

tering the upper and lower case alphabet, numerals, punctuation marks, plus certain other symbols such as +, =, \$, etc. There are some 96 such printable characters and they, along with certain control codes, constitute the 128 characters in ASCII (American Standard Code for Information Interchange). On the cathode ray tube (CRT) screen each character is made up of a collection of dots occupying a rectangular cell, called a matrix, and these dot patterns are usually stored inside most computers in programmable read only memory (PROM). All printers are equipped with these same ASCII characters. However, no standard code exists for Greek letters and mathematical symbols such as integral signs, union and intersection, etc., and the number of such symbols available will vary greatly from one computer and printer to another.

Earlier minicomputer-based scientific wordprocessing systems such as TEX of Knuth and TROFF developed at Bell Laboratories use embedded commands to generate formulas. For example, the command

$$\$$ \sin[(n+1)\zeta/2] \overset{\text{oversin}(\zeta/2)}{\sin(\zeta/2)} \backslash \$$$$

is used by TEX to generate the quotient

$$\frac{\sin[(2n+1)\zeta/2]}{\sin(\zeta/2)}$$

With this *command-oriented* method, Greek letters and special symbols are normally not displayed on the screen as they are entered.

In contrast, some of the newer wordprocessing software can display Greek letters and mathematical symbols on the CRT screen nearly in the form you would see them on a typed page. In two of the packages described below (Brit Scientex and T³), superscripts will actually appear half a line above and subscripts will appear half a line below so you will see formulas as they would appear in final printed form, including on-screen italics and bold print. One other package, WordMARC, shows superscripts one full line above and subscripts one full line below on the screen, so the screen appearance is not quite the same as the final printed form. We call these "what you see is what you get" programs *screen-oriented* wordprocessors.

The Gutenberg Sr. package, which runs on Apple II computers, uses the Apple high resolution graphics screen to generate all its characters. In addition to the standard ASCII characters, it can display an additional 115 user-defined symbols so Greek letters and mathematical symbols can be shown on the screen. The T³ also has user-defined character font capability and the characters are displayed using the IBM color graphics card. Brit Scientex requires the Hercules graphics card instead, and user definable font utility is an option.

WordMARC uses a separate erasable programmable read only memory (EPROM) chip that matches the character set on the Diablo 630 ECS printer. This replaces the standard character generator chip on the IBM monochrome display controller card.

Δ Θ Π Σ Υ Φ Ψ Ω ε < > Α √ α + |] • /

Table 2

Dot matrix printers form their characters by striking a ribbon with print heads containing one or two closely spaced columns of fine wires that can be individually turned on and off. The procedure for printing a character is similar to character generation on the CRT screen, namely individual dots within a dot matrix are turned on and off to form the desired character pattern. The print heads of dot matrix printers in the under \$700 class will typically use 7 to 9 pins and the individual dots of a character are often visible to the naked eye. These printers can print at 100 to 200 characters per second. By making two or more passes and moving the print head slightly each time, it is possible to blend the dots and thus improve the print quality.

Within the past year or so, a number of printers using 18 to 24 pin print heads have appeared on the market. The pins are spaced much closer together and can, in the multi-pass mode, generate characters that are virtually indistinguishable from those produced by letter quality printers. One such printer uses a 28 by 84 dot matrix to generate its characters in this letter quality mode, and the individual dots are not visible even when magnified six times. Such multi-mode printers will print at over 200 characters per second in the draft mode and over 60 characters per second in the correspondence mode. Since the characters are formed by selectively striking the pins of the print head, the number of distinct characters one can form is theoretically quite large. Combined with suitable wordprocessing software, a mathematician or linguist could have virtually unlimited selection of special symbols and fonts for use. Many of these dot matrix printers are also capable of graphical output. The graphics resolution, in dots per square inch, currently ranges from 144 by 160 to 288 by 960.

Most of the dot matrix printers can print in several sizes and styles, including normal, italics, bold, proportional, expanded, and condensed. In addition, some dot matrix printers also have provisions for downloading user-defined character fonts into their memory. Typically, each of the user defined fonts can contain from 96 to 128 characters and different fonts can be loaded in as needed under program control. Some of the wordprocessing packages under review will support this feature on selected printers while others make use of the graphics mode to generate Greek letters and symbols, which is often slower.

As mentioned earlier, the wordprocessing software you select will dictate the printer you should buy. This is particularly true of mathematical wordprocessing. Different printers will require different commands to perform the same function such as subscripting as no standards exist in this area. Sometimes, two models of the same printer will behave differently. The buyer should be extremely careful and check with the software publisher on the exact brand and model printer supported before buying. In Table 3, we list some of the preferred printers for mathematical wordprocessing for each of the programs mentioned in Table 1.

The Epson FX80 dot matrix printer will also work with any of these programs, but its print quality is inferior to the

to enter a display formula in Brit Scientex, you first enter formula mode and create a blank screen area of several lines. You are now in one-half line spacing and tabular mode. From then on formula entry within this area is fairly straightforward. However, formulas cannot be automatically centered. A separate function key is used to activate normal, italics, Greek, and scientific fonts so expressions involving several fonts are easily intermixed.

With T³ you must first call up a blank manuscript shell, which contains the necessary page layout and line spacing information. Text and display formulas are then entered freely as you go along.

WordMARC always remembers the base line and treats all subscripts and superscripts associated with that line as one integral unit so there is no need to go into half-line spacing.

Formulas can be centered or tab aligned with WordMARC and T³. The solid line used to separate numerator and denominator in fractions must be entered separately in Brit Scientex and T³ but is activated as an underlining function in WordMARC.

Brit Scientex and T³ permits the use of large symbols such as integral, summation, square roots sign, etc., which are composed of several individual key strokes. They also allow the sequence of key strokes to be saved to disk and called up by assigned name for later use. If the dot matrix printer has graphics capability, they also provide for user-definable characters and symbols and these user fonts can likewise be

Recommended Printers	
Program	Printer(s)
Brit Scientex	Santec S700, Toshiba 1351, Epson LQ1500, Xerox 2700
Gutenberg Sr.	Apple DMP/Imagewriter, C-Itoh 8510, NEC 8023
T ³	Okidata 2410, Sentec S700, Toshiba 1350
WordMARC	Diablo 630 ECS E103 and 630 ECS E109

Table 3

saved to disk. The Diablo 630 ECS is a daisy wheel printer and only the integral sign can be made larger.

A final note on display formulas: none of the three packages for the IBM PC has half space horizontal motion, so the fraction ($1/2n$) must have the 1 over the 2 or the n.

Additional Editing Features

Other useful features of some of the general purpose wordprocessing programs include merging of two or more files, automatic hyphenation, spelling checkers, split screen editing, and automatic footnotes. Merge is useful for generating formletters by merging an address list to a standard letter. Spelling checkers will help reduce typing errors by automatically comparing words of a document file against a built-in dictionary. Words can be added to or deleted from this dictionary so a specialized dictionary can be built up. Split-screen editing allows one to open two files and edit both simultaneously. Text can be moved back and forth between the files.

Brit Scientex

Brit Scientex was originally written as a scientific wordprocessor for the Victor 9000 computer and recently released

for the IBM PC. It uses the Hercules graphics card and a monochrome CRT display to show true superscripts and subscripts on the screen.

Four fonts — normal, italics, Greek, and scientific are available, and are accessed via function keys. Striking a function key once means the next character will be taken from that font. Striking the key twice will lock you into that font. You can call up a keyboard layout of the current font at any time.

The top line of the screen is used to display the current status of the editor, and the bottom line shows what functions are currently associated with each of the function keys. Normal text entry is very fast and the text file is stored in RAM. As noted earlier, multi-level subscripts and superscripts within a text paragraph are awkward, as the keys that activate these functions are toggles that reverse their function when next pressed. You must go into half-line spacing mode to do multi-level subscripting.

In the formula mode, the work space is in half-line spacing and tabular mode. You can then work on each half-line and proceed down the various levels of your formula. Overstriking a character with another to create a composite character is possible. Large integrals, summation signs, etc. can be composed from multiple key strokes, and a glossary of such symbols can be stored on disk and recalled during formula entry.

With the Santec S700 printer, the various fonts are stored on PROMs so additional characters can only be installed by adding PROMs to the printer. Up to 30 fonts can be installed in the Santec S700, but only four fonts are accessible at any time. Only monospaced Greek and scientific fonts are supplied with the Santec even though both proportional and monospaced fonts are available in roman and italic fonts. With the Epson LQ1500 and Toshiba 1351 printers, however, you can use the optional font utility to create and download character fonts directly under software control, and is therefore more flexible. A small adapter is supplied with the Brit package and this is attached to the printer port on the Hercules card to enable the system. This is also a security device. Without it, you will only be able to enter one page of text and print it but not save it to disk. If your printer has a parallel interface, then it can be connected to the back of the safety device. The Xerox 2700 laser printer is also supported.

T³

T³ is a newly released package from Triad Computing, Inc. and is designed specifically as a scientific wordprocessor. It can handle up to eight fonts simultaneously and the supplied Greek and scientific fonts are very well suited to mathematical work. You can view and print a copy of the keyboard layout for any currently active font at any time. A font utility is standard with this package and it allows the creation of special symbols not already available.

True subscripts and superscripts are shown on the CRT

WordMARC

WordMARC was originally written for DEC, Prime and some other minicomputers. It has been released for the IBM PC and XT as well as certain IBM compatibles and other microcomputers. It is really a general purpose wordprocessor with scientific wordprocessing capabilities. The package must first be configured for your particular system, but it is very straightforward and need not be repeated. For the IBM, the monochrome display adapter and a special EPROM chip is needed to generate the Greek alphabet and symbols on-screen. Rev. 4.1 uses a EPROM that matches the symbols available on the Diablo 630 ECS daisy wheel printer. The same symbols are available for the Epson FX80. Subscripts and superscripts are shown on screen one line lower and higher than the original text line so formulas are spaced apart more on screen, but this is not a serious problem as they will print correctly. Up to six levels of subscripts or superscripts are available at all times and are easily entered. Overstriking a character with another or a superscript character is equally easy. With the Diablo 630 ECS printer, you can create a large integral sign but not other symbols. The glossary file will not accept symbols, subscripts or superscripts so it is limited to ordinary text. An expanded glossary file with macro and formula capabilities is planned for Fall release. The spelling checker works well and seems to ignore equations.

The editor will automatically write to disk after each 200 characters, so text file size is not limited by memory. There are also provisions for saving textfiles in either WordMARC or ASCII format. The latter permits easy transfer of files to a remote computer via modem and phone line. A nominal charge for annual updates and direct phone line help is available. Documentation includes an 115-page self-teaching guide that takes the user step by step through all its major features. Separate user, installation, and technical reference guides are supplied. Special labels for each of the function keys as well as a reference card are supplied. A chart showing the function keys and list of symbols available on the Diablo 9R87020 print wheel is also included.

WordMARC supports a long list of daisy wheel printers. Support for some laser printer(s) with font downloading is planned for Fall 1984 release. Linking and merging of files at print time is possible.

Gutenberg, Sr.

The Gutenberg Sr. is a command orientated wordprocessor for the Apple II family. It was first introduced in 1981 and is designed to produce copies that closely approximate a typeset, rather than a typed, page. Its command structure is very similar to that found on typesetting systems, and it does not provide on-screen viewing of equations.

The number of print formatting commands available is quite large and permits great flexibility in output. Fully jus-

recommended dot matrix printers.

Since complex mathematical formulas are not displayed on the screen, command macros similar to those used in TEX are used to enter an expression. It is therefore more difficult for a typist to master. Multi-level subscripts are possible and these are achieved with appropriate "up" and "down" commands. The integral

$$\int_{-x}^x f(\sigma) \frac{\sin[(2n+1)\sigma/2]}{\sin(\sigma/2)} d\sigma$$

would be entered as

$$\langle I2 \rangle - x |x| f(\sigma) \langle F3 \rangle \sin[(2n+1)\sigma/2] |\sin(\sigma/2)| d\sigma,$$

where $\langle I2 \rangle$ is a predefined macro for large integrals and $\langle F3 \rangle$ is a macro for fractions.

Gutenberg Sr. has a very powerful editor with glossary, keyboard macro, and split-screen editing capabilities. Keyboard macro allows you to use one or two keystrokes to enter an entire phrase. With split-screen editing you can open two files on the same disk and edit both at the same time, including cut and paste from one to another. The program will automatically write to disk so a single file can be up to disk capacity or about 120,000 characters long. Mail merge, linking of files, and selective printing of up to four portions of a file is possible. A built-in communications utility for file transfer via modem and user installed command translation table is also provided.

Other Programs

We know of three other programs that claim scientific wordprocessing capabilities. A CP/M-based program called TechWriter has been available for some time, but we lacked the hardware to test it.

ProofWriter is a package designed for the IBM PC. Subscripts and subscripts are shown in inverse video when used within a text paragraph. Multilevel subscripts within a text paragraph are not possible. Its formula mode is similar to Brit Scientex, but subscripts and superscripts are shown one full line below and above the main line respectively. Displaying and printing Greek letters and symbols appear to be more difficult than in the packages reviewed above.

Another recent release for the IBM PC — Text Engineer, from Pelada — arrived too late for testing. This program uses either the color graphics or monochrome adapter. On the color graphics card, different colors are used to represent subscripts and subscripts while inverse video is used to do the same in the monochrome mode. A somewhat limited selection of Greek letters and symbols is included.

Programs written for the IBM PC will work on certain IBM-compatible machines but you should contact the publisher to verify this. The name and address of each publisher together with list price for the programs cited are given below

screen, and formula entry is very easy. You can either center or tab align display formulas on-screen as they are entered. The program is menu driven and various options are shown on overlapping pulldown menus similar to those found on much of the mouse activated software. The floppy disk version requires 512K of RAM while the PC XT version needs 256K. A color graphics card is needed. In the version tested, cut and paste of material to areas of textfile off-screen was not yet implemented. T³ also has a special reference mode that allows the entry of references in the format commonly found in mathematical publications. In addition to the Epson FX80/100, it also supports the Okidata 2410 and Toshiba 1351 high density dot matrix printers with font downloading.

The version of T³ tested was written in UCSD Pascal and is rather slow. A good typist will have to consciously slow down or else risk overtyping the buffer and run into unexpected problems. We encountered some problems while testing T³ but the publishers have assured us these will be corrected. Documentation includes an illustrated tutorial and reference guide, and free phone help for 180 days is also offered. A DOS version is under development and it should be significantly faster.

tified, multiple-column, newsletter layout using proportional fonts similar to what you see on these pages is possible. The same document file can be printed in any one of several different layouts by simply changing the format file.

A font utility permits the user to define character fonts of up to 115 characters each that are viewable on screen and in the printout. With 64K of RAM you will see your text in the 40 column mode only. However, a IIe equipped with the extended 80 column card or a IIc will permit you to see your text in 80 columns. Both the Apple DMP and Image-writer printers will support font downloading and fonts can be loaded from disk into the printer's memory while a document is being printed. An utility to create downloaded fonts is included.

You can place graphs and pictures anywhere within the text. It's the only wordprocessor under review that can intermix graphics and text; it has its own graphics utility that will also accept standard Apple DOS binary picture files. Another utility is included for conversion of CPM or DOS 3.3 textfiles to and from Gutenberg files.

Gutenberg has excellent foreign language handling capabilities, including on-screen viewing of Hebrew from right to left as well as printing of justified Hebrew text using the

general with list price for the programs cited are given below for reference.

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Brit Scientex (\$800)
Scientific
Communications Corp.
The Science Center
3508 Market Street
Philadelphia, PA 19104
(215) 386-6840

T³ (\$495)
Triad Computing, Inc.
1190 B Foster
Las Cruces, NM 83001
(505) 522-4600

WordMARC (\$500)
MARC Software International
260 Sheridan Ave., Suite 200
Palo Alto, CA 94306
(415) 326-1971

Gutenberg Sr. (\$325)
Gutenberg Software
47 Lewiston Road
Scarborough, Ontario,
Canada M1P 1X8
(416) 757-3320

Text Engineer (\$500)
Pelada Informatica, Inc.
87 Queen St.
Kingston, Ontario,
Canada K7K 1A5
(613) 544-1603

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own; and what is hoped to be an accomodation for a short period of stringency then becomes a permanent fixture. It can be argued that the policy followed in the late 1970s, a period of budgetary stringency, of trying to support as many senior mathematicians as possible by reducing, temporarily, the support of graduate students or summer researchers, was a mistake. We in the mathematical sciences became accustomed to it, and, what is worse, our colleagues in other disciplines came to believe that that was all that was needed, and even worse, that perhaps we could do without even that. The lesson we learned from this is that the mode in which one spends one's funds today is highly determinant of the amount of funds that will be made available tomorrow.

During the past four years, I believe I have heard an enunciation of science policy from the federal government which is crisper and sharper than previous administrations, and I believe that this policy should be considered in depth in the construction of policy for the mathematical sciences. My understanding of this policy is based on three often-used ideas: excellence, sophisticated personnel, and payoff. It is, I believe, also based on the concept of leveraging, and of university-industry cooperation.

By excellence, science policymakers today mean precisely that: an emphasis on quality and a deemphasis on egalitarian access to the scarce resources available, and on the use of science policy to correct social and sociological ills. I believe that this message is often misconstrued by members of the academic community, who tend to forget that science

policy is being enunciated not only at universities, but at national labs and government and industry research facilities as well.

The second emphasis has been on personnel, as exemplified by the recently initiated Presidential Young Investigator Program, and on young people in general. I detect a

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great concern by policymakers for the quantity and quality of the young people attracted to research, not only for the academic, but especially for the industrial and defense sector. Many newly instituted activities at the federal level are directed to correct perceived deficiency in this area and such emphasis should be noted in our plans.

Finally, there is an insistence by science policymakers today on a careful separation between the domain of responsibility of the federal government — basic research, and the domain of private industry — development. At the same time, there is an equally strong insistence that federal funds be leveraged, be viewed as attractors for industrial and state funds. Again the Presidential Young Investigator Program, which provides funds to be matched by industry, illustrates

this policy: basic research should be funded at universities in support of young people and should attract industrial funds.

This characterization of science policy has significant implications for the support of research in the mathematical sciences. We have to emphasize areas which share the qualities of excellence, of need of sophisticated personnel, and of expected industrial and economic payoff. Combinatorics, numerical analysis, and scientific computing come to mind. Such emphasis will not detract in the long run from the other areas of the mathematical sciences, but rather will protect and indeed enhance them. It would be wise for the math sciences research community, through appropriate mechanisms such as the Mathematical Sciences Board at the National Academy of Sciences, to devise proper and appropriate thrusts to this end, and especially, to ensure that they do no violence to the discipline as a whole, but strengthen it. This is the most important task facing us at this time if we are to continue the redress our still too low level of funding.

It has been a distinct pleasure, indeed, a privilege, for me to be able to participate, with my NSF, DOD, and DOE colleagues and with members of the research community in the active and enthusiastic endeavors of the recent past, in studying the needs and opportunities of our discipline. While I have returned to a university setting, I look forward to continued participation in the activities of the research community.

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