1 and TEXT2 for Data.

JAMES A. SMITH
 100 ENDICOTT RD
 SAN JOSE CA 95126

CHECKS AND OTHER DEBITS	DEPOSIT	DATE	BALANCE
CHECKING A/C 012-9876			
	OPENING BALANCE AS OF	12/31	675.4
15.00		01/02	660.0
27.37	10.00 9.72	01/06	613.0
25.00	100.00	01/10	488.0
3.51	310.62 500.00	01/13	674.0
50.00		01/14	624.0
37.42	12.17 5.00	01/15	569.0
117.00	41.97	01/17	410.0
		12.15	422.0
10.00	7.50	01/21	405.0
74.82		01/22	330.0
175.00	10.00 25.00	01/23	120.0
50.00		01/23	70.0
21.71	36.35	01/24	12.4
		500.00	512.42
100.00		01/28	412.42
	CLOSING BALANCE AS OF	01/31	412.42

ITEMS ENCLOSED 27 THANK YOU

TRANSACTION DESCRIPTION	AMOUNT	DATE	BALANCE
SIMPLE SAV A/C 01-8765-4			
	OPENING BALANCE AS OF	12/31	757.30
	- 100.00	01/10	657.30
	+ 2.82	01/13	660.12
	- 50.00	01/20	610.12
	+ 125.75	01/27	735.87
		01/31	735.87

Figure C4c1. Example of Form Printed Using Forms Overlay for Rules and Gothic-10 for Data.

possible to have 50 different combinations of paper sizes.

C6b. Paper can be plain or preprinted. The surface of the paper can be coated stock, or can have any other texture, provided it is not heat-sensitive. Unusually smooth surfaces may present difficulties with adherence of the toner and, therefore, they should be used only after thorough tests.

C7. Limitations

C7a. Paper. There are limitations on paper sizes and weights, as detailed in C6. In addition, the paper or other material that is to be fed through the IBM 3800 must be electrically non-conductive, and not too sensitive to heat because the temperature at the fusing station could soften or melt some materials that then could jam the paper transport mechanism.

C7b. Overprinting.

It is not possible to stop the paper and print over characters that have already been printed. The purposes of overprinting can best be served in other ways. If, for example, overprinting is done to make material not legible, the same purpose is served by leaving the area blank; this can be done on selected copies of the pages in a data set under program control. If the purpose is to create special symbols, then it is best to use specially designed characters. Overprinting could also be intended as a means of emphasizing certain text; here again, the use of different characters from another character set could serve the same purpose.

C7c. Top and Bottom Margins.

Because the paper needs some time in which to start and stop, the top and bottom half inch on every page is reserved; no printing can be done in these areas, neither data nor forms overlay.

D. TIME

D1. The user is most concerned with the interval between the time he requests or expects a printout and the time he actually gets to use it. Many operations take place in between, but the user is interested only in how long he has to wait; by contrast, the operator is concerned with each small detail of the printing process. The time between request and delivery is taken up by operations such as the following:

1. Put job into job queue;
2. Take job out of the job queue;
3. Check job sheet for paper or form to be used;
4. Go to stockroom and bring paper to the printer;
5. Feed paper into printer, and adjust;
6. Check carriage control tape; change, if necessary;
7. Start system printer
8. Check paper feed for proper stacking;
9. When paper runs out, repeat steps 3 through 8;
10. On single-part paper, separate printout by job, and place on output table;
11. With multi-part paper, move output to the deleaver; feed paper into deleaver, adjust, periodically remove carbon paper, check paper stacking in bins, remove stacks to output table or to burster;
12. Address output and place on output table.

D2. There are two ways to shorten the printing time cycle; one is to eliminate a step or procedure, the other is to improve the efficiency of procedures and thus to speed them up. Both of these ways are available in the IBM 3800. For example, the deleaving step is eliminated because the IBM 3800 prints only on one-part paper. This also eliminates the time required to handle carbon paper as waste during cleaning operations, the time required to order multi-part paper, to store it, to account for it, etc. An example of improvement in procedures is the printing speed available through the IBM 3800; this speed (see C5) exceeds the highest speed of any IBM impact printer and makes it economical to use multi-part rather than multi-part techniques. Another example of cutting out steps is the elimination of carriage control tapes because the IBM 3800 system prints entirely under program control. Instead of cutting or adjusting control tapes, the operator can now use the time to perform other operations.

E. QUALITY

E1. In printed output we are concerned with those facets of quality that are a matter of legibility, namely contrast, uniformity, shape, and size.

E2. Contrast is given by the difference between the color of the characters and the color of the paper on which the characters are printed. This contrast in impact printers is determined by the ribbon in use and by the pressure between paper and ribbon. Some cloth ribbons are used repeatedly, and the carbon is gradually depleted, thus reducing the contrast between the "black" of the characters and the "white" of the paper. Ribbons that are used only once, such as some plastic-based types, give much better contrast. The printing process of the IBM 3800 uses a black plastic powder to shape the image, and contrast can be uniform throughout a document. Further, because the powder is fused to the paper, the image will not smudge, as it often does in impact printer output. In multi-part printing contrast decreases with each ply and is greatly affected by the quality of the carbon paper between the plies. Output from the IBM 3800 is of uniform contrast for all copies because each copy is printed separately. Contrast is also dependent on the type of boundary between the characters and the paper. In impact printers this boundary is soft and fuzzy when observed with a magnifying glass, because the transfer of carbon is made as a result of mechanical pressure that distorts the fibres of the paper; the greater the number of plies, the fuzzier this boundary becomes. In the IBM 3800 output this boundary is much sharper.

E3. Does one part of the printed letter differ in color from another part? Does the "ink" on one corner of the paper differ in color from another? These are symptoms of non-uniformities in pressure, in ribbon, or in paper texture on impact printers. In the IBM 3800 this might happen if the distribution of toner over the paper were not uniform. It could also happen if the photoconductive surface were used past its normal life. Both of these possibilities have been recognized and the design and operation of the system guard against them.

E4. Legibility and, therefore quality, is also greatly affected by the size of the printed character. Four factors enter here, the height of a character, its width, the thickness of the line that forms the

character, and the separation between characters or lines. The standard 10-pitch Gothic character set available on the IBM 3800 is similar in size and spacing to the characters on the standard IBM PN print chain. When printing at 6 lines to the inch, legibility is good; at 8 lines to the inch the small separation between lines makes reading more difficult. The smallest, the 15-pitch Gothic-15 is as legible at 8 lines to the inch as the large Gothic is at 6 lines to the inch. Other character sets available on the IBM 3800 have been designed with legibility in mind. When the user designs his own characters, these considerations should be remembered.

E5. If characters in one print line are not properly aligned or registered, the reader experiences a certain measure of discomfort when scanning the page. On impact printers, alignment and registration problems can be caused by a loose print chain, by uneven tension on the paper, by improper hammer timing or carriage operation, etc. In the IBM 3800 alignment of the characters is automatically achieved through the optical system. When printing on preprinted forms, the placement of the overprint characters within the confines of the form can become a matter of concern, especially if the paper has a tendency to shift as, for example, in multi-ply forms. This problem is eliminated on the IBM 3800 when using the form overlay or when forms are printed by using the FORMAT character sets.

E6. Uneven, fuzzy, or broken ruled lines on a form degrade the quality of printing and can result in misreading of information. On preprinted forms the lines are reproduced from typeset rules or from lines drawn by hand. As mentioned in C4, the FORMAT character sets can be used to generate rules on forms. These sets consist of T's, corners, crosses, vertical and horizontal segments, etc. These characters "draw" sharp, crisp lines of uniform width, set at precise intervals, all under program control.

F. CONVENIENCE

F1. Many of the time or cost saving features of the printing system are viewed by the user or the operator primarily as matters of convenience. For example, the use of 15-pitch characters prints the standard 132-character line in a width of 8.8 inches; this makes it possible to print on 8-1/2 x 11 inch paper instead of 11 x 14, and therefore these listings can be bound in standard 3-ring binders, stored in desk drawers, manilla folders, brief cases, or filing cabinets. In addition to the reductions in cost, this feature makes it more convenient for the user to store and refer to this size paper.

F2. Another example of a feature that can be viewed as a convenience is the capability to print 204 characters per line on 14-7/8 inch paper. This makes it possible to use more or wider columns in tabular material than can be done on impact printers, and therefore some kinds of information can be presented more concisely, or can be perceived more easily.

F3. Similar convenience features become apparent to the operator of the system as he becomes familiar with the machinery and the shortcuts available. Less noise, less vibration, no print chains to change, no carbon paper to dispose of, addressing of output, job separation, etc., can all be considered by the operator to be matters of varying degrees of convenience. At the same time, these can be important cost factors in the printing operation.

G. SECURITY OF DATA

G1. In the area of data security the three significant differences between impact printers and the IBM 3800 are the absence of carbon paper, the ability to print selected data on selected copies of the pages of a report, and the features that protect data in the page buffer from disclosure or alteration. Since the IBM 3800 does not use carbon paper on multiple-print jobs, proprietary or other restricted data cannot be gathered from carbons discarded with the rubbish. It is therefore not necessary to use shredding or burning systems to dispose of such material, and the sensitive information can be confined to the intended distribution path.

G2. The other difference that bears on security is the ability, under program control, to blank out from or to add data to any specific copy of the pages of a report of which multiple copies are to be made. This makes it possible to distribute information on a "need-to-know" basis.

G3. Data in the page buffer cannot be read back by available channel commands. All characters stored in the page buffer have been translated into a non-EBCDIC form, and are therefore not readily interpreted. Residual data (from pages already printed) in the page buffer cannot be printed because page definition is destroyed after the last copy of a page has been exposed onto the photoconductor. The photoconductor on the drum is cleaned continuously to remove any printed image so that a new image can be formed on a clean surface.

H. PROGRAMMING SUPPORT

H1. The IBM 3800 Printing Subsystem is supported as a system printer by the VS1 and VS2 operating systems of System/370, Models 145 and above. Commands for the IBM 3800 are compatible in structure with those for impact printers, except for additional commands that are needed to control functions which do not exist on other printers. Existing problem programs written for the current impact printers can be executed without change in the source code, except for programs which use overprinting or which cause printing in the top or bottom half inch margin. This includes programs written in higher level programming languages such as PL/I, COBOL, or FORTRAN.

H2. Default specifications for the selection and use of features and functions of the IBM 3800 can be built into the operating system at each installation. The IBM 3800 programming support gives the problem programmer complete printer control through JCL (Job Control Language) statements. Details on the programming support are given in the publications referenced in A3. The example that follows is given to illustrate some of the versatility of the system.

Example:

```
//GO.OUT DD UNIT = 3800,
// DCB = (RECFM = u,BLKSIZE = ???),
// COPIES = 6,FLASH = (ACCT,4),
// MODIFY = (SPEC,1),
// CHARS = (TEX1,TEX2,GOT5,FOR1),
// FCB = CM
```

H3. In this example the first two lines are standard, except that the output unit is specified to be the IBM 3800, and that the record format and the blocksize of the actual input need to be given. The new keyword COPIES controls the number of copies that are to be printed; in this job run the printing will be repeated six times, thus producing six collated copies of the report.

H4. The keyword FLASH is used to identify the forms overlay that is to be flashed on the pages of the output. Instructions from the system tell the operator which form overlay frame to mount. Before data is printed, the operator can make those adjustments to the form overlay that are specified in the setup manual. The form will then be flashed on the number of copies of each page indicated by the numeral that follows the

identifier. In this example the forms overlay whose identifier is ACCT will be flashed on 4 of the 6 copies printed; the last two copies will be printed without the form overlay.

H5. The Copy Modification function makes it possible to print a name, an address, a legend, or other data-independent text on a given line of every page of any given copy. It also makes it possible to prevent the printing of selected parts of the data on selected copies. Text used for copy modification must be individually identified by 4-character names assigned by the user, and must be stored in the SYS1.IMAGELIBrary. The desired text is then requested by the identifier that follows the MODIFY keyword (in the example it is SPEC). The selected text is to be printed using one of the character arrangements specified in the CHARS keyword. The numeral that follows the text identifier in the MODIFY keyword can have a value of 0, 1, 2, or 3; it corresponds to the order in which the character arrangements are specified. In the example, the numeral 1 indicates that the second character arrangement (that is, TEX2) is to be used to print the copy modification text.

H6. The character arrangements that are to be used to print the data are specified by the identifiers that follow the CHARS keyword. The number of identifiers specified must be not greater than four. Non-print codes in the line of data to be printed are used to indicate changes from one character arrangement to another. If only one character arrangement is specified, the codes in the data are not necessary.

H7. The forms control buffer (FCB) parameter specifies the FCB image that is to be loaded into the IBM 3800 from SYS1.IMAGELIB. This image controls the vertical spacing on the page, and contains the channel codes used for vertical formatting.

I. COSTS

I1. About 50% of the manufacturing cost of multiple-part forms is accounted for in the cost of the carbon paper between the plies, and in the cost of collating and fastening the multiple parts and carbons into a set. To understand how this affects the price, consider the cost of ordinary, stock 14-7/8 x 11 computer paper. The cost of two-ply forms today is approximately three times that of single-ply stock paper; this makes the forms cost about one third less if a report is printed twice on single-ply, rather than once on two-ply, forms. The price of six-ply forms is about nine times that of single-ply; here again, printing the report six times results in a net saving in paper cost. The same savings with larger dollar amounts apply to preprinted forms.

I2. Where smaller print is used, forms could be 40% smaller and cheaper. For example, 14-7/8 x 11 becomes 11 x 8-1/2. Each of the forms in use should be evaluated individually to determine

whether the same information content could be printed with smaller characters on a smaller size of paper.

I3. Internal reports which consist of simple line formats can be done on inexpensive plain paper with the use of the forms overlay or formatting. The IBM 3800 does not use ribbons, and this cost is eliminated. Decollating is also eliminated, resulting in a reduction in manpower, equipment, and maintenance costs. It may be possible to eliminate also the need to make additional or reduced copies on offline copier equipment.

I4. A cost analysis should account for:

- displaced impact printers
- single-part rather than multi-part sets (no carbon)
- use of the forms overlay and formatting
- reduced number of forms
- less paper because of smaller print sizes
- decollating
- elimination of ribbons
- offline operations

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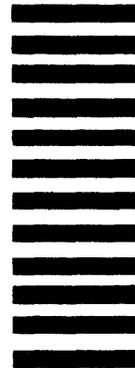
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