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ASSEMBLY LANGUAGE

statement. This override is necessary because the operand is anonymous. An anonymous reference is composed only of registers and constants. The assembly language would not know the type of this operand without the type override. The assembly language knows which of the three types of return to generate by the type of the procedure.

The main program follows TRAIL. Notice that the ASSUME statement prior to the main code reflects the conditions at the start of execution for an .EXE file. The label IP (instruction pointer) is used on the ENDS statement at the end of the program to indicate where to begin execution. The first statement executed is

```
MOV ES,CONDSEG
```

Because CONDSEG is declared in the CSEG segment, the assembly language knows that this statement requires a segment-prefix override for the code segment. If it were not for the ASSUME statement, the line would have to be coded

```
MOV ES,CS:CONDSEG
```

A more common way of coding this operation is

```
MOV AX,DSEG
MOV ES,AX
```

I prefer my method because no free register is needed. Constants cannot be moved directly into the segment registers because of their location in the BIU.

Note that immediately after this statement there is an ASSUME to inform the assembly language that the extra segment is now associated with the logical segment DSEG.

STRING OPERATIONS

The filenames from the command line are moved from the program-segment prefix into the FCBs in DSEG with the string operation REP MOVSB (move string byte). The source index and destination index point to the source and destination. The REP prefix means that MOVSB will be executed CX register times. Because there is no segment-prefix override, CX register bytes will be moved from DS:SI (data segment:source index) to ES:DI (extra segment:destination index). The count register is set to a constant computed

(continued)

```

:***** EXTENSION & CARRIAGE RETURN & LINE FEED
:----- MOVE ENTIRE FILE EXTENSION
MOV     CX,(SIZE FILE__EXTENSION)
MOV     SI,OFFSET FCBRES.FILE__EXTENSION
REP     MOVSB
:----- REMOVE TRAILING BLANKS
CALL    TRAIL
:----- CARRIAGE RETURN
MOV     AL,00DH
STOSB
:----- LINE FEED
MOV     AL,00AH
STOSB
:***** WRITE OUTPUT RECORD
:----- SET DISK TRANSFER ADDRESS FOR WRITE
MOV     AH,01AH
MOV     DX,OFFSET OUTLINE
INT     021H
:----- WRITE RECORD
MOV     AH,028H
MOV     CX,DI
SUB     CX,OFFSET OUTLINE
MOV     DX,OFFSET FCBOU
INT     021H
OR      AL,AL
JZ      WRITTEN
:----- WRITE ERROR
MOV     AH,009H
MOV     DX,OFFSET MSGWRI
INT     021H
JMP     DONE
:----- SUCCESS
WRITTEN LABEL NEAR
:----- SET VARFUN FOR SEARCH CONTINUATION
MOV     VARFUN,012H
JMP     NEXT
:***** SEARCH IS COMPLETE
DONE    LABEL NEAR
:----- CLOSE THE OUTPUT FILE
MOV     AH,010H
MOV     DX,OFFSET FCBOU
INT     021H
EXIT    LABEL NEAR
:----- JUMP TO DOUBLEWORD CONTENTS TO TERMINATE
JMP     RETURN
CSEG   ENDS
      ENDS IP

```

Table 1: The execution unit's registers and their uses.

Register	Operations
AX	word multiply, word divide, word I/O
AL	byte multiply, byte divide, byte I/O, translate, decimal arithmetic
AH	byte multiply, byte divide
BX	translate
CX	string operations, loops
CL	variable shift and rotate
DX	word multiply, word divide, indirect I/O
SP	stack operations
SI	string operations
DI	string operations



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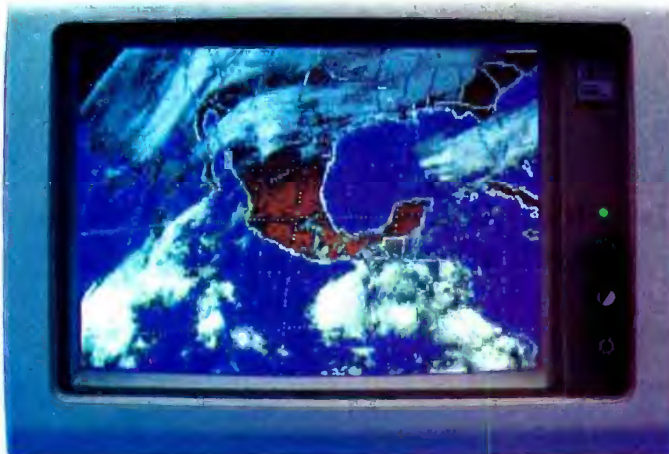
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Listing 3: An assembly-language routine for searching directories from BASIC.

```

=====STRUCTURES
-----FILE CONTROL BLOCK
FCB          STRUC
DRIVE__NUMBER  DB      ?
FILE__NAME     DB      8 DUP(?)
FILE__EXTENSION DB      3 DUP(?)
CURRENT__BLOCK DW      ?
REC__SIZE      DW      ?
FILE__SIZE__LO DW      ?
FILE__SIZE__HI DW      ?
FILE__DATE     DW      ?
              DB      10 DUP(?)
CURRENT__REC   DB      ?
RANDOM__REC__LO DW      ?
RANDOM__REC__HI DW      ?
FCB            ENDS

=====STRUCTURE FOR SEARCH PARAMETERS
SEARCHP      STRUC
              DW      ?      :BP
              DD      ?      :RETURN ADDRESS
REQUEST      DW      ?
ANSWER       DW      ?
SEARCHP      ENDS

=====CODE SEGMENT
*****BASIC SEGMENT
BASIC        SEGMENT PARA
              ASSUME  CS:BASIC,DS:BASIC,ES:BASIC,SS:BASIC
*****CSEG SEGMENT
CSEG         SEGMENT PARA
              ASSUME  CS:SEG
*****BLOAD HEADER INFORMATION
              DB      0FDH      :BLOAD MARKER
              DW      00000H     :OFFSET
              DW      00000H     :SEGMENT
              DW      FINISH-START :LENGTH
START        EQU      $
*****EXECUTION ENTRY POINT
              JMP      NEAR PTR SEARCH
*****DATA
FCBRES       FCB      <>
FCBSEA       FCB      <>
FCBTMP       FCB      <>
VARFUN       DB      ?
*****CS REGISTER ADJUST PROCEDURE
-----CORRECTS FOR RELOCATION TO BLOAD OFFSET
-----USES TWO PUSHES AND A FAR RETURN TO CHANGE CS:IP
ADJUST       PROC      NEAR
              USE DUMMY NEAR CALL AND POP TO GET CURRENT OFFSET INTO AX
              CALL     ADJUSTL
ADJUSTL      PROC      NEAR
ADJUSTL      ENDP
              POP      AX
              SUBTRACT REAL OFFSET TO DETERMINE BLOAD OFFSET
              SUB      AX,OFFSET ADJUSTL
              MOV      BX,AX
              CONVERT TO PARAGRAPHS AND COMPUTED ADJUSTED CS IN CX
              SHR      AX,1
              SHR      AX,1
              SHR      AX,1
              SHR      AX,1
              MOV      CX,CS
              ADD      CX,AX
              COMPUTED ADJUSTED RETURN OFFSET IN AX
              POP      AX
              SUB      AX,BX
              PUSH NEW CS,OFFSET AND DO FAR RETURN
              PUSH     CX
              PUSH     AX

```

by the assembly language as the sum of the sizes of three fields within FCB. The word "offset" in the assignment of the source index and destination index values tells the assembly language to code the offset of that variable into its segment (rather than the content). After the two filenames are moved, I no longer need a segment register pointing at the program-segment prefix so I set the data segment to point to DSEG and inform the assembly language with an ASSUME.

DOS FUNCTIONS

To reach DOS functions, place a function number in the AH register and do an INT 021H. Additional information is passed in other registers and varies by function. My first DOS function is to create the output file. This is function 016H and requires that the DX register point to the FCB. The AL register contains an error code that will be 0 if the file was created.

If there is an error I use function 009H to print my error message. The DX register points to the string to be printed and must end with a dollar sign. If there is no error I set the value of certain fields not initialized by an open or create. I also set the output record size to 1. The default record size is 128. Note the use of the FCB structure in assigning these values.

The disk-transfer address (DTA) is set by DOS function 01AH with the data register set to its value. The disk-transfer address is where subsequent reads or writes will take place. It is also the address at which directory searches place their result. The DOS function for the initial directory search request is different from the one for the continuation search request. The variable VARFUN has the value 011H the first time through the loop and the value 012H thereafter.

The output line is pieced together from the result of the directory search. The procedure TRAIL is used to eliminate unwanted trailing blanks. The disk transfer address for writing the line is set and the number of bytes in the output line is computed. The line is written using DOS function 028H. For this function the CX register is the number of records and the data register is the file control block. In this case the number of records is the line length

(continued)

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ASSEMBLY LANGUAGE

```

ADJUSTF  PROC      FAR
          RET

ADJUSTF  ENDP
ADJUST   ENDP
: ..... SEARCH
===== SEARCH PROCEDURE
SEARCH   PROC      FAR
: ----- GET FRAME POINTER
          PUSH      BP
          MOV       BPSP
: ----- SAVE REGISTERS
          PUSHF
          PUSH      AX
          PUSH      BX
          PUSH      CX
          CLD
: ----- ADJUST CS
          CALL      ADJUST
: ----- SET ES=CS
          PUSH      CS
          POP       ES
          ASSUME    ES:CSEG
: ----- PARSE FILENAME INTO TEMPORARY FCB
          MOV       AH,029H
          MOV       AL,000H
          MOV       SI,REQUEST[BP]
          MOV       SI,SI[1]
          MOV       DI,OFFSET FCBTMP
          INT       021H
: ----- SET DS=CS
          PUSH      CS
          POP       DS
          ASSUME    DS:CSEG
: ----- COMPARE FCBTMP TO BCBSEA
          MOV       CX,(SIZE DRIVE__NUMBER) + (SIZE FILE__NAME) + (SIZE
          FILE__EXTENSION)
          MOV       SI,OFFSET FCBTMP
          MOV       DI,OFFSET FCBSEA
          REP       CMPSB
          JZ        MORE
: ----- NEW REQUEST FCB
          MOV       CX,(SIZE DRIVE__NUMBER) + (SIZE FILE__NAME) + (SIZE
          FILE__EXTENSION)
          MOV       SI,OFFSET FCBTMP
          MOV       DI,OFFSET FCBSEA
          REP       MOVSB
          MOV       VARFUN,011H
MORE      LABEL     NEAR
: ----- PERFORM SEARCH
          MOV       AH,01AH
          MOV       DX,OFFSET FCBRES
          INT       021H
          MOV       AH,VARFUN
          MOV       DX,OFFSET FCBSEA
          INT       021H
          MOV       VARFUN,012H
: ----- TEST FOR SUCCESS
          OR        AL,AL
          JZ        SUCCESS
: ----- FAILED BLANK RESULT
          MOV       VARFUN,011H
          MOV       AL,' '
          MOV       CX,(SIZE DRIVE__NUMBER) + (SIZE FILE__NAME) + (SIZE
          FILE__EXTENSION)
          MOV       DI,OFFSET FCBRES
          REP       STOSB
SUCCESS   LABEL     NEAR
: ----- RESTORE ES
          PUSH      SS

```

```

POP      ES
ASSUME   ES:BASIC
:----- RESULT FILENAME INTO ANSWERS
MOV      CX,(SIZE DRIVE__NUMBER) + (SIZE FILE__NAME) + (SIZE
FILE__EXTENSION)
MOV      SI,OFFSET FCBRES
MOV      DI,ANSER[BP]
MOV      DI,ES:[DI][1]
REP      MOVSB
:----- RESTORE DS
PUSH     SS
POP      DS
ASSUME   DS:BASIC
:----- RESTORE REGISTERS
POP      CX
POP      BX
POP      AX
POPF
:----- RESTORE BP AND RETURN TO BASIC
POP      BP
RET      (SIZE SEARCH-6)
SEARCH   ENDP
:..... BLOAD TRAILER INFORMATION
FINISH   EQU      S
          DB      01AH
CSEG     ENDS
BASIC    ENDS
END

```

because the record size is set to 1. The program loops until it can't find any more directory entries. It then closes the output file with DOS function 010H.

Writing an entire program in assembly language is time consuming. Often it is more practical to write the program in BASIC and make assembly-language calls where necessary.

ROUTINE WALKTHROUGH

Listing 3, SEARCH.ASM, shows an assembly language routine for searching directories from BASIC. This procedure uses a relocation technique that is superior to the methods advocated in the IBM BASIC manual. It allows the user to BLOAD the assembly-language routine anywhere in memory. Hard-coded DEFSEG values are not used. The routine is not a POKE into memory from values in a DATA statement. This technique has two components: BLOAD and the ADJUST procedure.

The BLOAD prefix makes the routine look like a BLOAD file to BASIC after it has been converted from an .EXE file to a .COM-style file. This conversion is necessary because .EXE files have relocation information in them, while .COM files are simply memory images.

The ADJUST procedure adjusts the

code segment so that offsets compiled into the routine under the assumption that the code segment points to CSEG are maintained.

SEARCH begins with the FCB definition seen in MAKEBAT. SEARCHP is a structure that represents the layout of the stack after SEARCH has been called and the base pointer has been pushed. The components of SEARCHP will be used to get the parameter addresses off of the stack.

The BASIC segment represents BASIC. During the execution of BASIC, all segment registers point to the program-segment prefix of BASIC. This is reflected in the ASSUME statement.

Because SEARCH.ASM must be converted to a .COM file to be loaded, there can be only one logical segment. SEARCH will be loaded inside of BASIC, so I have nested the CSEG segment within the BASIC segment. The distinction between the BASIC and CSEG segments is important. All offsets assembled into the program will be from the beginning of CSEG. An unknown number of bytes will be between the beginning of the BASIC and CSEG segments at run time.

The first lines in CSEG define the 7 bytes of data that will make SEARCH

The adjusted code segment value is moved to the data segment.

Now all addresses refer to variables in CSEG.

The temporary FCB is compared to the request FCB. If they differ, this is a new request.

look like a BLOAD file to BASIC. A jump to SEARCH follows this prefix. This is done so the offset of the entry point is always known. Because of the one segment restriction, the data definitions also are made in CSEG.

ADJUST recomputes the code segment to adjust for the unknown number of bytes between the BASIC and CSEG segment. Offsets for variables within CSEG will be correct after this adjustment. The ADJUST procedure makes a Near call to a label within itself to get the offset from BASIC to that label. The offset from CSEG to the label is known, so the difference can be computed. This value is used to form a CS:IP (code segment:instruction pointer) for a Far return where the code segment points to CSEG. This procedure is not necessary unless there are references to data within CSEG.

SEARCH

The first two statements executed in the procedure are:

```

PUSH     BP
MOV      BP,SP

```

This preserves the BP register and sets what is known as the frame pointer. The frame pointer is used to access the parameter addresses that BASIC pushed onto the stack before calling SEARCH. SEARCH then calls ADJUST. The CLD (cleardown) instruction is also issued so that all string operations will proceed from left to right.

The adjusted code segment value is moved to the extra-segment register so

(continued)

Listing 4: SEARCH. BAS.

```

1000 REM RESERVE MEMORY
1010 CLEAR.&H8000
1020 REM LOAD AT PARAGRAPH + 7
1030 SEARCH%=&H8000+7
1040 BLOAD "SEARCH.BLO".SEARCH%
1050 REM REQUEST STRING AND TERMINATOR
1060 REQUESTS="*.ASM"+CHR$(13)
1070 REM RESERVE SPACE FOR ANSWER
1080 ANSWERS=SPACE$(12)
1090 REM CALL SEARCH
1100 CALL SEARCH%(ANSWERS,REQUESTS)
1110 REM IF ANSWER IS BLANK THEN DONE
1120 IF ANSWERS=SPACE$(12) THEN 1190
1130 REM MAP DRIVE NUMBER FROM 0-3 TO A-D
1140 DRIVES=CHR$(ASC(LEFT$(ANSWERS,1))+ASC("@"))
1150 FILENAMES=MID$(ANSWERS,2,8)
1160 EXTENSIONS=MID$(ANSWERS,10,3)
1170 PRINT DRIVES+"."+FILENAMES+"."+EXTENSIONS
1180 GOTO 1100
1190 END
    
```

that the destination index will point within CSEG. SI will still point within BASIC. SEARCH then takes the address of a 3-byte string descriptor from the

stack using the structure SEARCHP and the frame pointer. The first byte is the length of the string followed by the address of the string within the BASIC seg-

The CLEAR statement reserves memory for the assembly-language routine.

ment. The address of the string is used with the DOS parse filename function to create an FCB. No error checking is performed.

The adjusted code segment value is moved to the data segment. Now all addresses refer to variables in CSEG. The temporary FCB is compared to the request FCB. If they differ, this is a new request. If they are the same, this is a continuation request. If the search is unsuccessful, the resulting FCB is blanked.

The original extra segment value is retrieved from the stack so the result can be moved to the answer string in the BASIC segment. Again, no error checking is performed. The answer string must be at least 12 characters long and must not be a literal.

The original data segment value and registers are restored as well as the base pointer. The RETURN statement also pops off the 4 bytes of parameter addresses.

The steps in assembling this routine are

```

MASM SEARCH;
LINK SEARCH;
EXE2BIN SEARCH SEARCH.BLO
    
```

Use of this routine is illustrated in listing 4, SEARCH.BAS. The CLEAR statement is required to reserve memory for the assembly-language routine. The SEARCH routine must be BLOADED 7 bytes beyond a paragraph boundary because of the size of the BLOAD prefix. Notice that the program reserves the string space for ANSWERS by using SPACE\$(12) instead of a literal. ■

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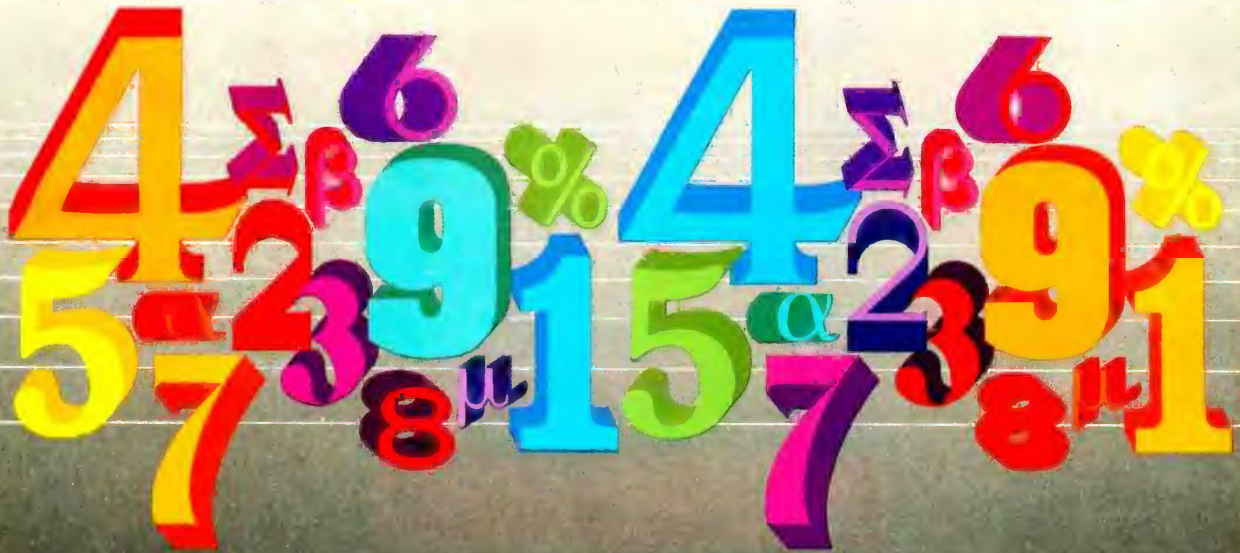
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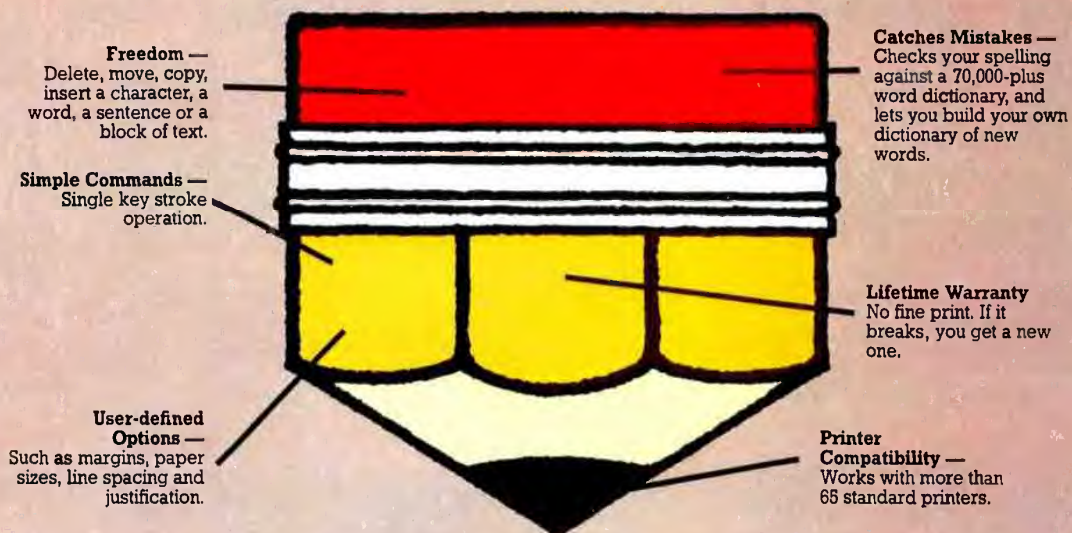
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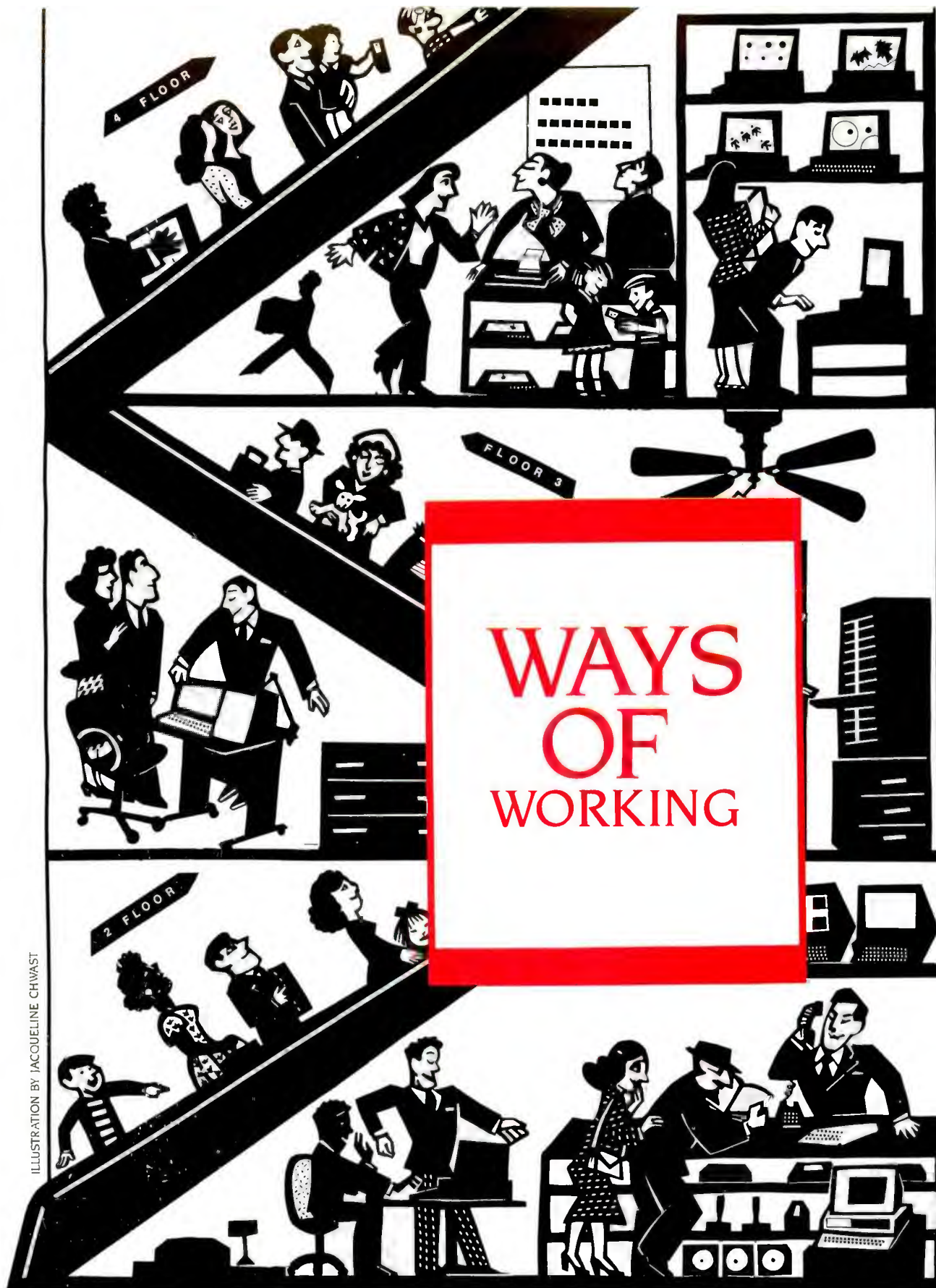
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TECHNICAL AND BUSINESS GRAPHICS ON THE IBM PC

*A quick look at some spreadsheets
and graphics packages in a crowded field*

BY JACK BISHOP

Charts have always been powerful tools for analyzing and selling products. But today's microcomputer graphics programs can make visual aids even more appealing, since they are easy to develop. The popularity of the IBM PC, PC XT, and clones has resulted in the development of even more powerful charting programs for technical and business analysts.

Many spreadsheet programs include graphics routines. Whether you use a spreadsheet for engineering a circuit design or a corporate takeover, you might need the power of a separate charting program. A separate program gives you more flexibility and power, and it often adds fine touches that characterize a professional piece of work. These advantages are often offset by the ease of use of the graphics tied to a spreadsheet package. I would be surprised if any specialized charting pack-

age was able to handle all your charting needs, and you might find that buying more than one is not a luxury.

It is hard to tell which charting package is right for you, since no one package seems to meet a wide variety of needs. Here are six of what I consider to be the better packages: SuperCalc3, Lotus 1-2-3, GrafTalk, Business Graphics System, DR Graph, and ChartMaster.

To evaluate these programs, I used an IBM PC with 256K bytes and an 8087 chip. This configuration includes a 15-megabyte Falcon hard disk, a ColorPlus graphics card, an Epson MX-80 with Grafrax, and a Sakata 200 monitor. I also used the Hewlett-Packard HP 7470A and Enter Computer Sweet-P plotters.

(continued)

Jack Bishop is a management consultant. He can be reached at Box 311, Evanston, IL 60204.

AT A GLANCE

Name

SuperCalc3

Type

Spreadsheet; menu (of sorts)

Manufacturer

Sorcim
2310 Lundy Ave.
San Jose, CA 95131

Price

\$395

Hardware required

IBM PC, IBM PC XT, or clones (Compaq, Eagle PC or 1600, Hyperion, Columbia); two double-sided floppy disks or one double-sided floppy disk and a hard disk; IBM or compatible color/graphics board (optional); IBM graphics dot-matrix printer; Epson MX-80/100 with Graftrax; FX-80/100; RX-80; HP plotters (including 7470A, 7475A); IBM XY/749 plotter; CalComp M84 plotter

Software required

PC-DOS 1.1 or 2.0

Documentation

About 300 pages, spiral bound, with handy bookmark

Audience

Technical and business professionals who need spreadsheet power with extensive charting

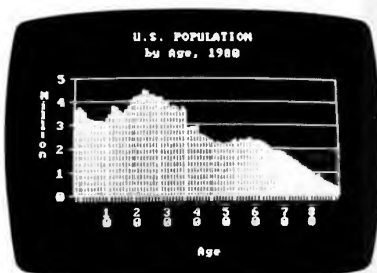


Photo 1: SuperCalc3 screen image of a multiyear bar chart. The screen display gives no hint of the excellent quality of the printed chart.

SUPERCALC3

SuperCalc3 began, without the trailing digit, many moons ago, when the world was either Apple or CP/M. Sorcim was one of the first companies to add really impressive features to a microcomputer spreadsheet. On-board HELP commands and extensive formatting of entries (including variable column widths, the dollar sign, commas, debit/credit/parentheses, and percents) contribute to the improved readability and professional character of the SuperCalc3 report.

The graphics capability was another welcome addition. SuperCalc3 sports all the basic charting routines (line, bar, pie) and a few specialty (high-low and area) charts. It is a single, self-contained product. You never have to leave SuperCalc3 to calculate, view, or print/plot the results.

SuperCalc3 uses a VIEW command to control six different charts for each spreadsheet. This capability is a real sleeper, since keeping track of charts and their source is a potential source of frustration and error. Because one chart can rarely cover all the analysis you need, this capability is even more valuable.

A chart that contains a lot of data allows a spreadsheet to shine. Developing a simple bar chart of the population age distribution is a simple, but surprisingly challenging, test for many products. The data entry and analysis is the sort of thing a spreadsheet cuts its teeth on. For data entry, you can set up SuperCalc3 to move from one cell to the next automatically. I wish more programs had that flexibility.

The VIEW command takes the data cell identities and other basics to develop each chart. I was surprised to find that titles for the charts must be kept in cells in the spreadsheet. I am still not too wild about cluttering up the spreadsheet with a series of extra titles designed for the charts. However, this is a minor inconvenience.

SuperCalc3's on-screen graphics are quite crude and have a decidedly "second-generation" quality. The letters are blocky, and the space devoted to the chart is limited. SuperCalc3 provides a clean, undistinguished chart on the screen, but it is nothing to brag about.

Lurking behind this plain facade of on-

screen graphics is a much more elegant SuperCalc3. The first indication of this beauty is its ability to select from eight type styles (fonts). The final plotted chart (figure 1) was a pleasant surprise.

This chart is a class act. It illustrates the two levels of titling, automatic legends, a variety of axis scaling, and the other basics. On the chart's field, SuperCalc3 will chart only the symbols or annotate data points with data values, to provide the small touches that help ensure that the message of the chart gets through. Upon close inspection, the chart is even more impressive. SuperCalc3 does not run the grid lines through the bars; it uses only the blank space between them. This rare feature makes for a particularly clean chart when you are using only a few bars.

Figure 2 is a simple two-line chart, but it illustrates SuperCalc3's power to perform a series of calculations, then chart the results without ever leaving the program. Its ability to space legends along the horizontal axes can be very useful in highlighting specific events, such as mergers or election years.

All in all, SuperCalc3's graphics are surprising. Its operation is essentially flawless, and it is easy to use in producing charts. For many technical and business uses, SuperCalc3 might be the only charting package you'll need.

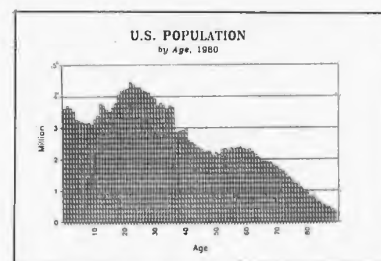


Figure 1: SuperCalc3 charts U.S. population.

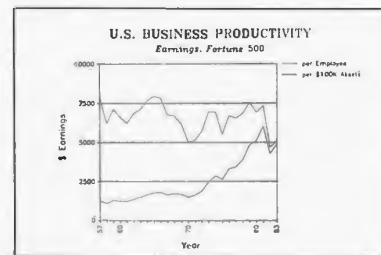


Figure 2: A SuperCalc3 two-line chart.

LOTUS 1-2-3

In a short period of time, Lotus 1-2-3 has captured the pocketbooks—and maybe even the hearts—of many microcomputer owners. Popularized by VisiCalc on the Apple, Lotus 1-2-3 brought the spreadsheet to the IBM PC market with some fine touches, such as its use of color, function keys, and its report-printing capability. The ability to have the spreadsheet integrated with graphics is a strong selling point for the spreadsheet itself.

The Lotus graphics offer multiple fonts for titling and a variety of chart types. The program is comparatively easy to use. However, you must leave Lotus 1-2-3 behind when you enter the print routines, which is somewhat bothersome. Some users will find the separate print routine an advantage, and most will probably not mind switching back and forth, but I like to have a hard copy of the chart in front of me while I continue to develop an analysis.

Lotus 1-2-3 handles a variety of charts, including line, bar, pie, and X-Y, with up to six data series on a single chart (generally more than anyone with good sense will use). The program shines when graphing a large amount of data developed from the spreadsheet. It does a superb job of developing and

charting Fortune 500 productivity.

Automatic placement of legends and sizing of titles makes Lotus 1-2-3 even easier to use. The ability to combine symbols with lines can be a substantial advantage for complex charts. While you can use only two fonts on any one chart, this is a modest limitation. Using more than two fonts (or more than four colors) on one chart usually is more for the fun of the creator than for clarity.

The pie chart (figure 4) lacks the ability to emphasize one segment of the pie. Similarly, the ability to distinguish between the segments of the chart is missing. The result is a basic chart with few frills. Including the percentages for each segment is, however, a nice touch. The ability to annotate your chart with the actual data values, plotted in a Lotus line or bar chart is also useful.

Lotus 1-2-3 performs best when you are developing a number of charts for later printing. The quality is excellent, and the range of capabilities is more than enough for most technical uses.

GRAFTALK

The operation of GrafTalk begins in a low-key way. The simple white text on a black background obviously was designed to appeal to engineers. This is a far cry, however, from the special charts you can develop with this package. I first saw GrafTalk on a Sony and fell in love with its crisp picture. With the addition of new menus, GrafTalk offers an easy-to-use package with extensive charting power.

The menus are an ideal way for us to develop a chart quickly. GrafTalk's menus are a mixed bag, both to me and (I guess) to the developers at the Redding Group. From my standpoint, the person the menus are designed to help (the client in a hurry) is most put off by having to remember a graphics language command (STATUS MENU) to get to the menus. Although it is simple, it is not English. The reason I think the developers have some reservations about menus is their suggestion in the manual that the full features of GrafTalk are not accessible from the menu. In addition, minor glitches in the release version of GrafTalk that I use appear in the menu section. GrafTalk can die in the middle of a chart for no apparent reason.

(continued)

AT A GLANCE

Name

Lotus 1-2-3

Type

Spreadsheet; menu (of sorts)

Manufacturer

Lotus Development Corp.
161 First St.
Cambridge, MA 02142

Price

\$495

Hardware required

IBM PC or IBM PC XT; IBM monochrome or color setup; Hercules or other graphics card; IBM printer

Software required

DOS 1.1 or 2.0

Audience

Technical and business professionals who need the power of a spreadsheet with sophisticated charting

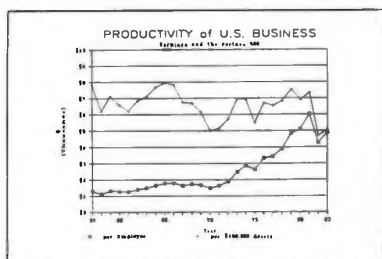


Figure 3: Lotus mixes symbols and lines.

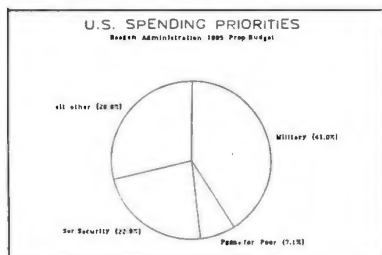


Figure 4: A Lotus pie-chart.



Photo 2: You could use a 35mm picture of the screen version of this productivity chart from Lotus 1-2-3 for a formal presentation.



Photo 3: Population distribution as a pie chart is simple and utilitarian with Lotus 1-2-3.

AT A GLANCE

Name
GrafTalk

Type
Graphics: menu and/or language

Manufacturer
Redding Group
609 Main St.
Ridgefield, CT 06877

Price
\$450

Hardware required
IBM PC, IBM PC XT, or any of the following: Compaq, Cannon As-100, Sord 23, Zenith Z-100, SONY SMC-70, DEC Rainbow, Epson QX-10, NEC PC-8801A, North Star Advantage, Otrona Attache, Sanyo MBC-1250, Sord M23, or Televideo 803

Software required
CP/M and MP/M; PC-DOS; other systems as standard above

Documentation
About 200 pages

Audience
Technical and business professionals who want a package moving toward the best of both worlds, menu and language

While the menus are nicely done in general, some rather gaping holes might trap the unwary. You cannot save the chart developed in a menu, nor can you save the commands. As a result, you do not have the use of the menu chart to steady you while you are learning the language. I did find a way to save the data entered from the menu (exit from the menu into the command language, save the data, then jump back into the menu), but all this foolishness is better left to the developers. GrafTalk does not yet support either a log axis or multiple fonts, both of which I was looking forward to seeing along with the new menus.

All these reservations aside, GrafTalk does a decent job with the productivity chart (figure 5). This chart, typical of a GrafTalk product, is clean and utilitarian. You can change both the height and width of the single font in the command language, but in the menu operation you can only rescale each type of character. I have yet to run into a limit on the number of data points, and a colleague regularly uses GrafTalk to chart a year of daily securities prices.

The power of the GrafTalk command language is revealed when the specialty chart arrives on the scene. Intel's sales for 10 years make a pedestrian bar chart—until a pie chart is dropped in the

middle of it to show the distribution of the sales dollar last year (figure 6). You can use the annotation capability to place a small label on the emphasized segment that represents research-and-development spending.

GrafTalk performs at its best for someone who wants to develop a special chart that combines many elements in unique and esoteric ways. While GrafTalk develops the run-of-the-mill chart with few hassles, I find it most useful for really special occasions.

BUSINESS GRAPHICS SYSTEM

Peachtree provides a series of products that are integrated to the extent that they can generate and read files created by each other. Each module is available on a stand-alone basis, and I evaluated the graphics program from this perspective. PeachGraph provides extensive menu operation and a few options that are definitely slanted toward the financial audience. PeachGraph is one of those unique packages whose limitations are balanced by the easy ability to develop charts that are difficult or impossible for its competitors.

The operation of the Business Graphics System is idiosyncratic. The process begins with the development of a LABEL file, which defines the parameters of the chart. You then go back to a main menu, then to a data file to add the data, back to the main menu, then to a display menu to show the chart. Bouncing from one menu to another can be reduced, but not by much, since you must type the name and type of file each time.

Getting beyond this maze, a single screen holds all the options. The operation within the menu takes some getting used to, as a return takes you out of the screen. (The cursor arrows are used to move around the menu, with the Delete key required to erase a command, rather than the more common Backspace key or AUTOERASE command.)

A major limitation in the Business Graphics System is found in the number of data points. With a maximum of 32 data points per series, the business user may feel cramped.

The pie chart (figure 7) approaches the subject uniquely. The legend is split to run down the right and left margins. This leaves the bottom of the chart free

(continued)

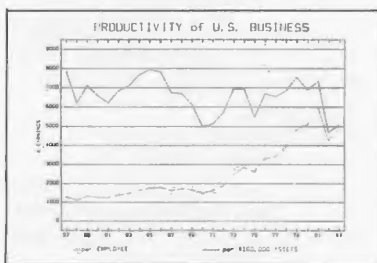


Figure 5: GrafTalk develops a clean and forceful chart from its new menu.

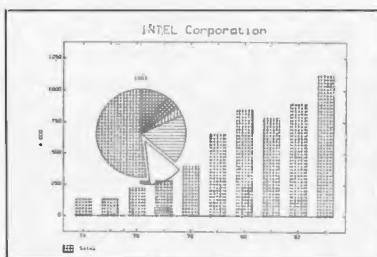


Figure 6: GrafTalk bar chart with pie chart.

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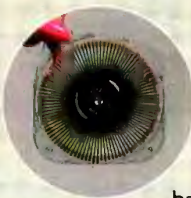


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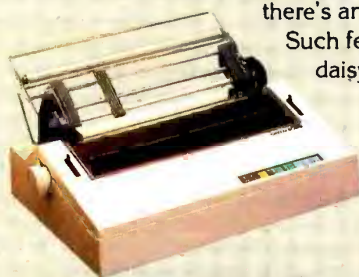
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GRAPHICS PACKAGES**AT A GLANCE****Name**

Business Graphics System

Type

Graphics; menu

Manufacturer

Peachtree Software Inc.
3445 Peachtree Rd. N.E., 8th Floor
Atlanta, GA 30326

Price

\$295 (PC-DOS)
\$125 (Osborne)

Hardware required

IBM PC or IBM PC XT, Osborne 1,
Zenith Z-100, or Epson QX-10; Epson
MX-80 printer; Hewlett-Packard plotters
(7470, 7220); Strobe s-100 plotter;
Houston Instrument (3,4,6,7,29)

Software required

MS-DOS or CP/M

Documentation

162 pages

Audience

Business professionals, particularly
financial

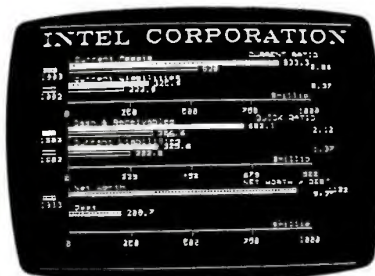


Photo 4: Ratio analysis is clearer on the plotter version than on this screen version of Peachtree's Business Graphics System. Both charts suffer from trying to put too much on one frame.

for a secondary title. You can also select the height and weight of the titling easily and give the characters some slant as well. (A slant to the title should not convey the impression that the figures are not level.) In addition, the placement of the legend provides enough room to include the amount and percentage, along with the identification of each segment.

The Business Graphics System clustered bar chart is distinguished by a three-dimensional effect. Again, the menu allows easy specification of the horizontal and vertical viewing angles. The result is a chart that is unusual and easy to read (figure 8).

The most intriguing chart is the CRITICAL RATIO chart. With this, you can create up to three sets of comparisons on one chart and specify the elements of each ratio. Business Graphics System takes the numerator

(continued)

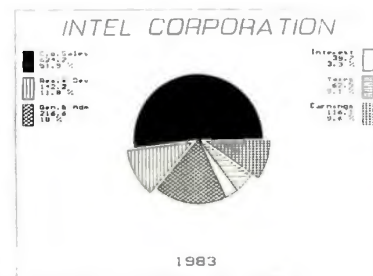


Figure 7: The Business Graphics System pie chart carries a lot of information in the labels.

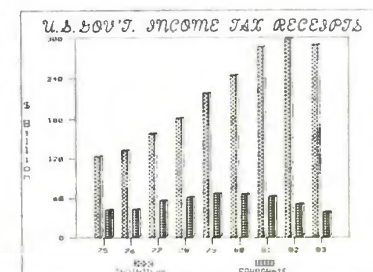


Figure 8: Three-dimensional bars add to a Peachtree chart's impact, while the script title is "a bit much" for most charts.

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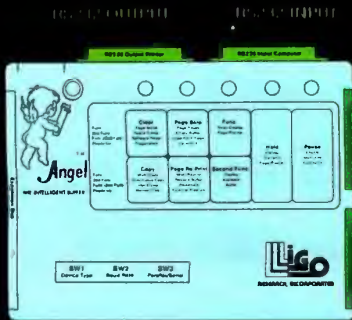
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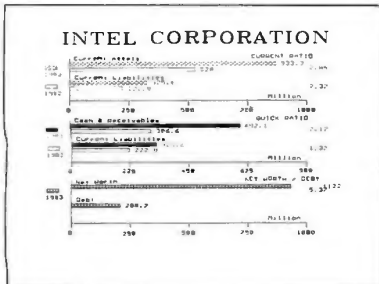


Figure 9: The Business Graphics System ratio chart offers a unique way to present key business ratios.

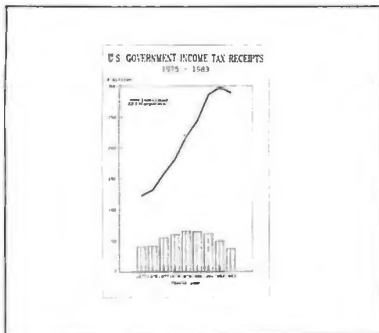


Figure 10: DR Graph combines the ability to vary the width of the line to enhance the concept of a combined line and bar chart.

and denominator to construct each chart, calculating the ratio and writing it in the margin. I can just see some of my accountant friends ripping up their green eyeshades in exaltation over this chart (figure 9). It is a clever, effective way to show a few key financial ratios.

In sum, PeachGraph shines in the development of specialized financial charts. Each chart provides a good, clean development of the subject. You can also develop charts with only text with the Business Graphics System. On the negative side, the few data points are a serious limitation on the usefulness of the system. I found Peachtree's menus more difficult to use than others, and their on-screen graphics are of limited use.

DR GRAPH

DR Graph provides an extensive varie-

ty of charting programs from a series of menus. Two of the biggest limitations for the technical user are its inability to handle more than 75 observations and its limited capability for specifying text as one of the variables to be plotted.

While I found the menus easy to use, data entry is a pain in the lower back. You enter the data one screen at a time, and you never know when you are reaching the end of the screen while you are looking at the data. It is easy to become engrossed in entering the data accurately, while DR Graph takes you to the top of the screen without warning and (I suspect gleefully) conspires to make you write over the data already entered.

On the other hand, the ability to set a number of annotations anywhere on the finished chart with one of several fonts represents one of the more interesting features of DR Graph. The program simplifies the selection of text sizes by allowing only four (designated 1, 2, 3, and 4). I found this a minor inconvenience since I really wanted to use a 2.5 size.

The menus give you substantial control over the chart's character, from font changes to a mixture of chart types. The charts DR Graph produces are clean and well laid out. With DR Graph, you can also combine line and bar charts. Few packages can do the same. Its ability to set the size of the line (including the width of the framing lines) is unique (figure 10). In a normal chart, the line would be lost in the chart, but DR Graph accommodates a variety of line widths to avoid such a problem.

A minor inconvenience occurred between the screen image and the plotted version of the chart. While all the labels of my pie chart fit well on the screen, the plotted version (figure 11) cropped a letter off each side. Similarly, the annotation ("Future Investment") did not overrun the segment in the screen version.

DR Graph presents a real anomaly. The charts are fine and the development is fairly easy, but the limited data capacity stops my evaluation short of a rave review. DR Graph is a solid package within its data and text limitations.

CHARTMASTER

ChartMaster does many things very (continued)

AT A GLANCE

Name

DR Graph

Type

Graphics; menu

Manufacturer

Digital Research
POB 579
Pacific Grove, CA 93950

Price

\$295

Hardware required

IBM PC or IBM PC XT; 8087 version available; versions available for 128K-byte or 192K-byte RAM

Software required

PC-DOS; CP/M-86

Documentation

130 pages

Audience

Business professionals

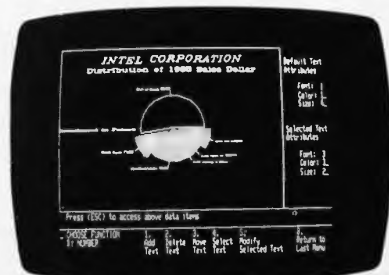


Photo 5: A DR Graph pie chart in the process of being annotated.

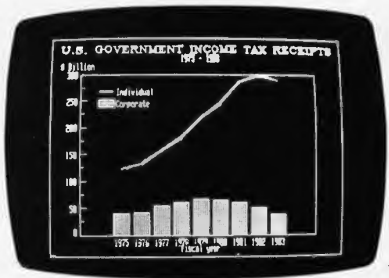


Photo 6: The screen image of a DR Graph chart.

AT A GLANCE

Name

ChartMaster

Type

Graphics; menu

Manufacturer

Decision Resources
Sylvan Rd. South
Westport, CT 06880

Price

\$395

Hardware required

IBM PC or IBM PC XT; monochrome adapter or Hercules color monitor or card; 192K bytes, 256K bytes for use with printer or Polaroid Palette

Software required

DOS 1.1 or 2.0

Documentation

130 pages

Audience

Technical and business professionals who want a fair degree of flexibility within a simplified menu operation

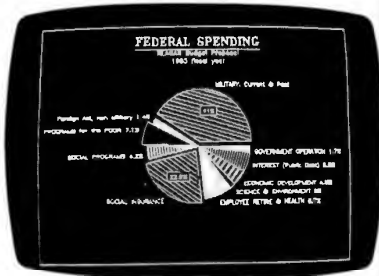


Photo 7: This black-and-white screen image of an 11-segment pie chart illustrates the shares of federal spending and the quality of ChartMaster.

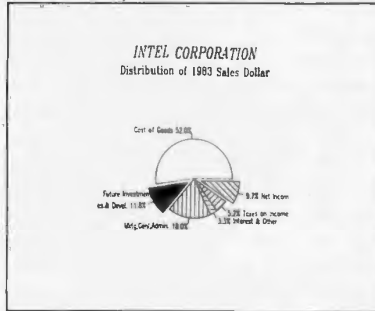


Figure 11: The pie chart from DR Graph trades some chopped-off labels for the ability to annotate the chart.

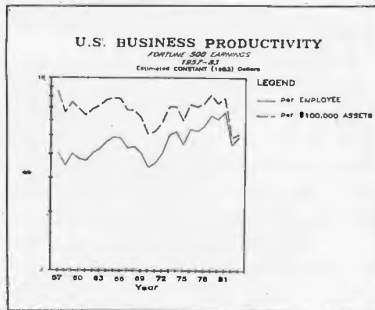


Figure 12: A paired line chart produced by ChartMaster.

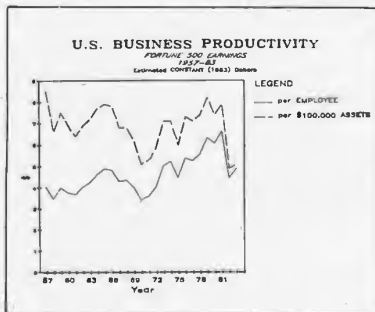


Figure 13: ChartMaster offers a logarithmic (ratio) scale.

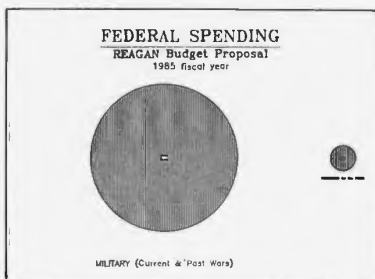


Figure 14: ChartMaster automatically generates a pair of proportional pies.

well, but it cannot do other things I would like. What you see is what you get. This is a menu-driven companion to SignMaster, which can be purchased (at about the same price) to develop text-only charts. SignMaster, like ChartMaster, operates easily and well.

A simple line chart of the productivity of U.S. business provides a good example of ChartMaster's capabilities (figure 12). Several different type styles, with and without italics and underlining, along with a number of different type sizes, provide you with custom-made charts. Data entry is simple, as is flipping back and forth between menus to develop the chart. In this case, constant dollar measures are used to eliminate the distortion because of inflation. You can overcome a second distortion, caused by a linear "Y" scale, by touching a few keys. Voila: you have a log scale and an excellent chart (figure 13).

The log scale is one of the several unique functions of ChartMaster, which is one of the only micro-based charting packages to support different scales on each of the "Y" axes. This capability means that you can chart two series with different scales without resorting to an index and losing some of your audience in the process.

A second unique ability of ChartMaster is illustrated in a pair of pie charts, unsegmented in this case (figure 14). Each chart is automatically drawn to scale and side by side. My only complaint about this chart is the scaling of the legends, which go beyond the limits of readability. The borders around the charts are a nice touch that adds to the chart's readability.

ChartMaster fits my own needs almost perfectly. Choosing from the items on the menu, I have yet to see ChartMaster fail to produce an excellent chart.

THE BOTTOM LINE

The power of charting to help you in analysis and presentation is within your reach, and the products are getting better by the day. With an IBM PC, you can create high-quality charts easily and quickly. Some charts will still be out of your reach, but these packages can do a great deal. I am still looking for a better package, but in the meantime, the programs that are available can get you started on the right track. ■

WORD PROCESSING REVISITED

A review of five new versions of familiar WP packages for the IBM PC—WordStar, Word, pfs:Write, MultiMate, and FinalWord

BY JANET CAMERON

Just a few years ago, we wordsmiths were satisfied with a word processor that would print out our text neatly. Today, though, our standards are considerably higher, and software manufacturers are responding with increasingly complex programs.

Part of the complexity of "installing" word-processing programs could be our own fault. Almost everyone who uses a word processor is spoiled. With our increasingly sophisticated palates, we have come to expect our word processor to be at least as good as a new and improved R2D2.

Some of them are. Some of them even do windows.

We demand an extremely high level of performance from word processors.

We pay for this with increased difficulty in learning and operation. New packages with varying degrees of user-friendliness are flooding the market; currently there are some 150 to 200 word processors available for the IBM PC alone.

Updates, too, are flying out of software manufacturers' doors faster than you can push Escape. Some programs offer significant improvements; some are simply gimmicky add-ons or "holding patterns," i.e., devices to keep users from switching their loyalties.

(continued)

Janet Cameron (POB 1069, Cambridge, MA 02238) is a professional business writer in the areas of printed circuit boards and micro-electronics.



ILLUSTRATION BY JACQUELINE CHWAST

AT A GLANCE

Name

WordStar 3.32

Type

Word-processing program

Manufacturer

MicroPro International Corp.
33 San Pablo Ave.
San Rafael, CA 94903
(415) 499-1200

Price

\$495; options package, \$345; both, \$695

Format

One 5¼-inch floppy disk; three additional disks for extended lesson tutorials; two additional disks required for optional speller/indexing programs

Language

Translation from 8080 machine language to 8086/8088 machine language (listing provided for some sections that may be customized by the user)

Computer

IBM Personal Computer (as reviewed)

Documentation

475-page loose-leaf manual including an installation, training, and reference guide; three disks with extended lessons; reference folder; key labels

Audience

Basic to sophisticated word-processing users, especially those who need to merge programs, create form letters, and use spelling and indexing capabilities

WordStar, Microsoft Word, pfs:Write, MultiMate, and FinalWord all are out with recent updates of their updates. Each of them has put in a few or many new bells and whistles. Each of them has deleted a few or many old bugs and gremlins. It seems that instead of trying to approach some sort of "standardization" in the way we operate word-processing software, the new wave of word-processing developers proceeds on the theory that whoever can achieve the ultimate in esoteric will achieve the ultimate in financial rewards.

I am a writer. I definitely am not a mathematical whiz-bang kid. Along with millions of others, then, I expect two things of a word processor: I want it to do a lot and I want it to be fairly easy to learn and operate. So far, although I've thoroughly tested more than two-dozen packages, I haven't found any such critter.

In researching this article, I used knowledge of and experience with these five packages, information from my anonymous calls to the manufacturers, opinions from friends who use these programs, and a recently published paperback, *The Ratings Book* (Wynnewood, PA: Software Digest, 1984), that features overviews of some 30 word-processing programs. I put the programs, in their updated forms, through some pretty strenuous paces on my machine, an IBM PC with DOS 1.1, 320K bytes of memory, and two disk drives.

WORDSTAR—VERSION 3.32

In spite of its reputation as hard to learn, MicroPro's WordStar is one of the easiest packages to get started. However, between the new version of WordStar and its options package, MicroPro must be attempting to earn a permanent place in the *Guinness Book of World Records*.

With WordStar and its options package, you receive six disks and two very thick and erudite manuals. Just making backups of this monumental mass of information costs a fortune. The increased benefits provided by this library of floppy disks is worth a lot, but users must be willing to wade through the newest WordStar changes, the new spelling checker (CorrectStar), the new index system (StarIndex), and the handy but involved WordStar tutorial.

WORDSTAR'S CAPABILITIES

There's not much you can't do with WordStar. Commands are initiated mostly with the Control key plus one to several keystrokes coupled with commands from one of the seven WordStar menus.

Beginning with the opening menu, a WordStar user can go to any of the program's seven help screens, open a file for editing, execute one of four file commands (print, rename, copy, or delete a file), see the file directory, set his level of help (from 0 to 3), or run either Mail-Merge or CorrectStar.

Besides the opening and help menus, WordStar users can access the editing and formatting screens and the print menu (which, strangely enough, is for special effects on the text and print defaults rather than for printing). Each screen is fairly self-explanatory. WordStar supports most of the best-selling printers on the market today.

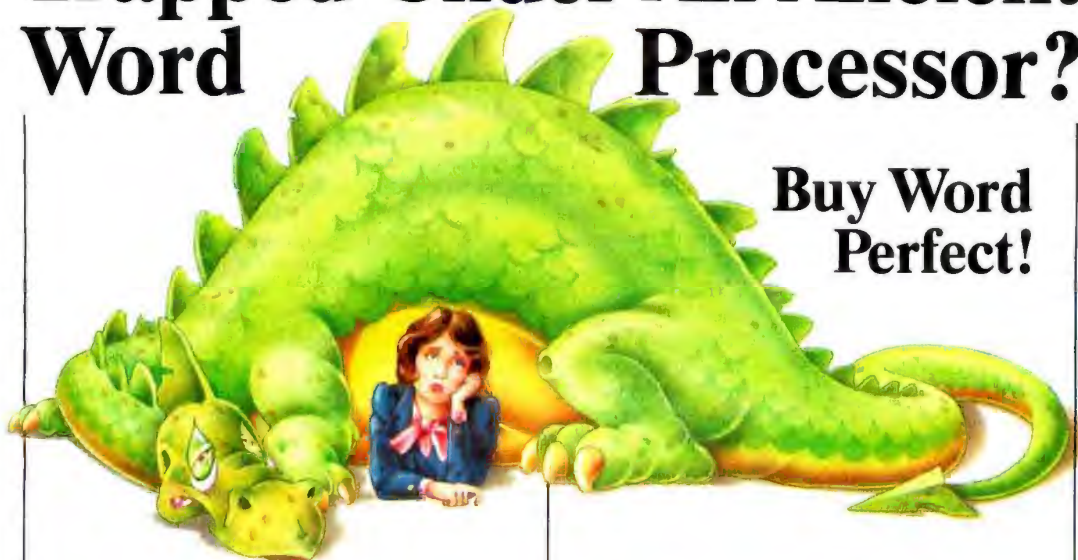
All that is required to run WordStar is 64K bytes and one disk drive, but CorrectStar takes a major upgrade to 192K bytes of system memory and two disk drives. On my benchmark tests of all five packages (see table 1 on page 180), WordStar came out with medium-range times on all four criteria: loading and saving the document, searching for the final word *End*, and scrolling from the beginning of the file to the last line. When I write with WordStar, its speed seems acceptable.

Some basic features WordStar handles with ease include moving, copying, inserting, and deleting small amounts or blocks of text; automatic search and replace, word wrap, and hyphenation; dynamic page-break display and default resetting; cursor moves to any part of the text; and a variety of format settings and within-text changes. WordStar supports special features such as double strike, boldface, superscript, subscript, underlining, and strike out. The program automatically justifies the text unless you change the default.

With WordStar, you can perform simultaneous editing and printing, as well as microjustification. Directions for true proportional spacing on WordStar are available in books that explain how to modify the format portion of the program to achieve this result.

(continued)

How Can You Avoid Getting Trapped Under An Ancient Word Processor?



Once upon a time, word processors were monstrous things. Dot commands, page orientation, and separate editing, formatting and printing programs turned them into lumbering beasts. Only a well-educated programmer would dare don his armor and tackle such a beast — not a pleasant task for a modern secretary, executive, or writer.

Then came WordPerfect and the beast was slain.

WordPerfect was designed to work for you not against you. WordPerfect has no command language to complicate your writing. Pressing a single key is all it takes to

bold, underline or center.

When writing, you don't want to worry about page formatting, making room for headers or footers, or

whether you are in "edit" or "create" mode. Your word processor should do it automatically and WordPerfect does. WordPerfect lets you think in terms of ideas, not pages. It is simple enough that you quickly forget about the mechanics and your writing flows easily.

So if you don't want to be caught under a word processing monster, try WordPerfect. We're certain it will improve the quality of your writing.

WordPerfect

**You'll love it —
not only for the features
we've built in, but
also for the
antiquities
we've
left out.**



SATELLITE SOFTWARE INTERNATIONAL

288 WEST CENTER STREET, OREM, UTAH 84057 (801) 224-4000 TELEX 820-618

SSI

AT A GLANCE

Name

Microsoft Word 1.1/2.0

Type

Word-processing program

ManufacturerMicrosoft Corp.
10700 Northup Way
Bellevue, WA 98004
(206) 828-8080**Price**

\$375 without mouse; \$475 with mouse

FormatWithout mouse, two 5¼-inch floppy disks;
mouse-driven system requires a third
5¼-inch floppy "mouse" disk and a mouse
card**Language**C (user-configurable for typesetter interface
but cannot be customized)**Computer**

IBM Personal Computer (as reviewed)

Documentation400-page loose-leaf manual, 120-page
mouse installation guide, graphics mouse
guide, mouse operations guide, reference
folder, and key labels**Audience**Basic to sophisticated users; mouse-driven
program appeals especially to users who
want speedier operation and less typewriter
orientation

MicroPro representatives say they are "working on" a toll-free telephone number for end-user support. Updates of WordStar and the add-on packages are available for fees varying from \$25 to \$85, depending on the program. WordStar is not copy-protected, enabling users to make backup copies for their own use.

Users of the MicroPro family will find they can merge not only information from other "Star" packages into WordStar, but also that this pioneering word-processing package can often handle the integration of other vendors' programs into its system. WordStar handily deals with the creation and manipulation of columnar text and figures.

Sophisticated .DOT commands enable the user to utilize microjustification, conditional page breaks, headers and footers, top and bottom margins, page numbers, margin offsets, line height and paper length, bidirectional printing commands, and a variety of other advanced formatting options.

File merging, support of a host of printers, an on-disk tutorial, column manipulation, and decimal tabbing are additional features appreciated by confirmed WordStar users. Although WordStar has been added to, subtracted from, and revamped as much as its own cut-and-paste feature, the latest version is a clean package that performs superbly.

Among the improvements of version 3.32 over 3.0 are more clearly written documentation (the new pictures are a big help), user-definable function keys (and they aren't too difficult to program), simpler installation, support for multicolor on color monitors, redesigned menus, and faster screen updating. The best of these features is the improved manual, although there are still voids and complexities that could have been eliminated by almost any beginning WordStar user. As with every package, there are problems and limitations.

WORDSTAR'S LIABILITIES

A sure way to be marked and deleted is to badmouth the American flag, Mom, apple pie, or the sacred cow of word processing, WordStar. The program has its liabilities, and they are as peculiarly confusing as MicroPro's continuing utilization of non-mnemonic commands.

The six-lesson tutorial, though quite time-consuming, is helpful in learning this heavy-duty program. But the documentation is difficult and puzzling to get through. I especially have difficulty trying to find the index.

With most of the other word-processing programs I use, there is an S command for the Search function. Not so with WordStar. It uses a command called Find. Even though WordStar practically invented word processing and set the defaults for many programs, I still find this difference irritating.

When I am totally immersed in the writing process, I find it almost impossible to return to WordStar's opening menu. The way WordStar is set up, most of its commands work off the opening menu; when I have a problem accessing it, I have a problem producing my document. In fact, getting back and forth between WordStar's menus is a real pain. There are several ways to get back and forth, including the CTRL-K commands, but they are awkward and frustrating.

Still, WordStar is a clean, satisfying, in-depth program. Writers, office workers with serious word-processing needs, and people who spend a lot of time preparing nonstandard reports, papers, articles, etc., will probably consider WordStar the respectable giant of word processing. And in spite of the huge amount of competing programs, MicroPro still has a winner.

**MICROSOFT WORD—
VERSIONS 1.1 AND 2.0
(WITH AND WITHOUT MOUSE)**

It sure will help when Microsoft gets a toll-free telephone number for Word users and writes some half-way decent documentation. New users of the clever little mouse especially will benefit from these improvements.

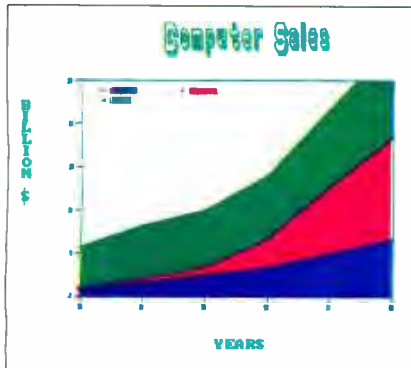
There's almost a consensus in informed circles that mice are the wave of the future. I'm not sure I'm happy about this trend. If you're accustomed to keyboards, operating the mouse takes some adjustment.

In my case, Microsoft Word's 122-page so-called "installation and operation manual" is a complete farce. A fine tutorial is really needed. In the newest version, the addition of a small folder about using the mouse doesn't help a

(continued)

WHEN SPREADSHEETS DON'T GIVE YOU THE PICTURE...

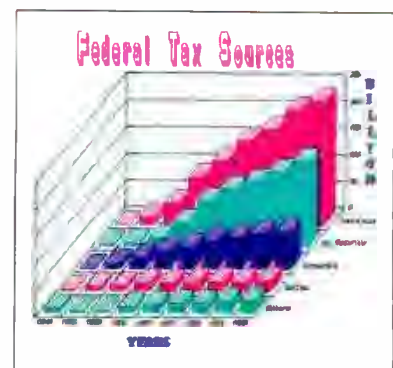
**LINE CHARTS
STATISTICS**



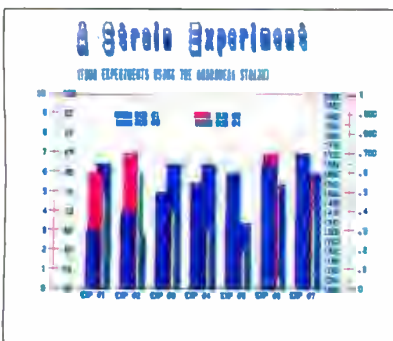
**GANTT CHARTS
PROJECT SCHEDULING**



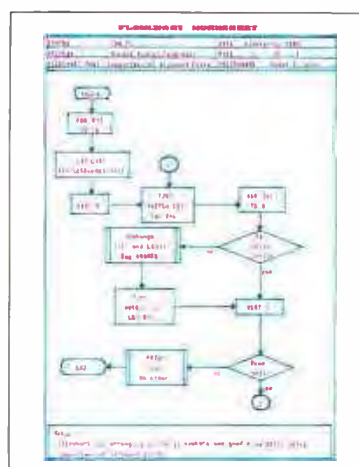
**3-DIMENSIONAL
BAR CHARTS**



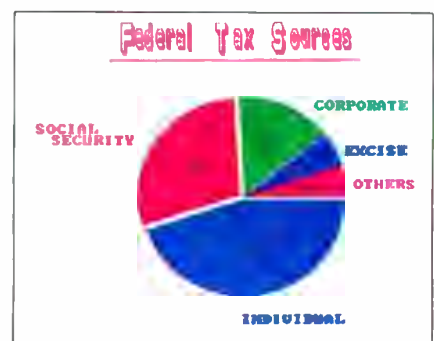
**MULTI-SCALE BAR CHARTS
NEGATIVE BAR CHARTS**



**FLOW CHARTS
ORGANIZATION CHARTS**



PIE CHARTS



THE FIRST COMPLETE GRAPHICS PROGRAM DESIGNED FOR EVERY BUSINESS USE ON IBM-PCs*

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Dynamic and so easy-to-use, **ENERGRAPHICS** is already helping business managers at 40 Fortune 500 companies. **ENERGRAPHICS** is used in Finance, Marketing, Sales, Advertising, Research and Data Processing. Both VisiCalc® and Lotus 123™ spreadsheet files interface with **ENERGRAPHICS**. For the first time business executives can plan, project, present, analyze and report with the best looking professional graphics available on the IBM-PC and compatibles.

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ENERTRONICS

Enertronics Research, Inc.
150 N. Meramec • Suite 207 • St. Louis, MO 63105 • (314) 725-5566
Fall 1984 • BYTE Guide to the IBM PC • 169

StarPolish brings out the best of WordStar (version 3.30) with a true display of special print effects before you print. **Boldface**, underlines, ^{subscript}, ^{superscript} and *italics* all appear in final format¹. What you see on the screen is exactly what you will get on paper. Word for word, line for line, space for space. There are no confusing control characters, like ^B or ^S, to clutter your screen and make the text hard to read. So you make fewer mistakes and correct them faster.

Use of WordStar with StarPolish is totally compatible with normal WordStar files *and* commands. You don't even have to remember command sequences because StarPolish HELP menus remind you, in terms you understand. And StarPolish puts

your PC function keys to work to give you the option of saving keystrokes. StarPolish also supports the full special print effects capability of your dot matrix or ink jet printer.

To make your WordStar shine for only \$125, ask your local dealer or call us today at (301) 340-8700.



TDI Systems, Inc.
620 Hungerford Drive
Suite 33
Rockville, MD 20850
(301) 340-8700

¹Photo display using PC with color monitor and color/graphics interface card.

StarPolish is a trademark of TDI Systems, Inc. The StarPolish programs and the copyrights to the product are owned by Alethic Software Associates.

WordStar is a registered trademark of MicroPro International Corporation.

Circle 172 on Inquiry card.

WordStar[®] with StarPolish[™]

What you see is what you print



www.americanradiohistory.com

great deal. Clearer prose would help new users to get into the program with less than a lifetime of frustration.

Generally speaking, Word (with or without the mouse) is clever, put together well, and performs some extraordinary feats. Its highly touted windows are well worth the high touting. It's command structure is relatively easy to learn, and Word can fully utilize all the special characters (listed in its extensive help menu), hexadecimal codes, and up to 64 different type fonts.

Word's formatting and style-sheet capabilities are complete and more than satisfactory, though I found them hard to use fully while operating with the mouse. The biggest problem I have with Word is its many built-in redundancies, including having to use two disks to get into and out of the program; the multiple commands; confusing labels (Alpha, Gallery, Transfer, Division, etc.); and the use of the right, left, and both-together mouse buttons. Word's system disk contains copy-protected material and thus cannot be cloned. The program disk can be copied.

Instead of working to make the program more flexible in the context of current word-processing programs, Word's developers seem to be trying to completely reinvent word processing. At this time, I care not to start over from scratch. Those users who are just discovering the wonders of word processing may feel differently about Word.

Major enhancements in this revision include a built-in merge for customized form letters, built-in support for the Hercules graphics card, a mouse utility program that provides mouse support for several external programs, optional compatible spelling checkers, and the support of other computers and printers.

Now, without shuffling disks, Word's users can produce form letters; merge data from other Word documents, ASCII (American National Standard Code for Information Interchange) files, or from the keyboard; use direct output from other programs, such as dBASE II; and use English-like instructions with no restrictions on the contents or lengths of text fields to be inserted.

The utility program (called Mouse Menus) that comes with the new version of Word furnishes support for Multiplan, Lotus 1-2-3, WordStar, and VisiCalc.

Word's developers say users may create menus to use with other programs.

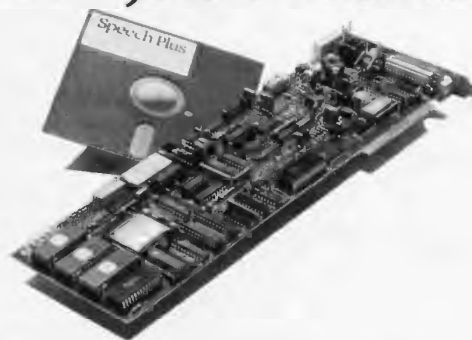
Two spelling checkers are now available (at additional cost) to Word users. Microsoft's package can run on more computers and is compatible with more printers than before. According to the manufacturer, with this current revision, Word has the capability to support vir-

tually every dot-matrix and daisy-wheel printer without requiring a special program. Only a printer-descriptor file (described in the manual) is required.

MICROSOFT WORD'S CAPABILITIES

Power and flexibility mark Word as a
(continued)

One board speaks over 450,000 words.



CallText™ Voice Synthesizers have an Unlimited Vocabulary

With CallText Voice Synthesizers, your computer can *speak* electronic mail, stock quotations, sales status, weather reports or any vital information. And CallText products include a telephone interface, so people can call in and listen as any ASCII text file is converted to speech in real time.

Advanced technology gives CallText Voice Synthesizers full command of the entire English language — nearly a half million words.

For a live, interactive demonstration of how data can be delivered in voice, call (415) 969-6257.

Features

- High quality text-to-speech conversion.
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INCORPORATED

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TELEPHONE (415) 964-7023

Touch-Tone™
is a trademark of
AT&T International
System

AT A GLANCE

Name

pfs:Write 1.1

Type

Word-processing program

Manufacturer

Software Publishing Corp.
1901 Landings Dr.
Mountain View, CA 94043
(415) 962-8910

Price

\$140

Format

One 5¼-inch floppy program disk, one
5¼-inch floppy "sampler" disk

Language

Pascal and assembly

Computer

IBM Personal Computer (as reviewed)

Documentation

70-page manual, on-disk "sampler" tutorial

Audience

Basic word-processing users and those who
want form-letter capabilities

multifaceted program that's worth checking out. But there are hundreds of new things to learn if you choose this package for your own, especially if you opt for the mouse.

For those of you who aren't familiar with this little gadget, the Microsoft mouse is a hand-held device with buttons used either separately or in tandem to carry out commands. The underside of the mouse has a rolling ball that positions the mouse's cursor on the screen. By utilizing short directional moves and pressing one or both mouse buttons, the user points to and carries out Word's commands and functions. Essentially, the left button chooses the option you desire; the right button executes the command and puts you into the following level of command. Pushing them both simultaneously negates the previous order.

Some of the features programmed into Word include compatibility with hard disks; an "undo" facility with a scrap buffer; and highlighting of characters, words, sentences, and paragraphs for use with various modes (such as Move, Copy, Insert, and Delete). This program lets the user make the most of standard and advanced formatting with an ease up to this time unknown in the word-processing game.

Entering the program requires first inserting the Word system disk; then, when Word prompts it, the program disk. Backing out of the program requires the same hassle in reverse.

One thing Microsoft did right: it made the mouse very easy to install. You position and secure the printed circuit board that comes with the mouse into an expansion slot. Then simply attach the mouse's plug to the I/O (input/output) port and you're in business.

After you get into the program, things start to happen fast. A screen with a double border appears. One is a selector rectangle, the other is the movable mouse cursor. A visible ruler outlines the top of the screen; Word's menu, command, status, message, and information lines take up the bottom four lines. The working portion of the screen (19 lines) is a bit short, but the space seems adequate for my needs.

With the mouse-driven version, complete words prompt the user to choose Alpha (for entering or editing text copy), Delete, Format, Gallery (an alternative

command/style process), Help, Insert, Jump (go to), Library (set aside for future features), and Options (sets measurements, turns on and off the alarm and overtyping modes).

The Print command sets the parameters for hard copy. Transfer is used for loading and saving documents from a data disk. Undo and Window round out the first level of commands. And that's just the primer.

In my benchmark tests, Word, along with WordStar, came out just about average in speed of saving, searching, and scrolling to the end of the document. In loading the document, Word was slightly ahead of the other four.

Word handles all routine chores with ease and dispatch. Some of its more advanced features include glossary options (an abbreviated way to delete or copy repetitive words, strings, or blocks of text) and windows (up to eight horizontal and/or vertical divisions of the screen for cutting and pasting, viewing and editing text, documents, footnotes, and so forth). Word also automatically reformats copy as you are working and displays a rainbow of colors when used with an RGB (red-green-blue) monitor.

You can use the mouse to create and handle windows by pointing to an area in the double border (the window bar) and clicking the button, or point to the lower right-hand corner of the screen and turn the cursor into a four-headed arrow. You can also create and manipulate windows with Word commands when the mouse is not being used.

Besides the standard word-processing functions, ASCII-based Microsoft Word has the capability to handle footnotes, multiple columns, the transfer of WordStar files, horizontal scrolling, and special features such as italics, sub- and superscript characters, small caps, underlining, boldface print, and combinations of these features. Integration with laser printers will be available as this type of printer becomes more commonly obtainable.

In the works, according to Microsoft, is badly needed revised documentation, a toll-free user support number, and an indexing capability.

WORD'S LIABILITIES

I have many friends who like this program a lot. For me, however, this program, especially when operated with

WORD PROCESSING

the mouse, has many more limitations than benefits. I'd like to mention a few.

Generally speaking, this package (even without the mouse) is extremely frustrating to learn and operate efficiently. With the advanced Word features, the user has to go to several different places and utilize more than one command level to get results. In order to operate the program with the mouse, you need some more-than-basic manual skills or a course in remedial pointing. It's very frustrating to miss the mark with the mouse's selector and destroy what has taken a good bit of time and effort to achieve, or to continually run the mouse headlong into the keyboard and risk ruining the keyboard or the mouse module itself.

Memory requirement for the program is 128K bytes and one disk drive, but my experience with Word leads me to believe 192K bytes and two disk drives are almost essential. An item most of us find extremely irritating is Microsoft's policy of copy protection. Yes, the program disk can be copied for your own use, but the system disk, necessary to boot and quit from the program, cannot be copied.

In order to tap into the mouse system, you have to read between the lines in the mouse non-manual and read the minds of the developers. Every now and again, when you hit a dead end, the only way to move ahead is to insert DOS (disk operating system) and utilize its capabilities. I could not find this situation mentioned in the documentation.

Word often moves text off the screen while it is in its operating mode. This is terrifying to those who need security blankets to keep their equilibrium while producing long or complex documents. Inadvertently wiping out text you intended to be permanent is frightening.

With Word, deleting is a two-stroke process. With many, many packages, deleting is safely accomplished with one stroke and response to a safety-valve question. Saving is even more disconcerting and time-consuming. Not only does Word require three or four steps to save material, but after you have executed these commands, it pauses more than 10 seconds before putting the message on screen that it actually is saving the material. This will be a long and awkward delay for most users.

PFS:WRITE—VERSION 1.1

Pfs:Write continues to plug along as an elementary program for users who don't have enough time to major in word processing or who have basic needs and aren't into the one-upmanship game. This revised program has some major deficiencies, though, including its inability to justify text except line by line, its insecure nature, and its extremely complex deletion mode.

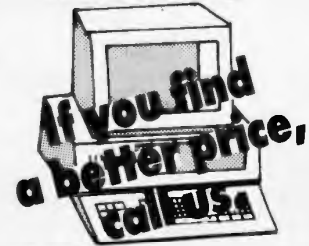
PFS:WRITE'S CAPABILITIES

The benefits of pfs:Write are many. The main advantage is its overall ease of operation. I get the feeling the developers set out to make the package as simple to use as possible. (What a novel approach.) For instance, this program's main menu really is self-explanatory; it offers six choices: Type/Edit, Define Page, Print, Get/Save/Remove, Clear, and Exit. Pfs:Write's Define Page menu lets users make formatting changes other than the default values. With this selector, you can set the margins (top, bottom, right, left), specify page length, put in headers and footers (up to two lines each), and have Write automatically insert the page numbers for you. There are some tradeoffs, however, such as the program's assuming that any number found in a footer is a page number. If you need to have the footer act as a footnote, you're out of luck.

Pfs:Write does a good job of automatically reformatting text when you change parameters through its Define Page feature. You can decide you want your material to be squashed down to a narrow column instead of given the space of a full-width page. With the Print menu you can set print parameters; cause the program to merge other documents, such as VisiCalc (as long as they have been printed to a disk file); and create a text file by printing to a disk. The Print function also enables you to add graphs from pfs:Write's fellow program, pfs:Report, if the material has been saved as a picture file. You can print an entire document, one or many pages, space your material, print envelopes from the addresses in your letters, change the position of your text on the paper, and print the document to almost any printer that you can con-

(continued)

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nect to your machine.

With the Print function, you can print more than one copy of your material. To take advantage of any of these features, or those from any other of this program's menus, however, you have to reprogram your thinking to use the Tab and F10 keys instead of the cursor and Enter keys.

More pluses for pfs:Write's Print mode include the ability to insert a command for special characters (such as italics or any others your printer will support), utilize more than one printer, pause between pages, and stop the print function at any stage simply by pressing the space bar (supposedly). When I tried this clever little "stop print" feature,

however, my printer kept on humming along.

Appending is exceptionally easy. Simply enter the command at the location in your working copy where the joined document is to appear, and pfs:Write makes it happen when you print it out.

The Get command works approximately the same way as the Save feature. Pfs:Write makes a working copy of your document so changes affect the backup instead of the original. The Remove command provides an exceptionally easy way to permanently erase a document or other on-disk file. But there is no going back, no undoing, no changing your mind. If you don't have a backup copy and you command the program to erase your copy, you'd better have some Valium or a stiff drink handy.

When I crank up pfs:Write, I like what I see on my screen. At the bottom, I see a ruler with decimal and text tabs, line and page numbers, amount of memory space left, cursor position, places for special editing functions, error messages, and special enhancements, such as Insert or Label. The program also tells me when I am in "working copy" mode and how to get to the help screen (F1).

The package's Insert function is fundamental and acceptable. The program's developers should get an award for the uncomplicated "labeling" method of changing, deleting, moving, removing, and copying blocks of text. Function keys are used for moving around in the text when you label (highlight) the areas you want to change. The Search function works only in forward gear, but the Search/Replace function (either manually or automatically) is almost sinfully simple.

The program creates standard ASCII files, supports a hard disk, several new machines (the IBM XT for one), DOS 2.0, and shows on-screen the location of page breaks (with cursor move only, not with page-up or page-down moves). A minimum of one disk drive and 128K bytes is necessary to run pfs:Write.

PFS:WRITE'S LIABILITIES

Even though the program is inexpensive and the manufacturer provides one backup, the fact that pfs:Write is copy-protected is inexcusable.

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Although the documentation summaries are good, the documentation itself (including the on-screen tutorials) leaves much to be desired. Yes, you can make a copy of "Sample," the on-screen tutorial, but who wants to? The tutorial teaches you about price lists before it even mentions cursor moves, and pfs:Write cursor moves aren't all that easy. In the book, the program's features are arranged from advanced to easy. Why? I found the material about form letters especially confusing. What should be elementary explanations are not. But the biggest problem I have with this pleasantly small, handy (not dandy) guide is that when I am searching for something, anything, the pages continually manage to get out of the spiral binding. Reinserting them is next to impossible. Thus I have a desk full of individual manual pages for this program.

To move the cursor more than one character at a time, it helps to have memorized the function keys. To move the cursor within a menu requires the use of the Tab key. The manufacturer provides a cheap cardboard template; when I tried to apply it over my function keys, it immediately tore.

The Get and Save portions of pfs:Write's Get/Save/Remove function aren't all they're cracked up to be. For a program with lots of built-in comfort, pfs:Write could excel here, but it doesn't.

Having to return to the main menu, push #4, type in the name of the document you're working on, and then press F10 is not only a huge waste of time but a sure exercise in how to forget what you were working on before you started into this process in futility. Then you have to reverse the procedure to get back into your document, consuming another few plodding minutes.

Pfs:Write's multiple-step Save procedure includes a sentence, "document about to be overwritten," each time you write the material to disk. "Press Escape to abandon this operation or F10 to continue." Sounds safe, eh? Wrong. To find out how safe it is, I pressed F10 in a couple of instances and instantly lost two hours' worth of data. After working with this problem, I concluded that the use of the term "overwritten" is questionable. Evidently, for some reason, the program doesn't always save newly entered material.

I got an additional dose of insecurity

when I twice lost some copy after pressing F10 to continue in the printing operation (instead of pressing Escape to "abandon this operation") and the program trashed my prose.

Since I have a penchant for doing funky things to formatting defaults, I found it extremely frustrating not to be able to permanently change them in pfs:Write. And the program operates in Strikeover mode when my personal preference is Insert, but since this program's Insert mode is simple to get into and out of, I adjusted fairly quickly.

Deleting is not easy with pfs:Write, especially in Command mode. There is a destructive backspace, but you have to remember to go past the last character to activate it. And deleting forward is jerky and sporadic. Right justification, boldface print, and underlining can be done after the fact—one line or word at a time. With the Shift and a function key, these enhancements eventually do happen. But not without effort.

Although pfs:Write came out in my benchmarks about average in all four tests, I found you can add another year or two to your life during the time it takes to save material.

Several other "couldn'ts" include not being able to get pfs:Write to append files from other ASCII programs (it's supposed to do this); alternate the placement of page numbers or headers and footers; copy columns (it's supposed to be able to do this); save large deletions in order to move them; change formats within a document; and keep the original format of the file being appended to or merged with the pfs:Write file.

Updates are available for less than the package's original price, but at this writing, a toll-free user hotline is not in operation.

Nevertheless, in spite of (or maybe because of) pfs:Write's developers' persistence in retaining its KISS (keep it simple)

(continued)

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AT A GLANCE

Name

MultiMate 3.20

Type

Word-processing program

ManufacturerMultiMate International Corp.
52 Oakland Ave. North
East Hartford, CT 06108
(800) 243-4646**Price**

\$495

FormatThree 5¼-inch floppy disks: boot/system,
utility, and speller/dictionary**Language**

Assembly

Computer

IBM Personal Computer (as reviewed)

Documentation469-page padded manual, reference card,
templates, and key labels**Audience**Sophisticated word-processing users who
want a Wang-like package with spelling-
checker capability

ple, stupid) policy, this firm has assured itself a permanent and unique place in the word-processing marathon. When Software Publishing or another company fixes this program's faults while keeping its assets, we'll really have something.

MULTIMATE—VERSION 3.20

MultiMate International Corporation's efforts to "modernize" its program have resulted in a good news/bad news effect. Now MultiMate is safer—the safest package of the five I compared; but it's also klunky—the klunkiest package of the five I tested. Would that the company had concentrated on reducing the number of steps required to use each of the program's handy features instead of providing so many safety backups of safety backups.

The consensus is that this Wang-like program has a multitude of benefits and a multitude of sins to contend with. And my investigation bears out this opinion. Wangs are known for their heavy use of dedicated keys for cutting and pasting, canceling, entering, etc.; MultiMate seems to have patterned part of its program around this concept.

MULTIMATE'S CAPABILITIES

MultiMate's documentation actually starts with what you need to begin; this marks a beatific trend I hope catches on. As soon as I got over the shock of it all, I realized it takes 192K bytes (256K bytes with DOS 2.0 or 2.1) to begin. So I went to the memory store and hiked up my memory past what MultiMate says is necessary.

It takes three disks—the DOS/boot/system disk, the utility disk, and the speller/dictionary disk—to do all of what MultiMate provides. Essentially, the DOS disk gets things up and running and does the major portion of the tasking. The utility disk handles the responsibilities of converting to standard ASCII files and recovering lost data or missing format lines. The speller/dictionary (accessed from the main menu) is self-explanatory and works satisfactorily.

The program is easy to install; the documentation has good basic directions. And typing *wp* to boot the system is a grand way to enter. Would that we could start them all this easily.

This package has good walk-through screens—many of them. My impression

of MultiMate's numerous help screens is that they are too numerous, and even with a chart in the manual, confusion reigns. It would have been easy and wonderfully clear had the developer simply put the key or keystroke combinations in boldface type followed by the explanation for each. For some reason, quick reference charts are few and far between. Why? Because MultiMate didn't do this, I did my own and found that within 15 minutes I had the most-used functions down pat. A template that does this is available from the company for \$6.95.

MultiMate's status line displays the document name, page, line, and column number. Its format line indicates the current line length, line spacing, and tab settings. It also puts an on/off sign on-screen to remind the user of the status of the Shift and Numlock. I had problems with the page-length parameter. This program sets a limit of 150 lines per page, but just try to get it to actualize this promise.

Defaults are easy to change. And the information this program's documentation offers the user is helpful and appreciated. Novices, however, might find the going a bit tough at first since the jargon in the manual is pretty intense and assumes everyone is familiar with word processing.

MultiMate has several points in its favor. Besides being very safe, it lets you customize the program both with its standard utility and its easy-to-use PAT (printer action table) functions. MultiMate is politely sparse with its error messages, too, and hurls them at you only when you've done a no-no.

MultiMate's ability to work with vertical and horizontal columns (including calculations) is a bonus. Unfortunately, moving the vertical columns doesn't always turn out new, perfectly aligned material.

This program handles formatting chores as if it were made to serve. Centering, underlining, boldfacing, justification, spooling, continuous automatic reformatting, visual page breaks, and getting back and forth between menus all are easily dealt with. Tabs, margins, hyphens (hard and soft), and line spacing are simple.

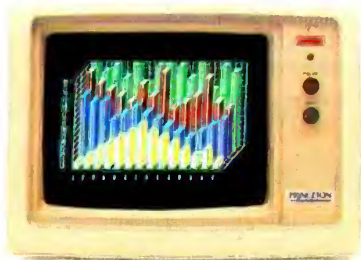
MultiMate has a vehicle (its library) that enables the user to create macros

(continued)



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for often-used words, phrases, strings, and other information the operator desires to call up at the press of a key. Although the program's speed has suffered since its developers reinforced its safety level, it came out as fastest in my save-document benchmark test.

At this writing, MultiMate International is shipping an update, version 3.3. Because of deadlines, I was unable to review this latest revision. According to the company, 3.3 incorporates faster screen refreshing, microjustification, an on-disk tutorial with an instruction booklet, and the optional capacity for the user to utilize ellipses for visible spaces when desired.

MultiMate handles moving, deleting, and copying with highlighting; headers and automatic page numbers are supported with little problem. There are some deficiencies in this area, however, and they will be noted under the section on liabilities.

The package supports a host of printers and is hard-disk compatible. The program is not copy-protected, and free updates are available for six months. Thereafter, they can be obtained for a reduced price.

The biggest bonus MultiMate has is its pool of knowledgeable, polite, and patient support people at the far end of a toll-free number (800-243-4646). It may take you a year or two to get through the busy signals, though, and even when you do manage to break into the hotline, you may end up on hold for another decade or two.

MULTIMATE'S LIABILITIES

MultiMate's many hitches and glitches all combine to make it the most awkward package of all I tested. Now I can really relate to the theory that the sum of the parts equals more than the whole. Just naming a document with MultiMate is a chore if you take the manual's reserved character list as gospel. The symbol #, for instance, can't be used in the naming process, although I couldn't find information anywhere that mentioned that.

In the benchmarks, MultiMate came out last in speed of both searching and scrolling to the end of the document. Searching and highlighting can be done only in the forward mode.

Shortly after entering the program, my disappointment level rising, I compre-

hended that MultiMate's documentation had neglected to mention adjusting the contrast in order to see the highlighting so necessary to operation. Additionally, the manual takes up the subject of merging before it teaches basic editing functions.

Cursor control is difficult with MultiMate. Often the keystroke combinations designated to move the cursor around chunk by chunk don't do so. Sometimes Ctrl+End put me at the end of the text, sometimes at the end of the line.

The destructive backspace is slow, shaky, and tenuous, as if it doesn't intend to obey. If you want to change the default and permanently operate in the Insert mode, select another word-processing package. And don't try to tab over if you already have text on-screen.

When changing MultiMate files to ASCII and back again, I saw my copy turned into gibberish. During my investigation, I discovered that although this package lets users insert as many formatting changes as desired into a document, operators can "indent" (indent each line below the first paragraph line) or enumerate paragraphs (automatically number each succeeding section) only by doing it manually. With a package this powerful, why?

Although I understand MultiMate is coming out with an improvement, the spelling checker that came with my version had inherent in it so many gremlins, I never could get it to do anything worthwhile. It caused me nothing but problems.

The manual promotes MultiMate's shadow print, boldfaced, and draft print, but I had problems with these enhancements until a kind voice in the 800 nether-nether land explained that the program has an IBM bug in this area. He gave me detailed instructions as to how to subvert this and eventually I did manage. MultiMate does not do footnotes.

I started out with high hopes for MultiMate, but its disadvantages outweighed its great benefits. Too bad. The program has incredible potential.

FINALWORD—VERSION 1.16

Until recently, FinalWord was almost alone in its ability to index documents. Now there are others that have this capability, including PeachText, Samna,

(continued)

AT A GLANCE

Name

FinalWord 1.16

Type

Word-processing program

Manufacturer

Mark of the Unicorn
222 Third St.
Cambridge, MA 02142
(617) 576-2760

Price

\$300

Format

Two 5¼-inch floppy disks

Language

C (user-configurable but cannot be customized)

Computer

IBM Personal Computer (as reviewed)

Documentation

Hard-cover manual, approximately 300 pages (manual not completed at time of this writing)

Audience

Basic to advanced word-processing users, especially those who need sophisticated features such as the ability to create long documents, tables of contents, and indexes

Edix, and WordStar's StarIndex.

I have used FinalWord for well over a year now, but I haven't even touched its full range of features. Because I use it and rely on it, I have a strong love/hate relationship with it. For my purposes, its talents are exceptional and well worth the massive effort it took to learn it and get through its dozens of eccentricities.

The most recent revision of FinalWord consists of improved documentation, badly needed and a long time coming. Version 1.16's upgrades include the ability to wrap footnotes, produce unlimited end notes, support the new DEC (Digital Equipment Corporation) printers, and create foreign characters on the IBM PC. I prefer less bureaucracy in this program's handling of its swap file and buffer functions.

It's hard to believe, but the operation of this extremely powerful, sophisticated program requires only 64K bytes with DOS 1.1 and 128K bytes with DOS 2.0. FinalWord's capabilities are comparable to or greater than those of the other programs I tested, and the program uses less memory than most of them unless you use its indexing skills, which means you'll have to upgrade in a serious way.

This program's developers promote its safety with a swap file you can put data into and take out of with abandon, and buffers that hold editing changes like little pockets you can stuff with goodies. But because of some flaws in these functions, my experience with FinalWord hasn't been reassuring.

Mark of the Unicorn says it has repaired these irregularities. But since I can't go back and use the "nix fix" in the situation where I lost four days' worth of text (and FinalWord duplicated the tragedy on the backup disk), I can't swear to the perfection of the revised edition or the efficiency of the debug program.

Nevertheless, because of FinalWord's

advanced (by an order of magnitude) formatting talents, I rate it extraordinarily high in performance for users who need to be able to do esoteric formatting chores. I also recommend it for people who produce extremely long and complex documents and need to be able to create indexes and tables of contents.

FINALWORD'S CAPABILITIES

There are many, but I'll start with its versatility in letting users move the cursor from place to place with the Cntrl and arrow keys. I give FinalWord a solid A here. Moving, copying, and deleting blocks of text are tasks this package performs with speed and efficiency.

To its credit, this program isn't copy-protected. Generally speaking, Mark of the Unicorn offers free updates and fairly comprehensive documentation—especially in version 1.16.

It's possible FinalWord was a pioneer with advanced features, such as its Default Insert mode, windows, highlighting, replace functions, and mnemonic commands. Its abilities, too, in the areas of footnoting; headers and footers; "state-save"; use of the IBM function keys; text movement from one file to another while displaying both documents on-screen; and numbering system for pages, blocks of copy, footnotes, and chapters, are greatly appreciated by those who have used them.

Creation of ASCII files, spooling, user-definable keys, optional help screens, and microjustification and proportional spacing on printers that support these features all are important. But its advanced formatting capabilities are the hub around which FinalWord's reputation has been built.

Suppose you want to write poetry or produce a document (or part of one) with automatically numbered paragraphs. Suppose you want to change the formatting style numerous times

within your text. Suppose you want to do some wondrous, aesthetic things with your material. FinalWord provides these and dozens of other advanced formatting functions.

The program lets you automatically underline words and spaces or just text; utilize sub- and superscript characters or boldfaced print; center, double-space, or justify text; set line length and bottom and top margins; alternate page numbers or headers and footers; and cross-reference material. There isn't much in the way of enhanced formatting or printing that FinalWord can't carry out for you.

FINALWORD'S LIABILITIES

There are, however, some basic and elementary tasks that FinalWord's developers have either overlooked or deemed low-priority items.

From my office, Mark of the Unicorn's support number is a local telephone call—fortunately. During my learning curve, I literally spent hours on the phone with the company's technical people. At that time, they were neither knowledgeable nor patient. That situation has improved, but a toll-free number has yet to be instituted.

FinalWord cannot handle columnar material (either text or numbers), horizontal scrolling, automatic hyphenation, or continuous reformatting tasks. Although the program came out ahead in the "scroll to end of document" benchmark, it is terminally slow in its preprinting sequential-paging mode.

You don't see what you get with FinalWord except with its View Screen command, which whips by so fast it's almost worthless. Because this package performs so many advanced functions, not being able to see what you have done (or want to do) is a serious drawback.

FinalWord's most frustrating characteristic is its habit of beeping and putting up error messages at the press of a key. A great deal of the time, too, the machine totally hangs up, either from an incorrect combination of keystrokes or just plain orneriness. Literally hundreds of times, in order to get FinalWord to accomplish a task, I have had to switch off my system, turn to another job, then return later and begin all over again.

FinalWord is a very powerful package.
(continued)

Table 1: Benchmark results for the word-processing programs reviewed. All times are in seconds.

	FinalWord	WordStar	Word	pfs:Write	MultiMate
Load document	11.9	9.9	8.9	9.6	9.3
Save document	71.0	31.66	42.6	20.1	3.9
Search document	10.4	12.43	15.1	13.5	42.1
Scroll to end of document	45.8	30.76	39.0	65.0	104.0

Table 2: An evaluation of features and performance.

Name	FinalWord (Version 1.16)	pfs:Write (Version 1.1)	WordStar (Version 3.32)	MultiMate (Version 3.20)	Word (Version 1.1/2.0)
Price	\$300	\$140	\$495	\$495	\$375; \$475 with mouse
Hardware Configuration	64K, two 5¼-inch single-sided floppy-disk drives or 300K capability and printer	128K, one single-sided drive	64K minimum, two floppy-disk drives recommended, but one drive is practicable if WordStar is already installed	192K with one double-sided drive (DOS 1.1); 256K with two double-sided drives (DOS 2.0/2.1)	128K, one double-sided disk drive (mouse optional)
Maximum Number of Characters Directly Manipulable	varies according to disk size and user-set size of swap file	largest document, 32,000 characters	files up to 8 megabytes, depending on storage capacity	128K in document; each page 6K long	varies according to disk size
Command Structure	control keystrokes organized by three-level menus, user-definable function-key support	menu-driven with function keys	command-driven, but uses function keys	mainly menu-driven with a few keystroke commands	command mode, line-structure oriented
On-line Help?	yes; optional command menus at top of screen accessed by keystroke commands	yes; through function keys and info screens	yes; four levels of help from no help to maximum help (user can specify level)	yes; while editing, hit Shift and F1, and from main menu	yes; 50-page text on-screen Help screens
Longest Line Length	65,535 characters (no horizontal scrolling)	79 columns	256 characters	156 characters	22 inches horizontally and vertically
Use of IBM PC Function Keys	optional; use of Alt, Shift, Cntrl, and assignable keys	extensive	yes; mainly as user-definable macros for WordStar functions	strong use of function keys; combinations of Cntrl, Alt, and Shift (40 options)	minimal; used specifically to jump from window to window and for selection of text
Insertion of Nonprinting ASCII Control Characters?	yes	yes	yes, i.e., phantom spacing	no	yes
Formatting Scheme	both on-screen and embedded command formatting possible	mostly through Define Page and through Type/Edit	through Cntrl commands, formats on screen	mainly format lines placed in document page (text)	on-screen and through style sheets
Print While Editing?	yes	product spools through printer card but not via product itself except file by file	yes	yes; background capabilities	yes; has queuing capability
Change Default Parameters? How?	yes; through menu-driven configuration program	no	yes; through its install program	yes; through menus	yes; via various menus or special key codes
Automatic Formatting Capabilities?	extensive and complex capabilities through embedded commands	yes; in Type/Edit	some; user can change margins	yes; some	alternating headers and footers
Change from Single- to Double-Spacing?	yes; through formatting "style" function	yes; at print time	yes; .DOT commands	yes; by search and replace of format lines	yes; via command menu or Alt key code
Can Text Be Searched for Printing Attributes?	yes	yes	yes	yes	no
Features of Disk-File Format	in 1.16, users have option to use full 8-bit characters covering entire PC character set, or users can stick to 7-bit characters and use the eighth bit for on-screen highlighting	DOS to format disk	n.a.	nonstandard file format with conversion utility to create standard ASCII files	can automatically save files in ASCII format
Reviewer's Assessment	I like this program's features slightly more than I dislike its limitations	I like this program slightly more than I dislike it	I like this program much more than I dislike it	I dislike this program slightly more than I like it	I dislike this program's features more than I like its benefits

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WORD PROCESSING

but it's extremely hard to learn and operate. However, your hefty investment in time and frustration will pay off handsomely, and you'll enjoy its sophisticated subtleties and considerable capabilities.

A ROUNDUP

These five programs appear to balance out in basic benefits and disadvantages. I wouldn't rate any of them unacceptable. Nor would I rate any of them way above the rest.

Particular features I like in WordStar are its compatibility with other programs, its capability to do just about anything you need a word processor to do, and the inherent integrity its developers adhere to in delivering on its promises to the user.

Advantages I appreciate most in pfs: Write include its built-in simplicity and its utility as a basic word-processing program.

Microsoft Word garners some favor because it is paving the way in flexibility. Microsoft's pioneering efforts may be the beginning of a whole different way for people to use word processors. MultiMate rates high in the areas of security and user support (through its toll-free user hotline).

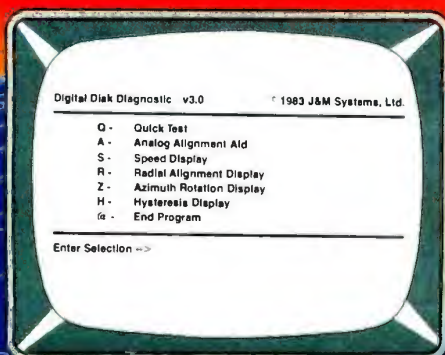
Advanced formatting capabilities distinguish FinalWord. Even with all the recent enhancements to other word-processing programs, FinalWord still ranks high as one of the most able handlers of text-processing tasks.

Certainly, how much an individual likes or dislikes any word processor depends on the application for which it is used. At the moment, there is no ideal or near-ideal word-processing program to be had. As there is no camera that suits the majority of photographers, there probably never will be any software that fills most people's word-processing needs.

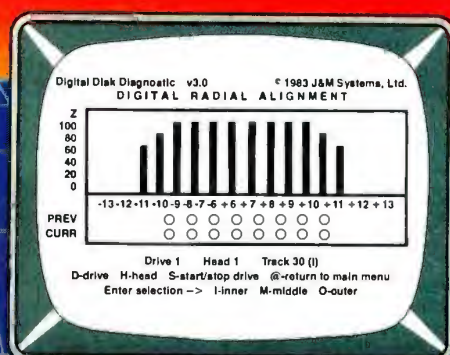
Along with many other word-processor users, I believe that some firm could make a serious financial killing were it to delete the disadvantages of these five programs and combine the benefits. My kudos will go to the developer who creates a word processor that has the ease of pfs:Write, the safety of MultiMate, the formatting capabilities of FinalWord, the flexibility of Microsoft Word, and the compatibility of WordStar. ■

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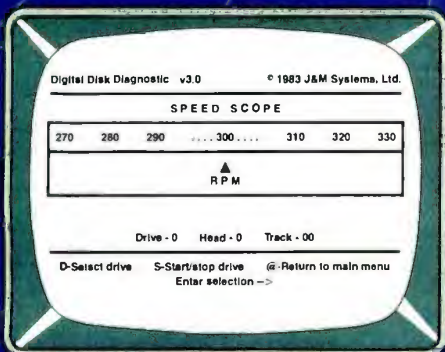
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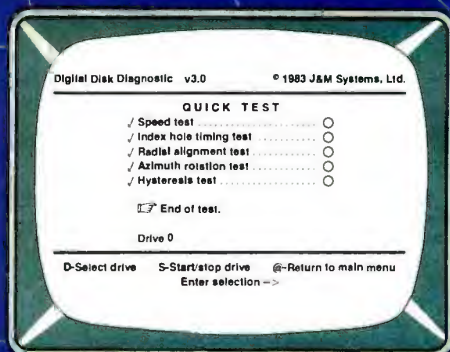
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UPDATE ON SIX DATABASE MANAGERS

*A comparison of six popular DBMSs
for the IBM PC*



ILLUSTRATION BY JACQUELINE CHWAST

BY DAVID KRUGLINSKI

In 1981, no more than half a dozen software packages purported to be database management systems (DBMSs). Most of these ran under CP/M, then considered to be the universal standard for microcomputer operating systems. Then came the IBM PC, a pathetic little thing at first, with one single-sided disk drive, 64K bytes of memory, a weird keyboard, and no printer port. BASIC and a slow version of WordStar were the only software available. "This is a waste," I thought. "I'll stick to my CP/M machines."

Now, just three years later, the old machines are out the door, and I am contemplating getting a *second* hard-disk PC. Why the switch? Recently, one magazine's annual software review listed 115 DBMSs (surely there are 150 by now),

all running on the IBM PC and compatible machines. Each DBMS has its own personality, however, and the one you choose should match both the job to be done and your staff's skills. Because DBMS projects can require a few hours or several person-years, choosing the wrong program can be very expensive. Therefore, the more you know about DBMSs, the better equipped you will be to choose the right software for your data-management task.

This article describes six popular DBMS packages in three categories. Pfs: file/pfs:report and C.I.P. fall into the "entry-level" class, requiring minimum

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skills and expense. Condor 3 and R:base 4000 are "programmerless" DBMSs with more power than the first group. dBASE II and KnowledgeMan are complete programming environments that require a skilled programmer for setup, but permit clerical workers to do data entry and retrieval.

COMMON DBMS FEATURES

Any DBMS application could be programmed from scratch. DBMS software just makes development easier and faster, and it makes the resulting system

more flexible and expandable.

The DBMS's window to the world is the PC's screen. Figure 1 shows how the owner of a computer bookstore would set up the screen for an inventory system. Each title is represented by one record, and the information within the record is represented by fields such as PUBLISHER and CATALOG.NUMBER. All the records for all the titles are known collectively as a file. A group of files forms a database. Some DBMS publishers use different terms, but the concepts are the same. The list of all

fields in a record, along with their names and characteristics, is known as the data dictionary (table 1). The data dictionary contains more information than is apparent from looking at the screen.

Once you have defined the screen and data dictionary, you can enter, view, and update data on the screen, as shown in figure 2. You can also print a report, either to the screen or to the printer, as shown in table 2. The DBMS allows you to select the fields to be printed, the records to be printed, and the sort order. You could, for example, print only those titles with a retail price over \$10.

Both reporting and screen viewing can be classified as a query—a question about the data in the file. The report is an example of tabular query output. If the useful data in a record exceeds 80 or 132 columns, then a full-screen query is necessary. You could, for instance, ask to see books costing more than \$10, then have the DBMS display those records one screen at a time.

Basically, this is how all DBMSs work. You build the screen and data dictionary, enter the data, and print the reports.

DIFFERENCES AMONG DBMSs

Despite the similarities among DBMSs, each system has a unique set of capabilities. Here are some ways in which they differ.

Limitations. Some DBMSs impose severe restrictions on field length, record length, and number of fields per record. These limitations are obvious from the specifications outlined in table

—Book Inventory Record—	
PUBLISHER ____	CATALOG.NUMBER ____
TITLE ____	
RETAIL.PRICE ____	REORDER.POINT ____
QUANTITY.ON.HAND ____	YTD.QUANTITY.SOLD ____
SALES.DOLLARS ____	QUANTITY.SOLD ____

Figure 1: Setting up a DBMS input screen.

Table 1: A typical DBMS data dictionary.

Field	Type	Length	Low Limit	High Limit
PUBLISHER:	Alphanumeric	3 chars		
CATALOG.NUMBER:	Numeric	4 digits	0	9999
TITLE:	Alphanumeric	30 chars		
RETAIL.PRICE:	Dollars	5 places	0.00	99.99
REORDER.POINT:	Numeric	4 digits	0	9999
QUANTITY.ON.HAND:	Numeric	4 digits	0	9999
YTD.QUANTITY.SOLD:	Numeric	5 digits	0	99999
SALES.DOLLARS:	Dollars	8 places	0.00	99999.99
QUANTITY.SOLD:	Numeric	4 digits	0	9999

Systems Reviewed

dBASE II

Ashton-Tate
10150 W. Jefferson Blvd.
Culver City, CA 90230
(800) 437-4329
(213) 204-5570

Condor 3

Condor Computer Corporation
2051 S. State St.
Ann Arbor, MI 48104
(313) 769-3988

C.I.P.

Concentric Data Systems Inc.
18 Lyman St.
Westboro, MA 01581
(800) 325-9035
(617) 366-1122

KnowledgeMan

Micro Data Base Systems Inc.
POB 248
Lafayette, IN 47902
(317) 463-2581

pfs:file/pfs:report

Software Publishing Corp.
1901 Landings Dr.
Mountain View, CA 94043
(415) 962-8910

R:base 4000

Microrim Inc.
3380 146th Pl., SE
Bellevue, WA 98007
(206) 641-6619

3. If you need 60-character product descriptions and a DBMS allows only 50 characters per record, you can eliminate that program.

Single vs. multifile. Suppose you have a file of company addresses and a file of product descriptions, one field of which contains the company name. A single-file DBMS lets you view and list the companies, then it lets you view and list the products. A multifile DBMS allows you to associate the two files based on company name. When the program needs the company name in the product file, it then goes to the company file to find its address. You can then print a list of products with company addresses. Despite this advantage, multifile DBMSs are more expensive and more difficult to learn than single-file systems. Remember that single-file programs cover a surprisingly large range of applications, so it might be easier and cheaper for you to combine

the company and product information in one file, even though it means duplicating addresses of companies offering more than one product.

One group of multifile DBMSs are referred to as relational systems. This means that files, known as relations, conform to a mathematical model so that certain relational operations can take place. This is a kind of electronic cut-and-paste allowing new relations to be created from existing relations. For example, if a company name is joined with a product name, the resulting relation contains a record for each company-product combination. Some relational DBMSs create a new physical file for each operation; others create a virtual file, thereby saving disk space and reducing redundancy.

Screen design. Each DBMS uses a different method for screen design. Sometimes you design the screen before the data dictionary, and some-

times you design the data dictionary first. Most packages let you design the screen as though you were using a word processor.

Query method. Here you find the biggest difference among DBMS products. Early DBMSs developed their own *ad hoc* query languages. For example, you could type

```
LIST CATALOG.NO, TITLE, PRICE
WHERE PRICE > 10 SORTED BY
CATALOG.NO.
```

This adapts to both tabular queries and full-screen queries. Query languages have been formalized by an IBM-developed standard called SQL (structured query language). SQL allows queries on multiple files, and it allows for subtotals and page headings. SQL and most other query "languages" require you to know the exact names of the fields and relations in the database.

Another query method, QBE (query by example), also comes from the IBM mainframe world. This is a wonderfully easy to use and useful system; unfortunately, it is not included in many DBMSs. Figure 3 shows an example. A real estate agent has asked to see all Sunnyvale listings with three or more bedrooms and costing less than \$130,000. The agent can run through the retrieved listings, using the same screen used for entering and updating those records. With a QBE system, you just move through the screen, filling in the blanks with conditions, all of which must be met for the selection to be displayed.

A new query method depends on advances in AI (artificial intelligence). The query language is English (or, presumably, French if you live in France), resulting in sentences like

LIST THE SALESPeOPLE AND
THEIR SALARIES

followed by

JUST THE ONES IN CALIFORNIA

An AI query language can handle multiple files and can look at the data within those files to make sense out of inquiries. The system will ask questions about words it does not understand and

(continued)

—Book Inventory Record—			
PUBLISHER	BYT	CATALOG.NUMBER	960
TITLE	Garcia's Circuit Cellar	REORDER.POINT	50
RETAIL.PRICE	8.00	YTD.QUANTITY.SOLD	30
QUANTITY.ON.HAND	25	QUANTITY.SOLD	15
SALES.DOLLARS	240.00		

Option: Revise (R), Delete (D), No Change (N), End (E) (save as shown)

Figure 2: Editing data using a formatted screen.

Table 2: A typical DBMS report or tabular query.

04/15/82 COMPUTER BOOK PRICE LIST Page 1			
PUBLISHER	CATALOG.NUMBER	TITLE	RETAIL.PRICE
BYT	960	Garcia's Circuit Cellar	8.00
BYT	1040	Layman's Guide to SBC's	10.00
BYT	4925	You Just Bought a Personal What	11.95
BYT	6745	Beginner's Gde to UCSD Pascal	11.95
BYT	8360	Threaded Interpreted Languages	18.95
OSB	1988	PET/IBM Personal Computer Guide	15.00
OSB	8806	Some Common BASIC Programs	14.99
OSB	8821	Z80 Assembly Language Prgrmg	16.99
OSB	8828	Running Wild	3.95
OSB	8844	CP/M User Guide	12.99
OSB	8847	Business Systems Buyers Guide	15.00

remember the answers for later queries. AI is very new and has not been proved in the marketplace. The major question concerning the use of AI is whether queries can be phrased precisely enough.

Ease of Change. If you are just start-

ing a new DBMS application, you will make mistakes. For instance, you might allow five numeric digits for a zip code, then be faced with a Canadian address containing a six-letter postal code. You must be able to restructure the file, changing the field characteristics and

length, but preserving the already-entered data.

Report Generator. A query language produces tabular lists, but it does not exercise enough control over the output format. Most DBMSs have a special module for producing fancy reports with page headings, group headings, subtotals, computed fields, and page footings. Some DBMSs allow you to lay out the report on the screen, using horizontal scrolling for 132-column reports. Others have a special language to describe the report format.

Import/Export. If you are starting a DBMS system, you might need to use data from an existing program. The DBMS should allow input of a variety of data formats produced by BASIC and COBOL programs and other DBMSs. It is also becoming more and more important to transfer data to (export) and from (import) spreadsheets and word processors. Common formats are delimited ASCII (BASIC), fielded ASCII (COBOL), DIF (VisiCalc, Lotus 1-2-3), and SYLK (Multiplan).

```

QUERY: ESC executes. CTRL C aborts.
F10 clears all. F1 for help.

** I: listings file**

listing number: |      |
address: |      | listed: |      |
city: |Sunnyvale | sold: |      |

footage bedrooms baths lotsize corner schools
|>=3|
asking price: |<130000| sale price: |
listing notes: |
|
|
listing agent: |      | agent number: 0
address:
city:
phone:
zip:
salary: $0.00
rating:
    
```

Figure 3: A query-by-example (QBE) screen.

Table 3: DBMS benchmarks for performance.

Version	Condor 3 2.11	dBASE II 2.4A	R:base 4000 1.10	KnowledgeMan 1.06	C.I.P 1A	pfs:file pfs:report
Sort time	18 min	2 hr. 15 min	25 min	27 min		
Sequential pass (using index)	1 min. 16 sec	1 min. 39 sec	1 min. 30 sec	4 min. 30 sec		
Index build	1 hr. 3 min	12 min. 16 sec	16 min	14 min. 27 sec	35 min	
Join (using index)	1 min. 40 sec	31 min	5 min. 34 sec	8 min	1 hr. 5 min	
Query method	SELECT command	LIST command	artificial intelligence	QRS multifile	menu	QBE
Report generator	80-column screen- oriented	REPQRT command + program mode	132-column screen oriented	QRS + program mode	menu	QBE select column def
Passwords	no	no	file	file + field	no	no
Special features	POST for account- ing transactions	screen painter training disks	flexible "rules" for data entry	spreadsheet	132-column	keyword search
Export/import files	delimited, fixed	delimited, fixed (DIF w/program)	DIF, SYLK delimited	DIF, delimited	DIF, delimited pfs in	ASCII out
Change field length	difficult	moderate	difficult	easy	easy	easy
Copy protect	no	APPEND command	unload/reload	REDEFINE command		
Max records/file	65534	no	no	no	yes	yes
Max characters/record	1024	65535	unlimited	65535	65000	
Max fields/record	127	1000	1530	65535	2000	
Max characters/field	127	32	400	255	40	
Numeric digits	10/18	254	1500	65535	50	
Date field	yes	10	9/16	14	12	
Memory requirements	yes	no	yes	no	yes	
List price	64K/128K \$650	128K \$495	256K \$495 \$195 CLOUT \$150 xtended report	192K \$500 \$100 kpaint \$225 kgraph	128K/192K \$395	64K/128K \$140 pfs:file \$125 pfs:report

Copy Protection. If you use a hard disk, you will be irritated by copy-protection schemes that make you load a special floppy disk for each protected program you run. Ironically, the most expensive DBMS programs are the least likely to be copy protected.

Password Protection. The newer DBMSs provide ways to protect individual files and even fields from unauthorized access and update. This feature is especially useful with hard disks.

Special Features. Some DBMSs have unique features such as built-in spreadsheets and training aids. Help screens, once rare, are now commonplace.

PERFORMANCE

As you would expect, DBMSs vary widely in performance. Table 3 presents some benchmark data for five of the six DBMSs. The main test file contained 5011 115-character records, and the secondary file contained 6233 27-character records. The benchmarks, run on a hard disk, involved sorting, indexing, and searching the main file and joining six main-file records with the secondary file. Pfs:file was excluded because it does not allow data import.

To understand the performance differences, you must understand indexes. An index is a disk-based data structure that allows quick access to a particular record in a file. If there is no index file, the DBMS must do a sequential pass to find the records for which you are looking. This is not as bad as it sounds, because sequential passes are very fast. For small files, it is sometimes better to forgo indexes because of the extra problems they create.

What is a "small file," and what problems do indexes create? A disk holds 360K bytes. Because there must be room for sorting and reorganizing, the largest practical file size is half a disk, or 180K bytes. Most DBMSs can sequentially search a floppy-disk-based 180K-byte file in a little more than a minute. If you can wait a minute, then 180K bytes is a small file. Indexed files provide instantaneous access if the query is made on a key field—one previously set up to be indexed. If a query is made on a nonkey field, it could take much longer than if the file were not indexed. You could index all the fields, but adding records would be slower. Also, some DBMSs do not allow you to

change the value of a key field. As a rule of thumb, don't use indexes unless you really need fast access.

Another choice you will have to make is whether to use a hard or a floppy disk. If you are really serious about data management for business, you will need a hard disk. Careful shopping can get you a complete IBM-compatible system with a 10-megabyte hard disk for less than \$3000. That's less than 8-bit floppy-disk-based systems cost in 1980. A hard disk will appear to run three times faster than a floppy disk, and it holds 30 times as much data. A hard disk also eliminates disk swapping and increases all-around dependability. All DBMSs do run with floppy disks, though, which gives you a chance to get started before committing to more expensive hardware.

Very few DBMSs do a proper job with deleted records. In most cases, if you delete a record, you will not be able to recover that disk space unless you perform a time-consuming reorganization. Reorganization time goes up with the number of indexes you use, and it is possible to get yourself into a jam if you do not have enough disk space to reorganize. Usually, if you delete a whole file, you can get the space back without reorganizing.

PFS:FILE/PFS:REPORT

Pfs:file from Software Publishing lets you do data entry and update, screen-oriented queries, and printed mailing labels, while pfs:report is necessary for tabular reports. They are generally used as a pair. What accounts for the spectacular success of these products? Probably because they're easy to use with the QBE query format.

Pfs:file combines data-dictionary definition and screen layout in one step. You simply move the cursor as necessary to type in a form. The tags become the field names. All the space between the tags is available for data entry, meaning that the program supports variable-length fields and records. In other words, you use only the disk space you need. For instance, "Reno" requires four characters, and "San Francisco" requires 13, so Reno will take up less space on the disk. You must, however, allow at least enough space for 13 characters on the form.

You can have several screens per record, and the last screen carries the label "ATTACHMENT" at the top left, allowing you to enter a full screen of text in a pseudo-word-processing mode with automatic word-wrap. If you insert

(continued)



Photo 1: PFS/File lets you enter data, update, and print mailing labels.

and delete words, you cannot expect the lower lines to be adjusted.

Pfs:report lets you define reports in a two-step process. First, a QBE select screen determines which records you will print. You use the same screen to specify which fields you will print and in what order. The program allows for headings, totals, subtotals, averages, counts, and page breaks. You must be careful with numeric data because pfs:file does not enforce numeric data entry. If you type "frog," the program converts the letters to a number and adds them into your total.

One special feature is the keyword field, which enables you to print multiple records for each individual word contained in that field. You could enter article abstracts, storing sequences of keywords in the first field. Then you could print a list of abstracts sorted by keyword.

The pfs products automatically index the first field of the record. Queries based on this field are instantaneous, but queries based on other fields are slower, depending on how deep the field is in the form. Deleted record space does appear to be reused. Both pfs:file and pfs:report are single-file systems, processing one file at a time and allowing no interaction between files. Reorganization is easy. All you have to do is keep the same tag names so that data in the new file comes across from the old. There is no provision for data import. Pfs:report does print to disk, however, allowing export to programs that can read fielded ASCII. Even though the disks are copy-protected, the programs do not require access to original disks after they are loaded to the hard disk.

You should use the pfs products if you want ease of use and if you don't mind waiting a minute or so to extract data from a large disk file. If you have very small disk files, you won't even notice the wait.

C.I.P: THE PUSH-BUTTON DBMS

C.I.P (Concentric Information Processor) from Concentric Data Systems is another single-file system that is easy to use and "visual." Because of the screen setup, a first-time user can be up and running in a matter of minutes. To choose from the menu, you just type

the first letter of the item or use the cursor keys.

File definition begins with the data dictionary, which allows you to specify the following:

- Length or "shape" of the fields
- Automatic field completion without Return key
- Field calculated from other fields
- Date
- Field must be full
- Key designation
- Numeric
- Required entry
- Key is unique
- Number of decimal places

You can then rearrange the data dictionary into a data-entry screen. This is a rather nifty visual process in which you drag field names and shapes around the screen à la Macintosh. Shapes are indicated by caterpillar-like strings of squares corresponding to field length.

C.I.P uses indexes and demands that at least one field be a key field. The trouble is that you can make full-screen queries only by using key fields. That means that you will have to do most of your querying via the report generator, which generates screen images that scroll up the screen instead of appear-

ing one at a time.

C.I.P handles report layouts the same way it handles screen layouts. You lay out the field shapes, headings, subtotal lines, and total lines on a scrolling 132-column screen. You have good control over numeric and data formatting, and you can highlight and right or left justify text. Since there is no query language as such, you must enter all record-selection criteria via the menu. This is awkward, but at least it is fool-proof. Wild-card matching is allowed, and you can select and sort reports by nonkey fields.

C.I.P's performance is a little disappointing. The six hours required to load the main test file did not bode well. C.I.P is, however, one of the few DBMSs that properly handle record deletions for indexed files. It uses a peculiar file structure that combines the indexes with the data and seems to do some compression. File sizes were smaller than I predicted by multiplying record quantity by record length.

Plan to use C.I.P when you need high-speed keyed access with frequent additions and deletions. The index system gives you quick access to ranges of key values. For instance, if you asked for "GREEN*," you would get all the last names beginning with GREEN, includ-



Photo 2: A first-time user can have C.I.P running in a matter of minutes.

ing GREENMAN, GREENWOOD, and so on. There is no need for a complete sequential pass here. Do not use C.I.P if you make frequent unstructured queries against nonkey fields.

CONDOR 3

Condor 3 has been around since the dawn of the microcomputer age, but it gets little recognition, even though DEC and Hewlett-Packard have endorsed it and it comes with the Seequa Chamelion. It is a stable, bug-free product whose performance specs are better than those of most of its competitors.

Condor is a full-blown relational DBMS designed to be set up and operated by nonprogrammers. The file-definition process starts with a screen that prompts you to define your field names. After you have "painted" the screen with the field names, Condor asks you for data-dictionary specifics that include field type (alpha, numeric, dollars, date), length, low limit, high limit, and default string. You can have only one screen per file, but the easy setup makes up for this restriction.

All of Condor's queries are two-step processes. First, in the SELECT process, you apply the record-selection criteria to create a new, temporary file. You can then list the new file, called RESULT, in

tabular form with specified fields, or you can view it in full-screen mode. You can either save the RESULT file or overwrite it with the next SELECT file. The UPDATE command allows you to edit a "live" file in full-screen mode.

The program also includes standard relational operators such as JOIN and PROJECT, and a COMPARE operator can subtract files. The POST operator totals transactions, adding them to a field in a master file or replacing an existing value there. This enables Condor to do accounting as well as information retrieval.

Condor allows command batch files, but the only commands available operate on entire files (relations). A batch file can request a variable from the keyboard and can set up a SELECT/LIST command pair, thereby automating queries.

One index per file is allowed, and you can create this index from a combination of several fields. The SELECT and UPDATE commands use this index automatically to reduce sequential passes through the file. For instance, you could quickly select all company names beginning with "Computer" with the command

```
SELECT COMPILE WHERE NAME IS
COMPUTER*
```

Until recently, Condor was strictly command-driven; in other words, you had to know the commands.

The asterisk is a wild card as used in PC-DOS. The indexing scheme does not let you change the key fields, and you cannot recover space from deleted records. If a file is indexed, queries by another key result in a fast sequential scan, not a slow indexed scan. You can shuffle a file by adding, deleting, and rearranging fields, and the screen layout can be conveniently changed. It is more difficult, however, to change field lengths. To do so, you must unload the file to an ASCII file, change the data dictionary, and reload the file.

Condor's report generator is quite sophisticated. You can use all the usual subtotals, page headings, and so on. The report is laid out on the screen as it will appear on paper, but there is no horizontal scrolling to permit design of wide reports. Long report lines will wrap around to the next screen line.

Until recently, Condor was strictly command driven—in other words, you had to know the commands. A new version provides optional menus that steer you toward the right command and help you set up the command once you get there. This is a great training aid, but you can disable it once you become proficient.

R:BASE 4000

Microrim, a start-up company with lots of venture capital, is flooding the computer press with two- and four-page ads for its R:base 4000 relational DBMS. The ads compare R:base with dBASE II, but in reality, R:base is closer to Condor 3. Like Condor, R:base's commands are designed to operate on entire relations.

R:base makes you define the data dictionary before you design screens, and this approach makes sense. First you define the fields, called "attributes," for all the relations in the database, then you

(continued)



Photo 3: With R:base, you define the fields called attributes for all relations in the database.

group these into the proper relations. One attribute might occur in several relations, implying a link between those relations.

You then define the screens, called "forms." Each relation can have several forms. Querying is via the SELECT command, which follows the SQL format except that it does not permit multifile queries. You must use the JOIN command or one of R:base's unique relational operators—INTERSECT, UNION, or SUBTRACT. In any case, you must know all the attribute names.

The report generator is somewhat elementary, but Microrim is preparing a new add-on report module that will do subtotals and draw data from several relations. Speaking of add-on modules, the CLOUT query module is really something special. It accepts English-language queries by extracting data from multiple files.

Suppose you have an employee relation and one field in that file is a branch code. A second relation associates branch code with city name. If you ask CLOUT

WHO'S IN CHICAGO

the program searches all relations for instances of "CHICAGO," then works backward to answer your question. If it finds "CHICAGO" in the branch relation, it matches the branch code to employee, knowing by predefinition that "WHO'S" means "LIST EMPLOYEES." If you had another relation listing rock groups, CLOUT would have asked

Do you mean CHICAGO the City or the Rock Group?

R:base stores the data for all database relations in one PC-DOS disk file. This is good because it follows the original database concept of one integrated store of data. A problem occurs, however, when a relation is deleted, which frequently happens to the results of the JOIN and other operators. The disk space is not recovered. You must perform a complete reorganization, including rebuilding all the indexes for all the relations. You must go through this time-consuming process frequently to prevent disks from filling up. Be sure you have enough free space available before starting.

R:base's index structure is not the familiar B+-tree, but a simpler form that does not permit indexed-sequential processing. This means that a sort must precede every report. The sort does not eat up any permanent disk space, but it does take time.

Version 1.1 of R:base has added variables, IF statements, and WHILE con-

structs to the command file language. It is possible to generate accounting applications programs, but that is a misuse of R:base. One developer invested more than 100 hours in a simple after-the-fact payroll system and was thoroughly frustrated.

R:base offers new users lots of help. For example, entering



Photo 4: R:base querying is done through the SELECT Command.

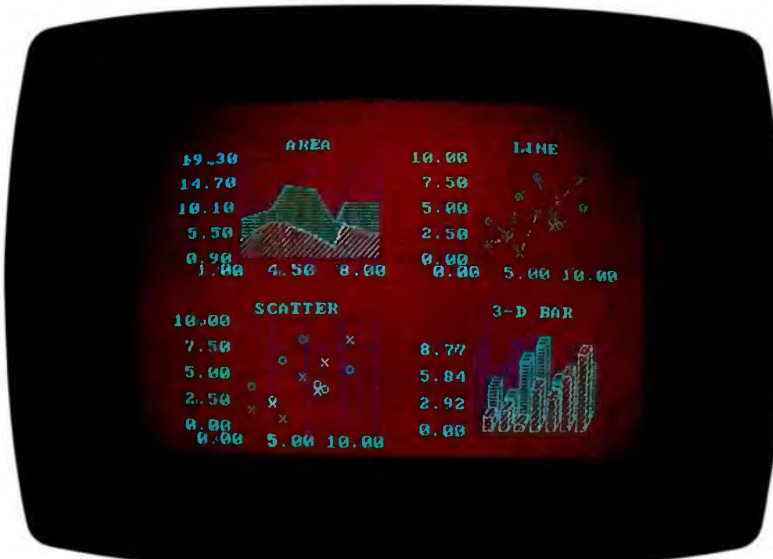


Photo 5: KnowledgeMan from Micro Data Base Systems has a built-in spreadsheet.

DATABASE MANAGEMENT SYSTEMS

Finding out about Ashton-Tate's dBASE II is simple. At least half a dozen books are dedicated to it.

HELP command

tells you everything you need to know about that command. In addition, a Prompt mode guides you through each command. Unfortunately, you do not always know what to do next because the global HELP command lists only R:base's available commands.

Changing the size of a field is really tricky. You must unload the whole relation to an ASCII file, delete the entire relation with all its attributes, key in all the attributes again, and reload the file. The program's alternate method is not any easier.

THE STANDARD BY WHICH OTHERS ARE JUDGED

Finding out about Ashton-Tate's dBASE II is simple. At least half a dozen books and several computer magazine issues have been dedicated to the subject. Classes and seminars on the program are also available. dBASE is really more of a programming environment than a DBMS. Of course, the DBMS elements are there, but the product has been successful because of its flexibility in developing computer applications. dBASE is distributed with a catalog listing hundreds of applications ranging from a \$75 personal credit-card register to a \$21,000 vending machine operator's management system.

Experienced dBASE users like the product because of the control it gives them over their data. In the Development mode, there is a direct link between keyboard, screen, and disk. You can create and rearrange files quickly and easily, and you can import and export ASCII files more rapidly than with any other product.

The dBASE programming language can operate on individual records in

several files at once, and it can control the screen, permitting full-screen cursor movement for data entry and editing. All this takes skill, but experienced dBASE programmers abound.

Even so, I have a few complaints about the program. Working with more than two files at once is awkward, and the 32-field-per-record limit is restrictive. You cannot recover space for deleted records, but multiple indexes are maintained through additions, deletions, and key-field updates. A major problem is the time required to rebuild an index after you have purged deleted records. One person reported a 20-hour rebuild time for a large file.

dBASE file definition starts with the data dictionary. If you do not make any changes, you end up with an ugly one-line-per-field default data-entry screen. To generate a nice screen, you must lay it out on grid paper, then code a succession of GET, SAY statements referencing the proper coordinates. An alternative is to use a stand-alone utility program provided by Ashton-Tate. This generates code that you incorporate into your programs.

Ashton-Tate also provides a set of dBASE lessons on disk. These are reported to be useful and might be an alternative to an expensive seminar.

A BETTER dBASE?

KnowledgeMan, alias Knowledge Manager and KMAN, comes from Micro Data Base Systems, author of the MDBS III extended-network DBMS. One might have expected an end-user version of MDBS III from Micro Data Base Systems, but the marketing department must have targeted Ashton-Tate's market as the most lucrative. The resulting product is not related to MDBS III at all, but is clearly intended to be a dBASE substitute.

A dBASE programmer would feel quite at home with KnowledgeMan. There have even been rumors of a dBASE-to-KnowledgeMan translator, which would swallow dBASE code and spit out KnowledgeMan code. KnowledgeMan has eliminated many of the frustrating dBASE restrictions. For instance, KnowledgeMan allows 255 fields per record versus dBASE's 32, and any number of files can be open at once, whereas dBASE allows only two. Knowl-

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KnowledgeMan lets you write a program that sets up a spreadsheet and references cells directly through variables such as "#a1" (row 1, column a).

edgeMan adds a built-in spreadsheet plus optional integrated screen-painting and graphing utilities. Trig functions, nestable macros, DIF file import/export, and other useful tools have also been added.

KnowledgeMan's SQL query system is powerful but not efficient. Here's a sample two-file query that matches shareholders (SHARE relation) with multiple stock certificates (CERTIF relation) based on the common field SHNUMBER.

```
SELECT SHARE.SHNUMBER,
SHARE.LASTNAME,SHARE.
FIRSTNAME,CERTIFNO FROM
SHARE FROM CERTIF WHERE
SHARE.SHNUMBER=CERTIF.
SHNUMBER
```

This is KnowledgeMan's equivalent of the JOIN command with no temporary file required. Listing 1 shows a short two-file program that lists a shareholder's name and the associated stock certificates. This program does the same thing as KnowledgeMan's JOIN command, but it does it much more quickly. Apparently, KnowledgeMan does not make effective use of existing indexes.

As with dBASE, deleted records do not release their space; instead of using the PACK command, though, you must use COMPRESS. KnowledgeMan does not seem to give the user the same hands-on contact with the data that dBASE does. In addition, displaying and modifying a file's structure is more difficult with KnowledgeMan, and you cannot see what is on disk unless you know the file names in advance. Because of its rich supply of features, however, KnowledgeMan still comes out ahead in applications development.

One special feature of KnowledgeMan is a built-in spreadsheet, which deserves some close inspection. You might think, "With VisiCalc, Multiplan, and 1-2-3, who needs another spreadsheet?" But take another look. KnowledgeMan lets you write a program that sets up a spreadsheet and references cells directly through variables such as "#a1" (row 1, column a). Thus, you can dump selected values and formulas onto the sheet, turn control over to the operator, then retrieve results from the spreadsheet for storage back in the database. Think of the possibilities!

KnowledgeMan is a tough nut to crack if you have not started with dBASE. The book *Using KnowledgeMan* is probably just around the corner, though. In the meantime, you can attend KnowledgeMan seminars and classes, which are appearing throughout the country.

CHOOSING YOUR DBMS

With all these options available, how do you choose a DBMS package? First, be sure you zero in on the right category. If you are a beginner, choose an entry-level package such as pfs or C.I.P. Others in this group are Personal Pearl, VisiFile, T.I.M. IV, Data Base Manager II, Friday!, EasyFiler, and Perfect Filer. You can't really go wrong with any of these programs if you realize that most let you access only one file at a time. All are as easy to use as present technology allows, and they solve a wide range of everyday business problems.

If you need more power, but you don't

want to learn programming, consider a multifile package such as Condor or R:base. These are relational DBMSs, which are satisfactory for information storage and retrieval, but are not ideal for more conventional accounting applications. Packages such as InfoStar, Power-base, Aladin, and DataPath offer innovative approaches to handling multiple files that are outside the realm of relational theory. You will have to study them all to find the one that suits your application.

If you need more flexibility, consider a DBMS with a built-in programming language. dBASE II and KnowledgeMan have similar languages and are based on relational theory. Dataflex, Sensible Solution, Mag Base, and Revelation automate the coding of data-entry procedures while still allowing programming flexibility. Each of these has its own way of doing things, so you must adapt your requirements accordingly.

A new crop of DBMS software consists of mainframe/minicomputer hand-me-downs. PC/Focus, Oracle, and Informix are the first entries. Informix is a fully relational package with all the record-deletion problems properly solved. The other two are too new to categorize.

Finally, there is MDBS III, the extended-network DBMS for application developers. It has started to show up in sophisticated accounting packages such as Solomon III. Use it only if you are the Defense Department or if you are planning to sell at least a hundred copies of your program. ■

Listing 1: KnowledgeMan program to display shareholder information.

```
/* KnowledgeMan program to display shareholder and certificate info */

USE ASHARE AS SHARE WITH "SHSHNO.IND" /* shareholder file, indexed */
USE STOCK WITH "STSHNO.IND" /* certificate file, indexed */
CLEAR
E.SUPD=TRUE
SNUM = "XXXXXXXXXXXX"
WHILE TRUE DO
  AT 1.1 INPUT SNUM USING "dddddddddd" WITH "ENTER SHAREHOLDER NUMBER"
  IF SNUM = "000000000000" THEN BREAK; ENDIF
  PLUCK SNUM FROM SHARE /* use index to find shareholder record */
  ? NUMBER LASTNAME FIRSTNAME ZIP
  PLUCK SNUM FROM STOCK /* find first certificate record */
  WHILE STOCK.SHNUMBER=SNUM DO
    ? STOCK.SHNUMBER STOCK.CNUMBER STOCK.QUANTITY
    OBTAIN NEXT FROM STOCK /* find subsequent certificate records */
  ENDWHILE
ENDWHILE
STOP
```

BY STEPHEN S. FRIED

EVALUATING 8087 PERFORMANCE ON THE IBM PC

*Saving time in engineering and business is easy if you
choose the right translator*

If you're an IBM PC owner, you probably know that the 8087 is a coprocessor that plugs into an empty socket on the PC motherboard. You probably also know that it does arithmetic and can be purchased for less than \$200. But you may not realize that the 8087 is actually a full-blown 80-bit processor that performs numeric operations up to 100 times faster than the 16-bit 8086. It has the potential to do arithmetic at the same speed as a medium-size minicomputer, while providing more accuracy than most mainframes.

To an engineer or programmer, that's good news. But the 8087 can also work wonders with business applications. There is a difference, however, between the business user who needs performance and the engineer or programmer. The business user will typically buy a turnkey application, while the technical user will probably have to write his own. This means the business user can remain ignorant of the chip's existence, while the technocrat has the added burden of evaluating 8087 support.

In this article we'll take a look at applications areas that are fertile for the 8087 and the types of support that are available. I've divided up programming language translators based on the efficiency of the support they provide.

THE 8087 IN OPERATION

How good is the 8087 in practice? For the evaluation of simple expressions, the quality of the 8087 code generated

by the best products (in-line compilers) will run 105 times faster than that generated by the weakest products (interpreters and spreadsheets). However, even spreadsheets are good candidates for 8087 support if they are used extensively to compute trigonometrics or exponentials, as these library functions run uniformly faster on all 8087 products. Typical increases in speed of 20 to 1 are common for business problems that depend heavily on library routines such as rate of return calculations.

The real power of the chip is most evident in scientific and engineering applications. While using one of the best FORTRAN compilers available, a PC user recently discovered that his CRAY computer executed one of his applications only a factor of 180 faster than his PC. But because the CRAY was serving 100 users, the turn-around time was only a factor of 2 better than the PC. The application being run involved a million floating-point operations and took .34 seconds of CRAY central-processor time. I don't suggest that you attempt a problem that takes an hour of CRAY time, unless you plan to go on vacation for a week. But I do advocate the use of desktop microcomputers to solve problems that involve 100 million floating-point operations or less.

(continued)

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The major difference between Intel and Microsoft code is the use of the 8087 stack. Intel uses it for storing temporaries such as common subexpressions, while Microsoft stores them on the 8088 stack.

TECHNICAL OVERVIEW

The 8087 is an 80-bit coprocessor that operates as an extension of an 8086 or 8088. It contains eight 80-bit registers which can each hold a single real number. The eight registers are set up as a stack: every time a number is loaded into register 0, its prior contents will be pushed into 1, and 1 into 2, etc. The processor is often referred to as a numeric data processor (NDP) because the basic 48 instructions it can carry out are oriented to numeric operations using the numbers in its stack. To the assembly-language programmer, the 8087 looks like an extension of the 8088 that has its own instruction set for manipulating real numbers instead of bytes and words.

The operations performed by the processor are broken into two classes: in-line and library. The in-line routines perform the basic arithmetic operations (addition, subtraction, multiplication, and division) and square roots, loads, and stores. These operations typically take 100 to 200 machine cycles (20 to 40 microseconds). The library operations include all the trigonometric, exponential, and other related transcendental functions and are really programs that use special primitive operations designed to speed up and improve the accuracy of the functions. The library operations also include programs for converting strings into temporary real numbers and vice versa (encoders and decoders). Most library operations take between 250 and 500 microseconds to execute.

The library functions can be either purchased or written by the user (it is a big task) and normally come with 8087 compilers or adaptations as part of the product. Several books and applications notes will help the ambitious user. Each of the library routines takes advantage of special primitives that do the time-consuming part of the job. For example, all trigonometrics are computed by first scaling angles into $\pi/4$ radians, then calling a partial tangent function which essentially computes the two sides of the corresponding right triangle. Applying Pythagoras at this point yields the sine, cosine, or tangent. The scaling operation, which is typical of the special 8087 calls, is critical for large angles (used by many people, including astronomers) and is done by one operation called a partial remainder. It does the job faster and with much greater accuracy than any algorithm running on an 8088.

The three primary benefits of using 80-bit registers for numeric computations are speed, extended floating-point range, and extended accuracy. Processes that previously had

to be factored to avoid overflowing now run simply by using the next largest format. The ability of the temporary real-number format to hold numbers up to 10 ± 4098 is sufficient to handle almost any real-world application. The added accuracy of the 80-bit format makes it possible to solve problems in which the propagation of round-off errors is significant.

The capability to invert large matrices is probably the biggest advantage of all. A study at the Avco Everett Research Laboratory revealed the startling fact that on the average 30 percent of mainframe time was eaten up inverting matrices and solving simultaneous linear equations. Faster matrix routines pay off in a hurry. More accurate ones not only execute faster but also extend the allowable size of the matrix that can be handled. For example, large structures are designed using finite element analysis. In a large structure, information about a small region of the structure has to propagate through the entire structure. This information will get lost through round-off errors unless a 64-bit or larger number format is used. The temporary real-number format of the 8087 makes it possible to extend the size of the structures that can be analyzed. Also, the matrix inversion process lends itself to parallel processing. One algorithm now available on the PC executes at 10 percent of the throughput of an IBM 360 or 25 percent of a Prime computer. One happy user pointed out that this routine in conjunction with an 8087 saved him \$4 per minute in rental fees!

CODE KINETICS

As an interdisciplinary scientist/engineer, I have benefited greatly from working in a number of unrelated fields. Often one field ends up giving incredible insight to another. Most of my "academic quality" research was done in chemical kinetics, the branch of chemistry involved in measuring the speed of reactions. Many reactions can be modeled as a series of processes that execute serially. That is, process one finishes before two, etc.

Often a single process takes the majority of the time. The slow running process can be thought of as a bottleneck. If it can be removed or circumvented, the whole process will go much faster. In chemical kinetics the step that holds back the process is usually referred to as the rate-limiting step. Identifying and understanding the rate-limiting steps are usually the keys to designing efficient chemical reactors and processors. In the case of code processes, the same is true. When people describe a program as "number intensive," "number bound," "floating-point bound," "I/O bound," or "integer bound," they are really describing a code process whose rate-limiting step is known to be floating-point arithmetic, I/O (input/output), or integer arithmetic.

Eliminating the rate-limiting step in the case of a tank containing hydrogen and oxygen is simple: you apply a match. In the case of a program that is number bound, you apply an 8087. The balance of this article is really a study in identifying rate-limiting steps in code produced by a variety of translators and interpreters.

8087 TRANSLATORS

To evaluate 8087 performance, I divided language translators

(continued)

into 4 classes: interpreters, native compilers with IEEE (Institute of Electrical and Electronics Engineers) libraries, native compilers that generate in-line code, and globally optimized programs that use pipelining. First, let's examine interpreters and see why adding an 8087 does not make a big improvement in simple expression evaluation but can make a substantial improvement in trigonometric and transcendental operations. Since most spreadsheets fall into the interpreter category, 8087 spreadsheet support, which should be available by time of publication, will primarily benefit bankers and financial analysts who do a lot of exponentiation.

Interpreters are a class of language translators that either parse program statements into immediate actions every time they are encountered or execute an intermediate form that is not machine executable. In contrast, native compilers translate a statement once and generate code that is directly executable on the target machine. The translation process itself is not always an incredibly heavy burden. But when you combine it with searching through a long table for the value of a variable, you end up losing a factor of 3 to 10 over a similar compiled program. To see why interpreters don't benefit from in-line 8087 instructions, let's examine a short BASIC program in detail. I have written three short programs to enable you to measure the time required to do a loop, look up a variable, and finally perform a floating-point operation. The first program prints the time and then does 5000 iterations of a meaningless loop:

```
5 DIM C(5000),D(5000)
6 DEFINT I
10 PRINT TIMES
20 FOR I=1 TO 5000:NEXT
30 PRINT TIMES
```

It takes 2.5 seconds to execute and tells you that the time to execute a raw loop with an integer index is $2.5/5000 = .5$ millisecond. Next you add an assignment statement to the loop. I have chosen a single-dimensioned array, since the majority of simple operations often appear in the innermost loops of programs whose operands are arrays:

```
40 PRINT TIMES
50 FOR I=1 TO 5000:C(I)=D(I):NEXT
60 PRINT TIMES
```

The above fragment takes 15 seconds longer to execute than the empty loop, indicating that the expression $C(I)=D(I)$ takes $15/5000 = 3$ milliseconds to execute. Because I am familiar with the way Microsoft BASIC executes an assignment, I know that most of the time is spent looking up where the variables are stored. This means it takes about .75 microsecond to look up a variable.

```
70 PRINT TIMES
80 FOR I=1 TO 5000:A=C(I)+D(I):NEXT
90 PRINT TIMES
```

Line 80 takes only 4 more seconds than the assignment in line 50, indicating that a floating-point addition takes $4/5000 = .8$ millisecond. You have to be careful in this assessment, as there is one extra variable lookup, which from the second program you know takes up to .75 millisecond. Therefore the add may actually take much less than .8 millisecond.

Let's examine what kind of improvement you could expect if you placed an 8087 in the machine. In fact, to make a point let's use the world's fastest floating-point processor, the V8-80087, a virtual processor that takes almost no time to execute an add. If you now examine the time to execute line 80, you discover the following:

	IBM BASIC Interpreter	IBM BASIC with V8-80087
loop	2.5 seconds	2.5 seconds
lookups	13.0	13.0
add	<u>4.0</u>	<u>0.0</u>
	19.5 seconds	15.5 seconds

You get only a 25 percent increase in performance. No matter how fast your numeric processor runs, you can never make a major impact on a process for which the rate-limiting step is not numeric. In this case the rate-limiting step is looking up variables. If you added a call to the screen, it would be I/O. Conclusion: 8087s do not speed up I/O-bound processes; for that you need an 8089 or 80286.

Now let us examine a BASIC interpreter program whose rate-limiting step is numeric. This time I will just list the test fragments, followed by the incremental run times.

```
6 DEFINT I
7 F=.512345!
10 PRINT TIMES
20 FOR I=1 TO 5000:NEXT
30 PRINT TIMES

40 PRINT TIMES
50 FOR I=1 TO 5000:E=F:NEXT
60 PRINT TIMES

70 PRINT TIMES
80 FOR I=1 TO 5000:E=COS(F):NEXT
90 PRINT TIMES
```

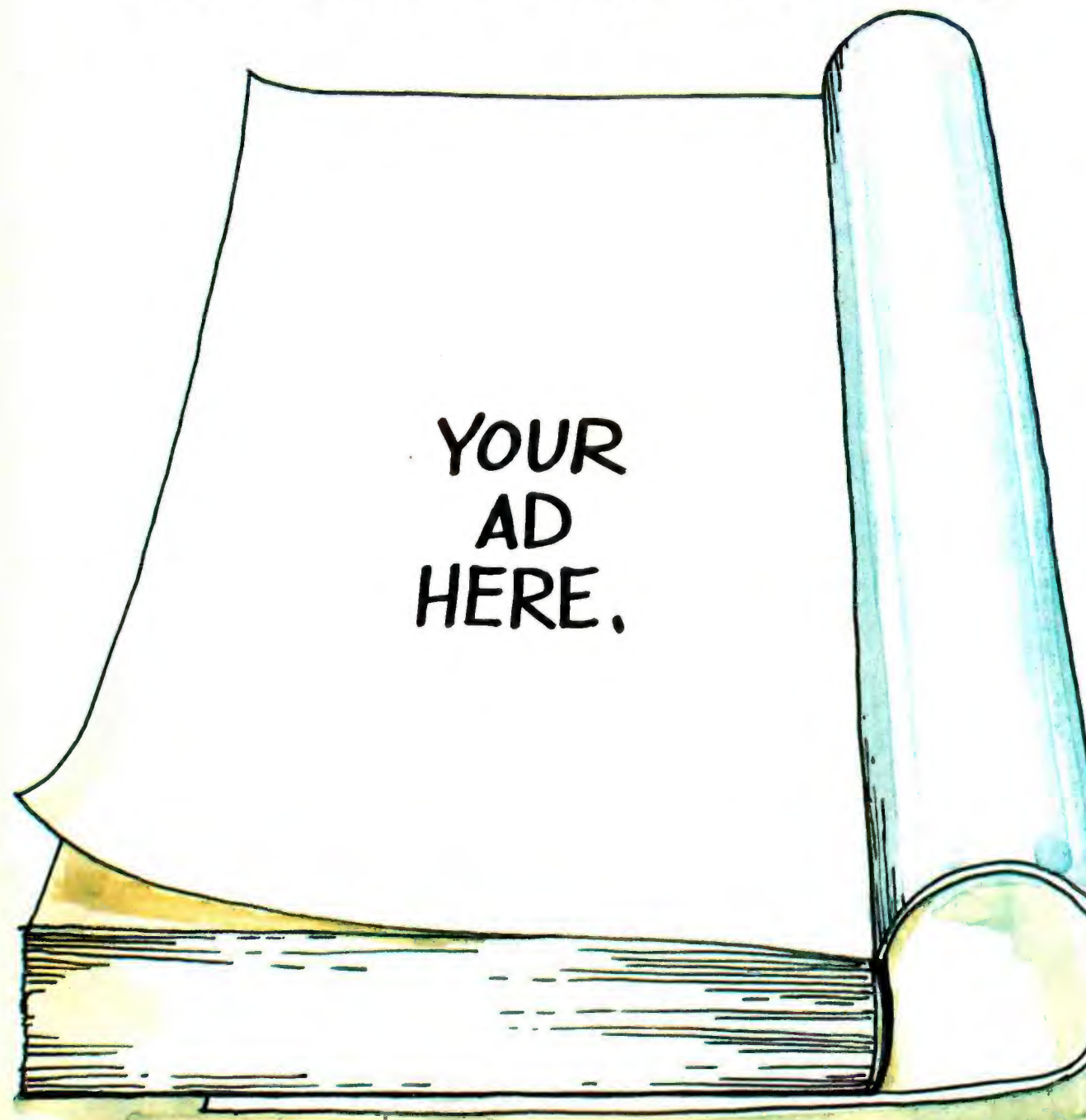
	IBM BASIC Interpreter	IBM BASIC with 8087
loop	2.5 seconds	2.5 seconds
lookups	9.0	9.0
cosine	<u>133.0</u>	<u>2.5</u>
	144.5 seconds	14.0 seconds

Looking at the summary for the interpreter without an 8087, you see there is a bottleneck. Ninety-three percent of the execution time is spent computing cosines. The right column contains the time required for a real 8087 to compute 5000 cosines. Notice the improvement in speed is 10 to 1. If you did a Gestalt benchmark for double precision, you would discover it should actually be a 20-to-1 improvement because the 8087 time does not change when you change precisions, while the IBM BASIC interpreter's time should double. The fact that changing the interpreter's precision does not slow up its execution speed correlates with the fact that the last eight places of double-precision calculations normally contain garbage. In other words, the PC Basic interpreter fakes double precision.

I repeated these runs with a recently developed BASIC compiler/interpreter, Professional BASIC from Morgan Computing, which has 8087 support. This product has some unusual run-time features that make it convenient for developing and

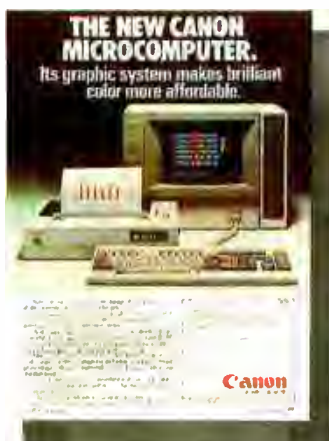
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debugging code. The run-time structure of the language is essentially a P-code interpreter. With the 8087, the rate-limiting step for most calculations turned out to be integer arithmetic and the FOR loop structure, which is, in my opinion, overburdened by the size of the integers (4 bytes). On the average, Professional BASIC evaluated simple expressions 4.5 times faster than the IBM BASIC interpreter, but ran at only 25 percent of the speed of MicroWare's 87BASIC, an IEEE 8087 adaptation of the IBM BASIC compiler. This is in line with other P-code compilers that have 8087 support. The transcendental and exponentials were on a par with well-written 8087 products.

Other products using run-time interpreters for which 8087 support is in the process of being developed include SuperCalc, VisiCalc, Visi OnCalc and Lotus 1-2-3. The Visi OnCalc spreadsheet is reported by VisiCorp to show only a 15 percent increase in speed using the 8087, although VisiCorp did not elaborate on whether this was for in-line or library operations. The new version of SuperCalc III shows improvements in execution speed that range from a factor of 2 to 20. In the case of a spreadsheet, it is obviously very important to make sure that your problem is number intensive as opposed to word intensive or symbol table intensive. Based on my conversations with Sorcim, it would appear that the "faster" spreadsheets are efficient enough to benefit from 8087 sup-

port and that their 8087 implementation really pays off in iterative financial analysis.

CODE GENERATION WITH NATIVE-CODE COMPILERS

Most conventional compilers perform floating-point arithmetic by calling routines from a library that comes with the compiler. Libraries are really object modules that have been bundled together to simplify the linking process. At link time the linker pulls the modules needed to support your program out of the library and builds them into your load module. There can be a little to a lot of overhead associated with library calls. It is all a function of the "linkage" between the program and the library and the way the library handles the 8087. As a general rule, compilers that generate library calls for simple operations run 4 to 6 times slower than in-line code.

From the user's standpoint, there are essentially three modes in which an 8087 can be run. If the problem you are solving spends the majority of its time executing library calls (exponentials or trigonometrics), then any good 8087 package will do, since the speed of the in-line operations will not be critical. In other words, with problems whose rate-limiting step is trigonometrics or exponentials, you do not need to

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be concerned with the quality of in-line operations (adds, subtracts, multiplies, divides).

The worst 8087 compiler support products are those libraries that adapted the 8087 to the original IBM compilers without converting the entire library and compiler over to the IEEE number format. Because of the ugliness of the conversion process for the IBM FORTRAN library I/O routines, none of the products for this compiler is IEEE compatible. This means they all convert on the fly, back and forth between IEEE and Microsoft format every time a numeric operation is performed. This adds a lot of linkage time to all numerics, but the original routines in IBM FORTRAN were so bad that adding even this limited 8087-only support typically improved run times by a factor of 4.

The IBM Pascal was a much better organized and documented product than the FORTRAN. The Pascal shared a common code generator with the FORTRAN and was well enough documented so that a careful person could coax the first pass of the compiler into generating constants in the IEEE format. Once this hurdle was overcome, it was just a matter of figuring out how to patch an undocumented library with IEEE code. Fortunately for me, the Intel translators leave their signatures behind, and a few calls verified that ASM86 was the Intel assembler and IBM's secret object-file format was essentially Intel's. The IEEE library that I developed for IBM Pascal ran 50 percent faster on simple operations than the non-IEEE library I developed for FORTRAN.

Compiler-generated code can produce 30,000 to 40,000 floating-point operations per second. The best that IEEE-compatible 8087 libraries can do is 8000 operations per second. Yet there are many languages and products that get by quite well with this level of support and do not need the elegant code described in the following paragraphs. If you already own a compiler, the IEEE library approach may be adequate if your application's rate-limiting step is trigonometrics or exponentials, or if you use your compiler primarily for writing operating systems or compilers.

The best of the IBM libraries reside in the IBM BASIC Compiler. These libraries are so good that 8087 adaptations that convert on the fly run at about the same speed as the original library routines. Users who want to see an improvement in BASIC programs are advised to use libraries that are IEEE compatible. With IEEE libraries, it is possible to get increases in speed of between 4 and 20 to 1, depending on the ratio of simple operations to trigonometrics and exponentials. A number of good products are out that only have library support (that is, they do not generate in-line code). If the compiler generates IEEE constants, then the support will be within a factor of 8 to 1 of the best in-line code.

How does a compiler with an IEEE library perform a floating-point operation and assignment? Assume you have written a program to compute a simple sum. Along with subtraction, this is the most severe test of the libraries. Because it is the most common operation by far, it is the one that typically sets the performance of the library. Let's analyze the following line of code:

```
FOR I = 1 to 200000: A = B+C: NEXT I
```

Because of the speed of the 8087 it is often necessary to make 200,000 loops to get good measurements of code

speed. I did this in the actual program by setting up an outer loop with a limit of 20 and an inner loop with a limit of 10,000. I have written this line in BASIC syntax, but it just as easily could have been C, Pascal, or FORTRAN. Now look at the code generated by this line located in a MAIN program (it will differ in PROCEDURES, etc.). A typical compiler will either set two pointers to the numbers or pass in the actual values, then compute the sum and return, leaving the computed value in a "floating-point accumulator" located in memory or in the 8088 registers. For example, one compiler generates the following code:

```
MOV    SI,OFFSET B    ;load pointer to A into SI
MOV    DI,OFFSET C    ;load pointer to B into DI
CALL   SADD           ;[SI] + [DI] → FPAC
MOV    DI,OFFSET A    ;load pointer to C into DI
CALL   SASS           ;Assign FPAC to [DI]
```

For those of you afraid of assembly language, hang in a second: 8087 code is easier to read and learn than straight assembly language. The first two instructions take the address of the variables B and C and place them into 8088 pointer registers SI and DI. The next line calls a single-precision add routine. The result of a single-precision add is left in the FPAC (floating-point accumulator). The last two lines perform the assignment by taking the value out of FPAC and putting it in A.

Now let's examine the library routines SADD and SASS.

SADD:	schematic	comments	cycles
FLD [SI]	[SI]	→ ST(0)	43
FADD [DI]	[DI] + ST(0)	→ ST(0)	105
FSTP FPAC	ST(0)	→ FPAC	89
RET			

The routine SADD first loads the 8087 top of stack, ST(0), with the value of the first operand. On the right side of each line I have written the number of machine cycles required to perform the operation. Operand one is pointed to by the SI register in the 8088. The first line tells the 8087 to use the value in SI as a pointer to a single real variable and load this value into ST(0). The actual code would contain an additional modifier, dword ptr, which would inform the assembler that the operand pointed to by SI is single precision. The next line tells the 8087 to get the value pointed to by DI, add it to ST(0), and leave the result of the addition in ST(0). The final line takes the result and stores it in memory at a location labeled FPAC. A quick analysis of these three instructions reveals that it takes 105 cycles to do the actual addition and another 130 cycles to move numbers into and out of the 8087. Put in other terms, a simple addition is less than 50 percent efficient if the operands have to be imported and the results exported on every addition. It turns out that for the library routines the code is worse because to complete the assignment you have to load the FPAC into A. This is done in SASS.

SASS:	schematic	comments	cycles
FLD FPAC	FPAC	→ ST(0)	43
FSTP [DI]	[DI]	ST(0) → [DI]	89
RET			

(continued)

This adds another 130 machine cycles to the code. Adding up the cycles reveals:

linkage overhead	100 cycles
2 FLD	86
2 FSTP	188
1 FADD	105
	<hr/> 479 cycles

But you are still not done! In the case of Microsoft BASIC, each of these two library calls has an additional 50 cycles of linkage to execute going in and coming out. This adds 200 cycles to the total assignment time, which makes a grand total of 679 cycles to do an add and make an assignment. Dividing 679 by 5 cycles per microsecond results in an approximate add, plus assignment time of 134 microseconds, which agrees with the measurements on 87BASIC. For those of you who are perplexed, 200,000 adds in 32 seconds = 6300 adds per second = 1 add every 159 microseconds.

Finally, let's evaluate the numeric efficiency of the code generated by single-register 8087 libraries. This criterion tells you how much of the work that gets done is related to the numeric process at hand, as opposed to numeric I/O. Of the 679 cycles, only 105 involved arithmetic as follows:

FLD B :B	→ ST(0)	43 cycles
FADD A :ST(0) + A	→ ST(0)	105
FSTP C :ST(0)	→ C	89
		<hr/> 237 cycles

Therefore, the numeric efficiency is $105/679 = 15$ percent.

NATIVE-CODE COMPILERS WITH IEEE CODE ROUTINES

The assignment just analyzed is handicapped by the fact that it is not amortized over more numeric operations. It still shows that in-line code will make a big improvement in numeric efficiency. In-line code can be approximated with run-time libraries that contain "code routines." Because of their ease of implementation, compiler-called code routines were the first forms of 8087 support to appear. Developing your own entails writing a library of subroutines, each of which performs a specific 8087 operation. The library must be written so that it can be called from the target language, which must use IEEE constants if the method is to avoid "conversions on the fly."

Code routines never caught on because they are neither user-friendly nor transparent. I use them for experimenting with 8087 code because the set I developed is easy to interact with and debug using the IBM BASIC compiler. The technique is most effective where it can be used to eliminate compiler-generated "numeric I/O" by allowing the user to write globally optimized code. For example, if you plan to use the variable C in a series of calculations, then you would compute its value and then leave it on the 8087 stack, as follows:

```
100 CALL FSRLD(B): rem ST0 now contains B
120 CALL FSRADD(C): rem ST0 now contains B+C
```

And then do some intermediate calculations:

```
130 CALL FDUP: rem ST0 and ST1 now contain B+C
140 CALL FSQRT: rem ST0 contains sqrt(B+C)
150 CALL FDIVP: rem ST0 contains ST0/ST1
```

before making the assignment.

```
160 CALL FSRSTP(A): rem assign ST0 to A
```

The syntax here uses F for all library routines and follows it with an SR if a memory reference is made to a single real number. If you analyze the same calculation performed by the compiler's call to its run-time library, you would see it involves twice as many 8087 operations and takes twice as long to run. This code routine technique can prove valuable if the compiler you own does not have in-line support, and if you can identify the most heavily executed code lines. Rewriting the key section(s) with code routines can usually make a factor of 2 improvement over compiler-generated library calls. Products that use this technique exist for IBM BASIC and Pascal.

UPPER LIMIT ON 8087 SPEED

For a compiler to generate really fast 8087 code, it must do two things: eliminate the wasted time in run-time library linkage and keep floating-point variables on the 8087 stack as long as possible. Before exploring these techniques, let's review other 8087 facilities. The 8087 has eight registers ST(0) . . . ST(7), which can be used for general-purpose storage of floating-point numbers. Any number that stays on the 8087 stack gets treated as if it were an 80-bit number for the duration of its stay on the stack. Keeping variables on the stack reduces not only 8087 I/O overhead but the accumulation of round-off errors. If you can keep numbers on the stack for many iterations without doing any loads or stores, then the throughput will quickly approach the speed of a stack operation. Because the number of cycles required to perform a stack operation is well known, we can easily place an upper limit on the speed of the 8087. This is a convenient yardstick for the code in table 1 we are about to analyze.

Notice in table 1 that I included the square root as a simple operation. The 8087 is unusual in that it does square roots as fast as division, and several hundred times faster than algorithms executed by the 8088. In typical code, it is rare to see a sequence of additions or subtractions without any multiplications or divisions. So it is deceptive to think about the upper limit as 59,000 floating-point operations per second (FLOPS). In fact, a series of tests reveals that, in an average expression, the throughput for stack operations actually is about 45,000 FLOPS. This roughly corresponds with the average of the times for the four primary operations.

IN-LINE 8087 SUPPORT

The best 8087 code is generated by native-code compilers, which emit 8087 instructions in-line. The quality of the code generated by these products is so good that the kinetics of

Table 1: Upper limit on 8087 throughput for stack operands.

Operation	Machine Cycles	Microseconds	Rate FLOPS
ADD	85	17	59,000
SUB	85	17	59,000
MULTIPLY	138	27	44,000
DIVIDE	198	40	25,000
SQUARE ROOT	183	36	28,000

the problem is more complicated than just identifying a rate-limiting step. Many factors now start to play a role. These include the form of the problem being solved, the memory model being used by the compiler, interleaving of 8088 instructions with 8087 instructions (pipelining), the quality of the translation of expressions into 8087 code, 8087 stack use for common subexpressions, and the use of the stack for global variables that are "hot." Ultimately, the key to improving 8087 performance revolves around minimizing 8087 I/O.

Now let's see how two of the best compilers use the stack in the programs they generate. In this section I'll concentrate on the evaluation of a single expression. It is a "fair" expression, which means I did not go overboard and choose an expression with five common subexpressions, which would show off the 8087 and the better 8087 code quality of one of these two compilers. The expression is typical of those that evaluate the properties of materials using polynomial expansions. Equation 1 is the expression I will evaluate. Equation 2 is an equivalent representation.

$$1) H = (C0 + (X-K) \cdot (C1 + (X-K) \cdot (C2 + (X-K) \cdot (C3 + (X-K) \cdot C4)))$$

$$2) H = C4 \cdot (X-K)^4 + C3 \cdot (X-K)^3 + \dots + C0$$

Equation 1 is preferable for this test because it replaces the computation of powers with multiplies, which execute a factor of 10 faster in the 8087. In these equations, $(X-K)$ is called a common subexpression. A good compiler factors out common subexpressions so that they have to be evaluated only once. Both of the compilers we will study do this. The only difference in the generated code is where the common subexpressions go. Let's examine the impact of the different strategies on the number of machine cycles required to calculate H.

First I'll use code generated by the Intel FORTRAN-86 compiler version 2.2. It is a four-year-old product developed by Intel to run on its development system and to demonstrate the power of the iAPX 86/88 concept. The compiler recently "migrated" under license to PC users running MicroWare's RTOS operating system. When this compiler came out, it was benchmarked by Intel against minicomputers and other 16-bit microcomputers and was shown to be superior for floating-point purposes.

In the upcoming section I will provide a guided tour of how Intel generates code for the example expression. To make this less painful, I have added comments to some of the code and also a stack chart on the right side of the code to help the reader visualize the activity on the 8087 stack. The stack is composed of eight registers, which are labeled ST(0) through ST(7) and are often abbreviated as ST0 through ST7. As you proceed along the code line, I will define the common subexpression and label it CSE. The compiler will also build partial results, which I will label F1 through F3. Each line is labeled with a number followed by an 8087 operation, which has optional operands that are followed by the state of the stack after the operation has occurred. I also included some schematics of the operations in the first 4 lines. Line 0 defines the initial state of the stack. All registers start out empty (MT) in line 0.

Line	op	Operands	ST(0)	ST(1)	ST(2)	Comments
0			MT	MT	MT	
1	FLD	K	K	MT	MT	:K → ST(0)

2	FSUBR	X	X-K	MT	MT	:X-ST(0) → ST(0)
3	FST	ST(1)	X-K	X-K	MT	:ST(0) → ST(1)
4	FMUL	C4	C4*(X-K)	X-K	MT	:C4*ST0 → ST(0)
5	FADD	C3	C3+C4*(X-K)	X-K	MT	:F1 = C3+C4*(X-K)

Looking at equation 1, you see that the innermost factor is $C3 + C4 \cdot (X-K)$. This factor contains the common subexpression $(X-K)$, which is computed in lines 1 and 2. Once evaluated, it is saved on the stack for future use. This is done in line 3, using an operation that copies ST0 into ST1. The next line forms the product $C4 \cdot (X-K)$ and leaves it in ST(0). Note that $(X-K)$ rides on top of the calculations being done in ST(0). Line 5 completes the first factor. The balance follows:

6	FMUL	ST0,ST1	(X-K)*F1	X-K	MT	
7	FADD	C2	C2+(X-K)*F1	X-K	MT	:F2 = C2+(X-K)*F1
8	FMUL	ST0,ST1	(X-K)*F2	X-K	MT	
9	FADD	C1	C1+(X-K)*F2	X-K	MT	:F3 = C1+(X-K)*F2
10	FMULP		(X-K)*F3	MT	MT	
11	FADD	C0	C0+(X-K)*F3	MT	MT	
12	FSTP	H	MT	MT	MT	

Looking over the second half, you see that it essentially repeats until you get to line 10. The compiler cleans up the stack for the next user by including two instructions that pop the stack (they also end in P).

Based on the fact that the line executes nine floating-point operations, I determined the number of FLOPS, and on the basis of the fact that it was replacing 12 instructions, I computed an "effective" FLOPS, which is labeled EFLOPS.

	Operations/second
EFLOPS	46,880
FLOPS	35,090

The code generated by Microsoft was identical for both versions of Microsoft's compiler (3.1 and 3.2). The major difference between Intel and Microsoft code is the use of the 8087 stack. Intel uses it for storing temporaries such as common subexpressions, while Microsoft stores them on the 8088 stack. You can see this by comparing lines 4 and 5 in the Microsoft code with line 3 in the Intel code. The most unusual thing about the Microsoft code is that it places copies of the subexpression $(X-K)$ on the stacks of both the 8088 and 8087.

Microsoft-Generated Code						
Line	op	Operands	ST(0)	ST(1)	ST(2)	ST(3)
0			MT	MT	MT	MT
1	FLD	X	X	MT	MT	MT
2	FSUB	K	X-K	MT	MT	MT
3	FLD	ST0	X-K	X-K	MT	MT
4	FSTP	[BP-8]	X-K	MT	MT	MT
5	FLD	[BP-8]	[BP-8]	X-K	MT	MT
6	FMUL	C4	C4*CSE	X-K	MT	MT
7	FADD	C3	C3+C4*CSE	X-K	MT	MT
8	FLD	[BP-8]	[BP-8]	C3+C4*CSE	X-K	MT
9	FMULP	ST1,ST0	[BP-8]*C3+..	X-K	MT	MT
10	FADD	C2	C2+[BP-8]*C3..	X-K	MT	MT
11	FLD	[BP-8]	[BP-8]	C2+[BP..	X-K	MT
12	FMULP	ST1,ST0	[BP-8]*C2..	X-K	MT	MT
13	FADD	C1	C1+[BP-8]*C2..	X-K	MT	MT
14	FMULP	ST1,ST0	(X-K)*[C1+..	MT	MT	MT
15	FADD	C0	C0+(X-K)*[C1..	MT	MT	MT
16	FSTP	H	MT	MT	MT	MT

(continued)

From a code efficiency standpoint, the cost of placing temporaries in memory and on the stack is 16 instructions for Microsoft as compared to 12 for Intel. This amounts to a 30 percent increase in code size and a corresponding increase in the number of machine cycles needed to execute it. When you analyze the number of cycles that each compiler takes for this job, you will see that the improvement is roughly 30 percent in favor of Intel. This also demonstrates that the difference between the best (the Intel code line for this expression can be shown to be optimal!) and good does not make for a huge difference in performance for well-optimized inline 8087 code generators. Once you are in the ball park, the law of diminishing returns starts to apply to code generators. Also in fairness to Microsoft and Intel, code quality is not the only factor by which to make a purchasing decision. On the average Microsoft code is actually more compact than Intel because Microsoft chose the Medium memory model, while Intel uses the Large model, which will be described later in the article. Designing a compiler involves hundreds of trade-offs, none of which should make or break a product.

Before leaving the example, I will analyze both code lines with an eye toward calculating the time spent doing I/O to memory versus arithmetic operations. This is easy. Just open any Intel user manual on the iAPX 86/88 series and turn to the section on the 8087. Most have a table listing all the operations and the number of cycles needed for each instruction as a function of the operand size and location. In my analysis, I segregated 8087 operations that do I/O only from arithmetic operations and then added up the cycles in each category. Every operation that references memory requires an effective address time (EA in table 2) to be calculated, as per Intel instructions. To complete the analysis, I transferred the 30 cycles it takes for an instruction of the form FOP mem (OP symbolizes arithmetic operations) to do I/O from the arithmetic

The second difference involves memory models. When Intel developed the iAPX 86/88 architecture, it created four memory models for writing programs. These are called Small, Compact, Medium, and Large. The 8088 can address a megabyte

Table 2: Analysis comparing time spent on I/O to memory versus arithmetic operations.

Intel					Microsoft						
					I/O OPERATIONS						
Operation		Cycles	(EA)	no.	Total	Operation		Cycles	(EA)	no.	Total
FLD	mem	46	5	1	51	FLD	mem	46	9	5	275
FST	sti	18		1	18	FSTP	mem	102	7	2	218
FSTP	mem	102	5	1	107						
+ arith I/O cycles					180	+ arith I/O cycles					180
					<hr/> 356						<hr/> 673
ARITHMETIC OPERATIONS											
FSUBR	mem	110	5	1	115	FSUB	mem	110	5	1	115
FMUL	mem	120	5	1	125	FMUL	mem	120	5	1	125
FMUL	sti	130		2	260	FMULP	sti	142		3	426
FMULP	sti	142		1	142	FADD	mem	110	5	4	460
FADD	mem	110	5	4	460						
- I/O cycles = 6*30					-180	- I/O cycles = 6*30					-180
					<hr/> 922						<hr/> 946
Numeric Cycles											
Total Cycles					1278						1619
Numeric Efficiency					72.14%						58.43%

8087 PERFORMANCE

of RAM (random-access read/write memory) broken up into 64K-byte segments. Segments can be located at any multiple of 16 bytes in the 8088 address space and are addressed in the processor by four segment registers. The convenient "cell" into which programs can be broken is the segment. Depending on how a program is broken into segments, it can be classified as falling into one of these four models. In general, the "smaller" the model used, the fewer number of times the values in the segment registers change. As a result, smaller programs run faster. In effect, Small programs still hold onto the 8-bit architecture of the 8080. The storage that can be accessed is increased as the models get larger. This is accompanied by a reduction in execution speed.

Most of the compilers on the PC market fall into one of the Intel memory models. The IBM FORTRAN and Pascal and Microsoft FORTRAN and Pascal fall into the Medium model. The latest FORTRAN, version 3.2, has an extension—mega-byte arrays—a feature that is not defined by the Intel models. The Intel FORTRAN uses the Large model with a similar extension for large arrays. In the comparison of the two compilers, I attempted to verify the use of these models and get an estimate of the decrease in numeric speed resulting from the use of the larger model.

The Medium and Large models are very similar. Both break up the program code into as many 64K byte segments as the

user would like. Essentially, the user can use up to 64K bytes for any main program or subroutine. In the Medium model a single data segment is used to store all constants and data. In addition, the user can define common and memory areas. The Large model associates a data segment with every code segment. From a code standpoint, the main difference between Large and Medium or Compact is that any time a subroutine is called using pass by reference (the FORTRAN standard), the compiler must pass 4 bytes of address information (Large) instead of two (Compact).

A secondary effect is that any time an expression is evaluated that contains dummy arguments (those passed in), for each dummy argument used the 8088 must calculate the effective address of the parameter used. This calculation would take additional time if it were not for 8087 pipelining: in a typical situation, the address calculation (8088) and the previous 8087 operation are done concurrently. The following listing compares the first three instructions of the example (direct addressing) with the code generated when dummy arguments are used (indirect addressing):

INDIRECT ADDRESSING		DIRECT ADDRESSING	
LES	BX,[BP+PARAM+24H]		:set address
FLD	ES:[BX],K	FLD K	:8087 operation
LES	BX,[BP+PARAM+20H]		:set address

(continued)

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Table 3: Comparison by class of translators that support the 8087.

Translator	EFLOPS	time	Efficiency
Native compiler with optimized in-line code			
Intel FORTRAN-86	46.800	51	1.04
Microsoft FORTRAN 3.1/3.2	37.060	65	.82
Native compiler with 8087 IEEE library and code routines			
87BASIC/87BAS+	15.000	160	.33
Native Compiler with 8087 IEEE libraries			
87BASIC	8391	286	.186
LATTICE C	7500	320	.166
Native compiler with 8087 non-IEEE libraries			
87FORTRAN (REAL*4)	4403	545	.07
P-code compiler interpreters with 8087 libraries			
Professional BASIC	2000	1200	.045
SS FORTRAN	5800	414	.129
Pure interpreter—no support			
IBM BASICA	444	5400	.0098

```
FSUBR ES:[BX].X      FSUBR X      :8087 operation
LES   BX,[BP+PARAM+8H] :set address
FST   ST1            FST   ST1      :8087 operation.
```

Note the overlapping of 8088 and 8087 instructions in the indirect case. It is also important to understand that it is possible to convert a pass by reference call into a pass by value call by simply assigning the incoming dummy argument to a local variable. When this is done, the code generated by the Intel Large model reverts back to direct addressing. I conclude that there is no penalty to Large model programs in which the majority of data references are made to the "local" data segment.

Summarizing, the Microsoft compiler produces uniformly good code independent of the complication level of the expression. Its efficiency is roughly 60 percent. The Intel code starts out at the Microsoft efficiency level and improves as the number of parameters that stay on the stack increases, asymptotically approaching 90 percent. Neither compiler does a good job with true mainframe optimizations, such as placing global real variables on the Numeric Data Processor stack, although the Intel compiler does keep real variables on the stack through basic blocks and passes parameters to library functions on the stack without unloading the stack. The biggest difference between the products is the use of memory. Intel uses the Large model, which allows each subroutine to have local data storage in an associated data segment, whereas Microsoft uses the Medium model, which requires all data to go in a single segment. The other difference is the linker. Microsoft generates only .EXE files, whereas Intel generates .EXE files and absolute files. The latter make it easy to place data in out-of-the-way places, like the RAM above the screen bank (B000 hexadecimal) but below the ROM (read-only memory) BIOS (basic input/output system). Including bank

A000 hexadecimal, this opens up 256K bytes to user storage that IBM has reserved but not yet used.

8087 ASSEMBLY-LANGUAGE SUPPORT

It is very easy to evaluate simple expressions using your own in-line code. Two approaches to generating 8087 code with the IBM assembler include the use of macro libraries and a preprocessor that converts 8087 opcodes into 8088 escape codes. For those users who own RTOS (MicroWare's real-time operating system), the choice will be the Intel assembler (ASM-86), which also serves as the definition for the language and mnemonics Intel invented for dealing with the 8088. It comes with an exhaustive library of "8087 common elementary functions" and an 8087 debugger.

The MS-DOS areas that require substantial additional user effort are debugging with Debug (which skips over 8087 escape codes and does not display the 8087 registers) and the development of trigonometric and transcendental libraries. Two products from MicroWare reduce these IBM 8087 support deficiencies. The first is a debugger, called 87DEBUG, that lets the users "watch" the 8087 as their codes execute. The second is a library of 8087 routines called 87MACRO which provides functions similar to the Intel libraries. For users who want to write their own routines, the suggested reading is the 87/88 Guide and Intel Application Notes. In any case, users who learn to write code for the 8087 will find it a valuable asset in generating special routines and in understanding the code generated by their compilers.

Table 3 compares the effective numeric efficiency of a number of different translators for the evaluation of the double-precision expression in equation 1, described earlier. The times given in the table are in seconds for 200,000 evaluations of this expression. The time to execute loops has been subtracted. The column labeled EFLOPS contains the number of floating-point operations per second, adjusted for the fact that some of the compilers eliminate common subexpressions. Note that about a 105 to 1 spread exists from the slowest to the fastest. The slower products are obviously very inefficient; this does not mean they have poor 8087 support, but that they are I/O bound as opposed to 8087 bound. It also points out that the 8087 is not a panacea, but rather a numeric processor that works best with very tight code. The effective numeric efficiency was computed by dividing EFLOPS by 45,000, the number of mixed stack operations that the 8087 can do in a second. I chose this definition because it can be applied across a spectrum of products. For products that use the 8087 stack effectively, the effective numeric efficiency depends on the expression used to evaluate it and goes up as the number of common expressions increases. The definition can result in efficiencies that are greater than one.

Table 3 ignores the other half of the story: library functions such as COS and EXP. If these functions are well written, they should perform with the same accuracy and speed in all implementations (even the interpreters). However, a number of these languages do not support, or do a poor job handling, double-precision variables. Therefore, the quality of double-precision arithmetic and the accuracy of functions turn out to be a whole new story. If accuracy is critical for your application, verify that the product in question meets the Intel/IEEE standard and allows the use of temporary real variables. ■

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THE IBM XT/370 PERSONAL COMPUTER

BY ERNEST SABINE

IBM's two extensions to its line of personal computers, the XT/370 (or 5160 Model 588 or Model 568) and the 3270 PC (or 5271 Model 2, 4, or 6), address the micro-to-mainframe link for the IBM 370, 43XX, and 30XX series of general-purpose computers. Each allows simultaneous operation of an IBM PC as a stand-alone computer and as an interactive terminal networked to an IBM mainframe. Beyond this the XT/370 and 3270 PC differ significantly. The XT/370's major emphasis is on executing IBM 370 programs on the XT itself. The 3270 PC's emphasis is on providing high-quality color graphics and interaction between the XT PC-DOS-based applications and the mainframe host. In this article we'll take a look at the XT/370.

WHAT IS THE XT/370?

The XT/370 operates in one of three ways: as an XT personal computer, an interactive full-screen terminal connected to an IBM mainframe computer, or as a mainframe-like system executing 370 programs. By using a "hot" (ESC) key, you can run in one or all three contexts concurrently.

In PC mode, the XT/370 operates as a regular IBM PC XT with 640K bytes of RAM (random-access read/write memory) and one or two 10-megabyte



Photo 1: The XT/370 from IBM.

fixed-disk storage units controlled by PC-DOS 2.0. It is slightly slower than the vanilla XT model, because some of the RAM operates more slowly to accommodate other microprocessors in the XT/370.

When operating as a mainframe computer terminal, the XT/370 emulates an IBM 3277 Model 2 display: a 24-line, 80-character-per-line, monochrome full-screen terminal. In this mode, you can interact directly with a mainframe host, including IBM's 370, 43XX, or 30XX processors. Because of a third mode, the mainframe can operate under VM/SP (Virtual Machine/System Product) interacting with the user through

CMS (Conversational Monitor System). CMS provides a timesharing environment for editing, compiling, debugging, and executing programs in a variety of languages. Under CMS, your XT/370 can store and retrieve data on magnetic tape and disk, route input and output to and from record equipment, such as card readers and line printers, or to other mainframes as well.

When operated in the System/370 mode, the XT/370 uses 480K bytes of real main storage. The system contains hardware that can map 4096K bytes (4 megabytes) of virtual memory onto the real memory using the 370 relocation method. The keyboard and display

A qualified success, IBM's XT/370 represents a genuine advance in desktop computing

operate as an IBM 3277 Model 2, and the disk and fixed-disk storage are accessible as CMS virtual-disk storage. Added to these features are a link to the IBM mainframe allowing access to its virtual disks for retrieving and storing programs and data, and access to printers for high-speed listings. The mainframe link can also upload/download files between the XT/370 and the mainframe host. If the XT/370 is locally attached—that is, connected through a mainframe channel—data is transferred at rates exceeding one million bps (bits per second).

THREE ADDITIONAL BOARDS

You can buy an XT/370 as a package, or you can upgrade an existing XT or IBM PC. The 10-megabyte fixed-disk version is the 5160 Model 588. If you need 20 megabytes (two fixed disks), you need the Model 568 without disks and the 5161 Model 3 expansion unit with two fixed disks. To upgrade an existing XT, get the XT/370 Option Kit—feature 3891. The kit even includes a new nameplate. Make sure your original computer has 256K bytes of RAM on the motherboard. In addition to the XT/370 or upgrade, you'll need software for terminal and 370 modes and manuals for diagnostics and reference.

The XT/370 includes a monochrome display and an adapter board. You can use a color monitor, but its color and graphics features are unavailable in ter-

minal or System/370 mode. The three boards that operate the two extra modes are the XT/370's most significant feature. One board operates the System/370 processor, another serves as both System/370 main storage and XT storage, and the third provides a mainframe connection.

The processor card (PC/370-P card) contains three microprocessors and a 370-page table with room for 1024 entries. A 370 VM/CMS page contains 4096 bytes, so the processor card supports a 1024 by 4096 or 4-megabyte virtual-address space. The processor card must be installed in slot 4 of the XT.

The processor card uses two Motorola 68000 chips and an Intel 8087 chip for the System/370 operation. One 68000 performs instruction fetch, decoding, and emulation of most 370 fixed-point instructions. It also uses its registers and program counter to emulate both the 370 general-purpose registers and program status word (PSW).

The second 68000 manipulates the 370-page table, processes exceptions (invalid op codes, zero divide, etc.), and emulates system-related fixed-point 370 instructions. This includes the supervisor call (SVC x'0a') op code used to pass requests from application programs to the CMS monitor and the DIAGNOSE (x'83') instruction. On a mainframe the DIAGNOSE instruction passes function requests beyond the

CMS monitor to the VM control program monitor, and on the XT/370 DIAGNOSE communicates function requests from the System/370 mode to PC-DOS.

The 8087 processor performs 370 floating-point instructions. Its registers emulate the 370 floating-point registers.

The memory card (PC/370-M card) contains 512K bytes of parity-checked RAM. It must occupy slot 3 of the XT. The memory is accessible from both the XT's 8088 processor and the System/370 processor card. The 8088 has priority over the processor card to ensure that time-critical operations, such as interrupt processing, are carried out properly.

When accessed by the 8088, the memory on the PC/370-M card is addressed as locations 256K on up, with the last 128K bytes mapped out. When accessed by the processor card, the first 480K bytes appear as locations 0 to 480K bytes of System/370 memory. The remaining 32K bytes are used for storing 68000 microcode used to emulate the 370 functions and interface operations with PC-DOS as carried out by the second 68000. The memory on this card operates slightly slower than the XT memory on the motherboard. This

(continued)

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XT/370: The Missing Link BY PAUL E. HOFFMAN AND G. MACK HICKS

IBM's introduction of the XT/370 will affect more people than just those who work with the IBM 370 mainframes.

If you're confused by the introduction of a "desktop" 370, remember first who IBM is: a company with 370,000 employees and an annual gross income of more than \$40 billion. If you are familiar only with IBM's microcomputers, you may not realize that, in spite of all the interest and excitement generated by the PC family, it represents only about 5 percent of IBM's income.

IBM's announcement of the XT/370 last October illuminates two major marketing strategies for the PC and 370 lines. First, IBM treats the PC as little more than a box that can be easily expanded with more powerful central processors. Second, the 370, IBM's primary mainframe offering, can now be on any user's desk as a real computer, not simply as a terminal. IBM recently stated that its major push for the rest of the eighties is toward intelligent workstations instead of completely centralized mainframes or completely decentralized microcomputers.

If you dismiss the XT/370 as simply part of a new method that IBM has devised to sell terminal equipment to 370 mainframe owners, you have missed the point. IBM would be happy to start you on an XT, upgrade you to an XT/370, and then eventually hook you into a 370 for software distribution. Thus, even if you do not currently use a mainframe computer, IBM's microcomputers give you an upward path to them. You are not required to use a mainframe 370 in order to use an XT/370.

DOWNLOADING PROGRAMS, NOT JUST DATA

Because the XT/370 uses the exact same instruction set as the 370 mainframe, you can copy executable programs from the mainframe to the microcomputer and run them directly. For example, imagine it is just before noon, and the mainframe 370 is becoming terribly slow. You really want to run a large database job, but you are afraid it may take hours at the current load. Instead of being tied to the mainframe, you can simply make a copy of the

database-management system on your XT/370 and run the job on your own system.

In fact, you do not need to download the program from the mainframe: if your office mates have it on their systems, they can give it to you on an ordinary floppy disk. You might even buy an XT/370 simply to run all of the thousands of programs that are already available for its mainframe namesake.

In the future you can expect IBM to use the XT/370 to distribute business software electronically. This, of course, will introduce further software licensing problems. IBM requires a separate license for each XT/370 on which a mainframe program runs. It has begun distributing directions for downloading programs onto the XT/370 with the standard software documentation. Other software vendors will probably do the same soon.

THE VM/PC OPERATING SYSTEM

Your interface with the XT/370 is almost identical to your interface with a 370. VM/PC (Virtual Machine/Personal Computer) control-program commands on the XT/370 are directly compatible with VM/SP (Virtual Machine/System Product) commands on the 370. This is important to microcomputer users for two reasons. First, if you already use VM/SP on a 370, you will be completely comfortable with your new XT/370. Second, while you can run PC-DOS on this new computer, IBM downplays its importance. (Anyone who feels that IBM has a long-term commitment to Microsoft and MS-DOS should take note.)

The user's interface to VM/PC and VM/SP is called CMS, which stands for Conversational Monitor System. You give commands to CMS in a fashion similar to the way you give commands to CP/M or MS-DOS: you respond to a prompt by typing in a command followed by a number of arguments. CMS runs under CP, the control program. (In fact, the command syntax of Digital Research's CP/M was derived from IBM's CP.) CMS is the most popular operating system within IBM and is used extensively by its huge marketing staff.

CMS is also used on many of IBM's other large computers, including the 360, the 4300, and the 308X series. If you've used any of these computers, you will have no problems using the XT/370. Though certain programs do not run on the XT/370, the problem is with the current version of VM/PC, not the hardware. Future versions of the VM/PC will be able to run even more programs.

Two of VM/SP's major tools are its editor, XEDIT, and its batch programming language, EXEC. With these tools, any programmer can create a wide variety of environments for users, such as interactive help and menu-driven processing. The distinction between the editor and the batch processor is blurred, since you can give the editor a list of commands to perform on a set of files and even execute operating-system commands from within it. XT/370 users are given both of these programs as part of VM/PC.

One of the unique features of the XT/370 is its ability to access disks on the mainframe as if they were its own. For instance, when you download Pascal/VS from a 370, you can choose to copy only a few of the program libraries. Then, simply link the disk on which they reside on the mainframe to VM/PC with a command. When Pascal/VS looks for the libraries, it will go through its normal search order, first on the XT/370, then on the mainframe.

VM VS. PC-DOS PROGRAMS

Because VM programs use virtual memory, a program has available an almost unlimited amount of memory space. Most PC-DOS programs address only 128K bytes; imagine similar programs that can use up to 4 megabytes, or 32 times as much memory. With virtual memory, the limited text editors and formatters of PC-DOS could become incredibly powerful tools.

Other business programs, such as spreadsheets and database managers, also thrive with the significant increase in available memory. When VM program designers work, they do not need to worry about memory limitations nearly as much as their microcomputer peers. This results in more powerful programs

that are laden with features.

THE FUTURE

Although many people think of the PC as a full-blown microcomputer, IBM conceives of it as an easily upgradable box with many expansion slots, a bit of memory, some mass storage, and an insignificant central processor. (In fact, when you run VM/PC, you use the 8088 as an I/O processor.)

You will see a number of impressive innovations on the PC in its configuration as an XT/370. More people who work in companies with 370s but have no access to the computer will have XT/370s on their desks and will use them for the majority of their business communications.

It is always difficult to tell which of IBM's new products it intends to push and which are red herrings. For instance, many people felt that IBM "legitimized" the UNIX market with its PC/IX announcement; since then, almost nothing has been heard of the product. However, the XT/370 is certainly going to be important to IBM, because it gives IBM an easy way to let users reduce the strain on their 370 mainframes and inexpensively gives end users more power at the same time.

The XT/370 is a strong entry into the new market of decentralized mainframes. Instead of coming up with a new mainframe, IBM designed a new microcomputer that works with the already established line. In fact, it also used an already existing communications path between the two computers, so that the IBM PC/XT could be easily integrated into the current 370 environment. Both mainframe users and microcomputer users will soon see the results of this development, and within a few years, it may be hard to tell the two sets of users apart.

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allows it to meet the timing constraints designed in the processor card.

The 3277 emulation card (PC/370 EM card) must occupy slot 2 in the XT. It contains the circuitry and coaxial connector for attaching the XT/370 to an IBM mainframe. The coax, which can be up to 2000 feet long, is run to an IBM 3274 Display Control Unit with a type B terminal adapter. The 3274 may be locally attached to a high-speed data channel (about 1 megabyte per second) or connected through a synchronous data link control (SDLC) telecommunication link, typically at 4800 or 7200 bps.

TWO OPERATING SYSTEMS

The software for the XT/370 includes PC-DOS 2.0 and a "Licensed Product," Virtual Machine/Personal Computer (VM/PC), which operates only on the XT/370 version of the XT. While operating as a personal computer, the XT/370 requires only PC-DOS. You'll need both software components for operating your XT/370 as either a 3277 display terminal or in System/370 mode.

Besides supporting the XT/370 as a personal computer, PC-DOS performs the same functions on the XT as the VM control program does on a mainframe 370: file handling, paging I/O, display and keyboard I/O, and file transfers between the XT/370 and the mainframe. Requests for I/O by a 370 program are reflected to PC-DOS by interrupts generated when the 370 DIAGNOSE instruction is executed. This instruction is used by the CMS monitor to pass system-related function calls to the VM control program monitor on a mainframe. On the XT/370, PC-DOS processes the interrupt, and the associated I/O parameters are passed to an I/O driver running under PC-DOS.

VM/PC is a "skinny" version of IBM's VM/CMS mainframe timesharing operating system. It allows 3277 display terminal emulation, includes utilities for moving CMS formatted files between the XT and the mainframe, and transfers files on the XT between CMS and PC-DOS.

Using the PC-to-mainframe link, an XT/370 CMS application program can access CMS files on the mainframe, record by record. Print files, created by the CMS application, can be spooled either to a printer connected to the

XT/370 or to the mainframe for high-speed output.

VM/PC also supports CMS I/O devices such as the console (the keyboard and display), local CMS virtual disks on fixed-disk and floppy-disk drives, and local printing. It also enables you to remotely access CMS files and the printer spool on the mainframe. The full CMS and control-program command repertoire is available, including the full-screen XEDIT file editor, the EXEC2 command language (a more powerful batch-like command processor), and the DEBUG subcommand environment. VM/PC also includes a 370 Processor Control debug function that provides access to the 370 registers, program status word (PSW), and main storage. It also allows execution and tracing of 370 programs in single step and stop-on-address-compare modes.

Besides XT/370 resident software, VM/PC includes a remote server program that operates on the mainframe host. The remote server coordinates data transfer at the mainframe end, between the XT/370 and the host.

VM/PC provides a full CMS environment, but you may want to run other 370 applications under CMS as well. You can download any 370 program running on the mainframe to the XT/370 and it will operate correctly if its I/O is restricted to the XT/370 CMS devices: its real and virtual storage requirements do not exceed 416K bytes and 4 megabytes, respectively; and it has no time or operating system's internal dependent code.

Compilers, data management, financial analysis, and other types of packaged applications software present a special case if they are sold, leased, rented, or otherwise licensed for use on the mainframe only. Third-party 370 applications software vendors will have to establish additional policies for distributing their products on the XT/370. Most mainframe pay-for-use software packages lack copy protection. IBM has already established a pricing policy on its software products, which includes a gentleman's agreement on distribution to paying XT/370 customers only.

The XT/370's functions add considerable storage requirements to those of PC-DOS. Table 1 presents the RAM and fixed-disk requirements for both PC-

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DOS and VM/PC. Free storage on the fixed disk can be severely constrained if several of the commonly used compilers are included. For example, if you run both the COBOL and PL/I compilers, less than 50 percent of a 10-megabyte fixed disk is left for source, data, and other user files. Using a single disk can also constrain performance, especially if you load your compilers frequently. In that case, you may need two fixed disks, one for the operating system and compilers and the other for user files.

OPERATING THE XT/370

Because the XT/370 has multiple modes, you can operate it as a personal computer or a remote terminal hosted to a System 370. Here are a few typical operational scenarios:

- CMS/PC-DOS bridge. By capturing data from PC-DOS, perhaps on disk, you can import it to the local CMS for subsequent processing. Exporting data would reverse the operation.
- Local CMS editing/remote computing. By using XEDIT on the XT/370 for file editing, you avoid response-time delays because of a mainframe's heavy workload. You can also SPOOL source programs and data to the mainframe for processing.
- Local compilation and testing/remote computing. You can go the above step one further on the XT/370 by using a local copy of a 370 compiler.
- Local computation/remote database. You can compile data locally or extract object programs from the mainframe and run them under CMS on the XT/370. You can also access files from a large, perhaps shared, database on a mainframe.
- Local database/remote computation. Using local data on the XT/370, you can execute central-processor or large memory-intensive programs on the mainframe. The results can be returned to the XT/370.
- Local computation/local database. You can use the XT/370 locally to process sensitive or proprietary data and programs.

With VM/PC you can switch modes

while another mode is still executing. Although you can run a local and remote CMS session and move files across the systems concurrently, you'll probably find it difficult to work on parallel activities. The easiest way to take advantage of multiple operations is to spin off the printing, file access and transfer, and remote batch jobs that don't require your interaction. It would be less confusing to use multiple sessions if the file and spooling functions were unified so the user could "reach out and touch" software tools and data from one environment while operating in another. Some commands used in CMS have similar counterparts in the CP monitor,

which leads to occasional confusion as to whether you're in the VM/CP or CMS environment.

Like any computer, the XT/370's performance depends on the characteristics of the workload. Any computer can be made to look either very fast or slow with a careful selection of programs.

For raw number crunching in System/370 mode, the XT/370 operates at approximately 0.2 million instructions per second (MIPS), slightly slower than an IBM 4331-I mainframe carrying a \$70,000 sticker price. The floating-point speed derives from the math chip on the processor card.

Table 1: XT/370 storage requirements.

MAIN STORAGE:	
Use	Storage (K bytes)
Processor control storage	32
VM/PC control program	64
370 CMS/user memory	416
Total	512

FIXED DISK:	
Use	Storage (megabytes)
PC-DOS 2.0	0.1
VM/PC system	1.5
Total	1.6

OTHER 370 SOFTWARE FOR FIXED DISK:	
Software	Storage (megabytes)
ASSEMBLER H	0.2
BASIC processor and library	0.5
COBOL compiler and library	1.0
FORTRAN VS compiler and library	1.5
PASCAL VS compiler	1.2
PL/I optimizing compiler and libraries	3.0
DCF (SCRIPT VS)	0.6

Table 2: List prices for a basic XT/370.

Hardware	
5160 model 588 (XT/370)	\$8085
5151 monochrome display	275
5152 80-cps graphics printer	449
4900 mono display/printer adapter board	250
5162 printer cable	45
Subtotal	\$9104
Software	
DOS/BASIC 2.1	\$ 65
VM/PC	1000
Subtotal	\$1065
Manuals	
XT/370 Hardware Maintenance	\$ 60
XT/370 Technical Reference	28
Subtotal	\$ 88
Total cost for base unit	\$10,257

THE XT/370

For raw number crunching, the XT/370 operates at approximately 0.2 million instructions per second, slightly slower than a \$70,000 IBM mainframe.

When executing CPU-bound code, using a general mix of LOAD/STORE/BRANCH type of 370 instructions, the system executes at approximately 0.1 MIPS. For short, interactive programs such as a text editor or data entry, this speed is quite adequate. Compiling large source programs can take much longer than the same activity conducted on a 370 mainframe.

A more subtle performance phenomenon occurs when you're executing programs using extensive 370 supervisor instructions. These instructions change the state of control registers and page tables and cause 370 system state changes, all of which require more microcode and time than a simple LOAD or STORE.

I/O-intensive programs accessing a fixed disk will run quite slowly because PC-DOS performs the I/O through the XT 8088's 8-bit data path. I/O access to data on the mainframe through the coax/3274 controller link can be quite fast if the 3274 is attached to a channel and the mainframe is not heavily loaded. A remote 3274 will suffer from telecommunications data rates so slow as to require short records or transmission to be infrequent.

COSTS

Operating the XT/370 requires you to purchase both XT-related hardware and software. You'll also incur the costs of connecting to the mainframe. Table 2 lists the base price of an XT/370 with

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a monochrome display and a 10-mega-byte fixed disk. The \$10,257 price tag does not include PC-related software and extra hardware, which could bring the actual purchase price up into the \$12,000 to \$14,000 range. Clearly, the XT/370 is to be used in the IBM mainframe environment, where monthly budgets for system hardware may fall in the \$20,000 to \$2,000,000 range. If you already have an XT system, you can upgrade it to the XT/370 for \$3790. (Order the IBM Personal Computer XT/370 Option Kit, feature 3891.)

The additional mainframe costs include coax cable and 3274 port connections. They can run from \$100 to \$200 per terminal. The number of XT/370s actively connected to a 3274 control unit affects total performance. Extensive file transfers will slow 3274 performance and cause poor response times from other terminals connected to the same 3274.

If you use leased software, add it to your operating costs. IBM's policy on VM/CMS licensed program products is to charge a monthly usage fee for each

XT/370 using the software. Table 3 shows the monthly charge for some of IBM's commonly licensed products.

Balance against these costs the potential savings in mainframe costs that using the XT/370 can mean. If you purchase the XT/370 in lieu of an IBM display terminal, you'll save about \$2000. You'll realize an indirect saving by reducing the load or response time of the shared mainframe. This can, in turn, postpone mainframe upgrade expenditures. The most important savings, and the most difficult to measure, are

The Fifth Generation By David L. Cohn

Once again, the Japanese are taking an American idea, modifying it, and selling it back to us. In the past, it was TVs, stereos, and automobiles. Now, it is computer "generations."

Generations began simply enough. When transistor-based computers were introduced in the late fifties, a major change took place. Suddenly, the old vacuum-tube machines were obsolete and a new era had dawned. The old machines became the first generation, and the new machines the second.

In the mid-sixties transistors gave way to integrated circuits, and IBM's System/360 heralded the arrival of a third generation. The increased circuit integration of the IBM System/370 earned it the title of fourth generation. Since then, there's been chaos. No new technology has been anointed as the fifth generation.

The family tree seemed so pat. A new generation was declared whenever circuit technology changed the nature of computers. At each step, computers became more available and more important. Until, fortunately, since the System/370, computers have improved through evolution, not revolution. There have been no new generations... or have there?

The Japanese have been watching. They saw that no one had used the fifth-generation label. They grabbed it and turned it to their own purposes. They would have us believe that fifth generation means artificial intelligence and talking computers and listening computers and fancy software and robots and... Enough!

"Generations" refers to circuit technology, not applications. Sure, applications are important; sure, the Japanese

pose a threat. Sure, we must reclaim our technology leadership. But let's start at the beginning; let's reclaim our terminology leadership.

THE REAL FIFTH GENERATION

The fifth generation means microprocessors! There, I said it. In the past, hardened computerists, those who dealt with mainframes, would have laughed at such a statement. "A microprocessor isn't even a computer," they would say. "Clearly, it can't be the next generation of computers."

Although that might have been true of the 6502s and even the 8088s, it's no longer true. The IBM PC XT/370 is a real computer with a real operating system and real programs. It even offers virtual memory.

Perhaps the greatest problem with declaring microprocessors as the fifth generation is that they, too, are based on integrated circuits. Consider this, however: the large-scale integration (LSI) circuits of the fourth generation evolved from the small-scale integration circuits of the third generation. What mattered was that this evolution in component technology changed the nature of computers. The same thing is true of the transition to microprocessors. Although they evolved from LSI technology, they have undeniably altered the concept of a computer.

But why declare the XT/370 the fifth generation of computers? Why not the PC? Or the Apple II? Or the Altair? Because the XT/370 brings the microprocessor directly into the world of the big computer. It cannot be dismissed as a hobbyist's toy. With its System/370 instruction set, its powerful system software, and its high-speed communication, it can

act as an integral part of a larger computer.

Just as each of the first four generations marked a distinct role for computers, so does the IBM PC XT/370. Soon these machines will be connected into networks of interoperating systems. In fact, one of the nicest features of the XT/370 is its high-speed communication with a host computer. When the host is running IBM's virtual machine (VM) operating system, an XT/370 can access host files as if they were local. All of VM's file protection and multiple-access features are still in place, but the processing is done in the small computer.

If my argument has a weakness, it is that the IBM XT/370 is not really "a microprocessor." In fact, it uses three microprocessor chips and a fourth coprocessor. These function as two cooperating computers to form the full system.

The familiar 8088 processor on the PC motherboard is really a slave computer in the XT/370. It acts as an I/O (input/output) processor to the XT/370 processor. The 8088 takes care of the keyboard, screen, disks, and communications hardware. Most of these devices use standard PC-DOS routines to respond to XT/370 processor requests. The major additions to the XT/370 include the new 3277 emulator board, which allows high-speed communication with an IBM host.

The other two microprocessors and the coprocessor (an 8087 and two 68000s) form the XT/370 processor. The System/370 instruction set is too complex to be controlled by a single chip—that is, by a single chip using 1982 circuit technology. (It takes a while to go from chip design to finished computer.) IBM decided to divide the instruction set into three pieces

in your own improved productivity. An XT/370 user can now compute at a pace independent of mainframe load and availability.

A NEW DIRECTION

As a personal computer, the XT/370 fits close to the top of the IBM PC line. Most of its memory is slower, its fixed disk has less free space available, and the loss of three board slots restricts the number of board-level products that you can add.

Within the VM/CMS environment, the

XT/370 can only benefit by its coexistence with a personal computer operating system and from the thousands of available microcomputer software packages. Software innovation over the past five years has come for the most part from the microcomputer end of the industry. Mainframe software innovation suffers the inertia of having to support older software and hardware technologies even on new hardware. For most mainframe users, however, the XT/370 link—though it's designed to be used with a mainframe—is not general

Table 3: Monthly charges for licensed XT/370 software.

370 Product	Monthly Charge per XT/370
ASSEMBLER H	\$9
BASIC	\$21
COBOL (Compiler)	\$19
COBOL (Debug)	\$21
DCF/SCRIPT	\$18
FORTRAN (VS)	\$17
PL/I (Compiler and Library)	\$29

and incorporate each piece on a separate chip. The three sets include the popular nonmathematical instructions, the popular mathematical instructions, and everything else.

The first instruction set is on a modified 68000 chip. Its microcode has been altered so that it responds to System/370 instructions rather than 68000 instructions.

A modified Intel 8087 is used for the important mathematical instructions. The chip now does arithmetic according to the IBM standard rather than the IEEE standard. The differences are in the details, but the XT/370 will produce precisely the same numerical results as a large IBM mainframe.

The leftovers in the third set are accommodated on a second 68000. This one uses standard 68000 instructions to do these odd jobs. It's a bit slow, but these instructions aren't used much.

THEORY AND PRACTICE

Together, the three processors make up the central processing unit of a mainframe System/370 computer. They can run almost all programs on an XT/370 that can run on a mainframe 370.

The major limitation relates to memory addressing. Even though the memory shared by the XT/370 processor and the 8088 contains 512K bytes, the XT/370 can use 4 megabytes. If the XT/370 wants data not in the physical memory, the 8088 fetches it from a DOS file on the disk. In this way, the XT/370 processor can address up to 4 megabytes of "virtual memory." However, a large 370 has 16 megabytes of virtual memory. Therefore, the unusual program that needs more than 4 megabytes won't run on an

IBM PC XT/370.

For an operating system, IBM has developed VM/PC (Virtual Machine/Personal Computer). This popular software is really two pieces: VM/CP (Control Program) and VM/CMS (Conversational Monitor System). CP is the basic interface to the hardware and CMS is the user interface.

For the IBM PC XT/370, portions of the control program run on the XT/370 processor and portions on the 8088. This software was created especially for the XT/370. CMS is a direct descendant of the mainframe CMS. All other software comes straight from the big System/370s: the same compilers, the same editors, the same applications.

On mainframe System/370s, it is possible to use environments other than CMS. In fact, some researchers even run UNIX. On the XT/370, IBM supports only CMS. However, provisions exist to create other environments, and someone may choose to create them.

Thus, the IBM PC XT/370 is a true System/370. It marks the first time mainframe power can sit on a desktop. It certainly won't be the last. DEC is preparing a desktop VAX. IBM may use its XT/370 chip set in other packages. It may even be possible to fit the entire System/370 instruction set onto one chip using 1984 technology. In any case, the IBM PC XT/370 is a definite step forward in computer technology, the first of a new breed of computers—the Fifth Generation.

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enough to support their software. The IBM MVS and DOS users and people who use incompatible mainframe systems will have to wait for the next upgrade.

The market will determine the value of the XT/370. Unfortunately, the large and growing number of IBM mainframe VM/CMS sites has a relatively small budget and attendant hardware. For IBM, the value, beyond revenue, of the XT/370 is its position as a desktop version of a mainframe system. This presents direct competition to desktop 370 vendors such as Canaan Systems and Spartacus Computer and indirect competition to vendors of plug-compatible mainframe and desktop-to-mainframe systems alike.

Viewed as the first in a series of desktop systems, the XT/370 is a qualified success. The hardware and software design teams at IBM deserve credit for fitting all of the 370's features into the XT. Future advances and integrations might result in an even better computer. For example, IBM might add:

- Speed—there's never enough
- More RAM storage—at least 1 megabyte for VM/CMS; more for MVS
- Greater and faster fixed-disk storage
- Better I/O support—a 16- or 32-bit data bus
- MVS operation—needs a "skinny" MVS
- Autonomous operation—comes as a result of more storage above
- Color display support—3270 PC and 3279 display
- Networking support with integrated remote file management. ■

NUMBER CRUNCHING ON IBM'S NE S9000

*IBM joins with MIT's National Magnet Lab
to develop spectrometers for imaging systems*

BY DAVID J. STATES



Photo 1: IBM's scientific computers, the S9000 series. At right is the S9001, at left is the S9002.

The National Magnet Lab NMR group, which builds and supports high-performance nuclear magnetic resonance (NMR) spectrometers for research use, has recently collaborated with IBM in the development of NMR imaging systems. In the past, the lab has used minicomputers such as the PDP 11/34 to control spectrometers, but for this project we elected to use the IBM S9000. While the S9000 is a desktop computer, it is based on the Motorola 68000 processor and has considerable processing power. This was enhanced by the SKY MNK-V array processor from SKY Computers (figure 1). The 24-bit address

space of the 68000 and the S9000's ability to support large amounts of RAM (we use as much as 2 megabytes in some machines) make the S9000 suitable for running the large control and analysis programs used in NMR spectroscopy and imaging.

Figure 2 is a block diagram of the electronics in our imaging spectrometer. NMR signals are generated by exciting a sample in a high magnetic field with RF (radio frequency) pulses from the transmitter. These signals are amplified in the receiver, digitized, and averaged. NMR imaging uses magnetic-field gradients to label nuclei spatially. In modern

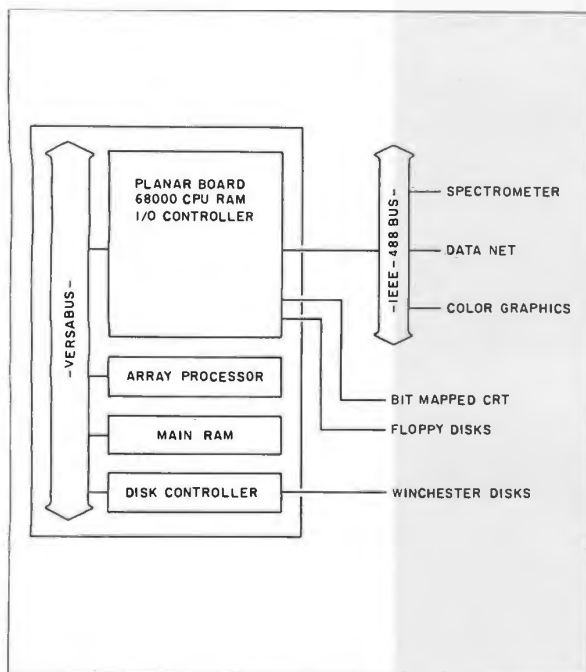


Figure 1: The architecture of the S9000 computer system used in the MIT NMR project. The 68000 CPU and SKY MNK-V array processor share access to memory over the VERSABus. You can use as much as 2 megabytes of memory in imaging applications.

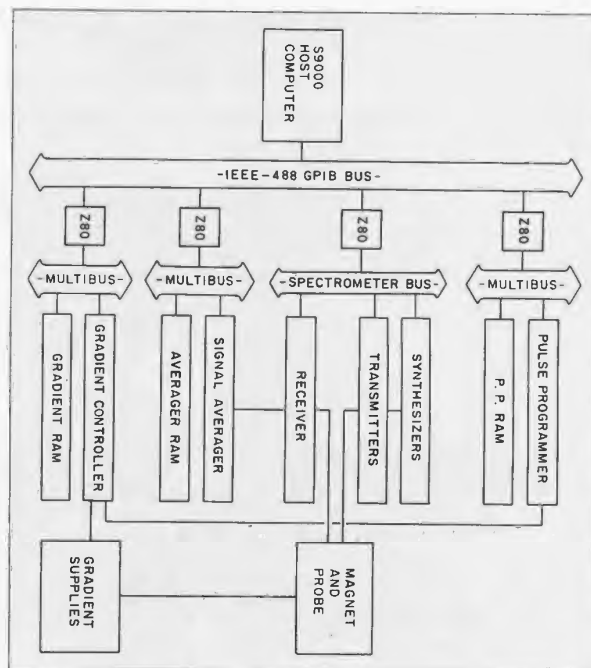


Figure 2: The electronics of a state of the art NMR imaging spectrometer. Nuclear spins in the sample probe are excited by RF pulses from the transmitter, and their response is recorded by the receiver and signal averager.

NMR spectroscopy, experimental control and data processing are performed digitally. Our design emphasizes modularity and standard interfaces so we can customize the spectrometer by swapping modules. The use of multiple independent processors simplifies design and eliminates bus contention problems.

NMR includes two important time scales. The first is the time scale of nuclear spin motion in the magnetic field, typically involving fractions of microseconds. The RF hardware and custom-built pulse programmer in the spectrometer deal with these extremely rapid events. The second time scale deals with repetitive-signal averaging and the user interface, events that take about a second. This regime is coordinated by the host computer.

Our control program is based on a powerful command parser. Making all aspects of spectrometer control accessible through the command language gives us versatility, and a sophisticated set of control-flow operations in the command language let us program and execute complex experimental protocols easily. The command interpreter allows us to define symbols and macros of commands. Loops, branches, and conditional branching are supported within macros, and macro calls can be deeply and recursively nested.

In a typical experiment, the pulse programmer is triggered, the signal average records from 1000 to 16,000 data points, and a subset of this data is sent back to the host to be displayed. When signal averaging is complete, the entire data set is sent to the host, stored on disk, and manipulated in a variety of ways such as scaling, baseline correction, Fourier transformation, data smoothing, and application of resolu-

tion enhancements.

Because some experiments run for hours, we needed the ability to perform simultaneous data acquisition and analysis. This is achieved through multitasking. One task runs the command interpreter and interacts with the user, while a second monitors the actual hardware.

The hardware-control task is responsible for real-time chores such as polling devices and fetching data during free periods of the signal-averaging cycle. Since these free periods might be as short as 100 milliseconds (ms) and as much as 8K bytes might have to be fetched, a reasonably fast transfer is necessary. The IEEE-488 general-purpose instrumentation bus (GPIB) from National Instruments serves this purpose and is supported by a fast direct memory access (DMA) port on the S9000. The CSOS operating system provides asynchronous I/O (input/output) and intertask signaling capabilities necessary to coordinate the activities of the main command interpreter and the subordinate hardware-control tasks.

Our spectrometer control program, RNMR, was developed by Dr. David Ruben at the National Magnet Lab (NML) and consists of approximately 20,000 lines of FORTRAN code and an additional 2000 lines of assembly-language support

(continued)

David J. States, M.D., Ph.D., wrote this article while he was doing research at the Francis Bitter National Magnet Laboratory at MIT. IBM was collaborating with the laboratory in imaging medical applications.

States has begun his internship at the University of California, San Diego, Medical Center (225 Dickinson Rd., San Diego, CA 92110).

Scientific Computing: The Shortcomings of the Micro

The university computing centers of the sixties provided a haven for the growth and development of computing technology, primarily applied to scientific number crunching. Similarly, the minicomputers of the seventies were developed and applied with great success in scientific work. Microcomputers with significant computational power have recently appeared, and they are becoming increasingly attractive as scientific processors. The desktop IBM S9000 and SKY array processor used in this project perform the computations we need in our work at a real rate of better than 2 microseconds per floating-point operation. To appreciate how impressive this is, remember that the ENIAC, that room-sized behemoth that gave birth to electronic computing, required 200 milliseconds to do the same operations. In an hour of processing, the S9000/SKY system will do more computation than the ENIAC did in its entire lifetime! Raw arithmetic benchmark speed is not the only requirement of a scientific computer, however.

Scientific work usually involves work with floating-point numbers, big programs written in FORTRAN, and the manipulation of substantial data sets. Program development is often a major part of the task. Where are micros weak? First, there have been problems with support, documentation, and access to experienced users. Microcomputer compilers have also not been up to snuff, and FORTRAN is probably the worst offender. If program development is your work, compilation speed and reliability is essential. Micro compilers and linkers operating off floppy disks are just not fast enough. Computing speed has also been an issue. Floating-point arithmetic has, in the past, been too slow on micros to be useful. The storage capacity of floppy disks has also been insufficient for reasonable-sized programs (or even source listings). And then there are bugs.

What is the cost of a bug? With a major demonstration and site visit coming up on December 4, I came into the lab on December 1 and found my computer hung up. I tried rebooting, but that didn't work. I tried going back to backup copies of the software. That didn't work. I figured that maybe my machine was flaking out, so I tried running the program on two others. Still no dice. Panic! Why does my program load, begin execution, and then just hang up? About 3 a.m. on December 2, I finally found the answer. It was not my program after all. There was a small

error in the system relative time clock that caused it to return a year and 100 milliseconds when you asked for a 100-millisecond delay during the month of December. With the last month of the year, the carry got screwed up. Logical, right? No problem. By 3:30 a.m. I had everything converted over to absolute times and running perfectly. Of course, my hairline had receded a quarter inch, and I had barely spoken to my wife for two days.

A scientific computer cannot tolerate bugs. To date, micros have accepted far too many. In this regard, the big companies have a tremendous advantage and responsibility. I was disappointed with the extent to which even IBM was willing to cut corners on reliability and documentation in the early stages of the S9000 project. Perhaps it is unfair to compare a brand-new little machine with the mature VAX system, but the VAX is the current standard, and it has very few bugs.

COMPILER AND DATA STORAGE

Most scientific computing is performed with floating-point numbers. These numbers exploit our usual concern with relative rather than absolute precision, and they allow for a wide range of absolute values in the real world. In floating-point format, numbers are represented as the product of a power of two and a fraction. The exponent is used to obtain the range, while the fraction provides relative accuracy. For example, the number 12.0 is 1.5000 times two to the third power. In IEEE standard floating-point format, this would be coded as follows:

Sign	Exponent	Fraction
bit 31	30-23	22-0
12.0 = 0	10000010	(1)1000000000000000000000
+	(3 + 127)	(1.5)

where the exponent is shifted by 127 so that both large and small numbers may be represented, and the leading 1 in the fraction is implicit.

To add a pair of numbers, each must be separated into its exponent and fraction, the exponents must be compared, and one fraction must be shifted relative to the other so that they are aligned (in effect, multiplication by powers of two). Then the fractions can be added, and a new exponent must be calculated. Finally, the sum and exponent must be recombined to return the result as a new floating-point number. Microcomputers

usually perform floating-point arithmetic slowly because they must perform the bit manipulations in software. Larger computers do this in dedicated hardware, with a great improvement in speed.

COMPILERS

Scientific programming necessarily involves the use of compiled code to achieve adequate speed. With large programs, there is also a premium placed on the speed and reliability of the compilation. Micro compilers usually fail in two respects—they are slow, and they are buggy. They are slow because micros do not always have that much central-processor power and because most micros operate off floppy disks. Reading and writing work files on a floppy disk slows the whole process down to the lackadaisical speed of floppy-disk I/O. Also, interactive work on a timeshared system may not accumulate much total central-processor time, but what is used will be clustered into bursts of compilations and links. A micro capable of providing the same average computational rate will not compete in real response time. Hard disks and a 68000 processor go a long way toward overcoming these speed problems.

DATA STORAGE

Scientific computing often requires more storage capacity at greater speeds than micros have been able to provide. For data, the requirements are obvious, and most workers are quite aware of how much storage space they will need. Program development also requires storage space, but this requirement is often overlooked. For example, 10,000 lines of source code (a moderate-sized project) might contain 100,000 characters. Compiling it will generate object and/or listing files of comparable size. Allowing for a couple of backup copies, library files, sources for library files, the compiler, and the linker, the capacity of most floppy disks is rapidly exceeded. I/O to floppy disks is also slow. The one- and two-second delays every time you need a new piece of data off the floppy disk add up and take their toll in aggravation and lost productivity.

We overcame these problems by configuring our program-development stations with 10-megabyte hard disks. These give adequate storage space and cut access times dramatically. The hard disks allow you to scan through files about as fast as a video screen can display the data.

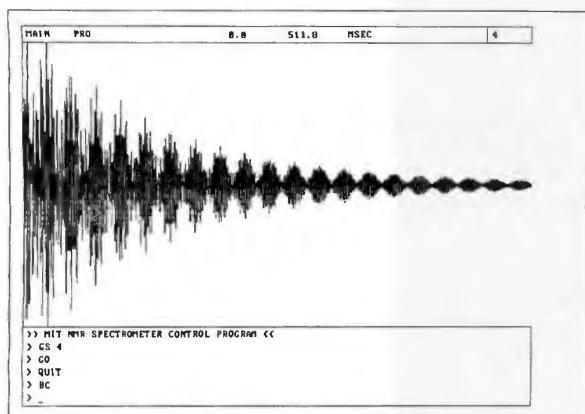


Figure 3: The raster graphics display of the S9000. You can draw data very rapidly by writing directly to the RAM, which is mapped bit by bit to the screen pixels.

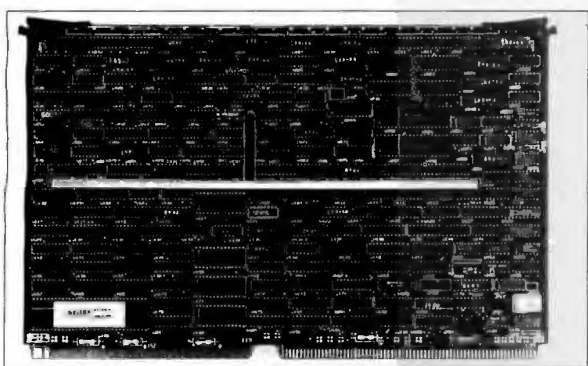


Photo 2: The SKY MNK-V array processor performs floating-point operations at high speeds.

routines. In the course of my work, the program was adapted to the S9000. On the S9000, Pascal routines can be substituted for much of the assembly code, a tribute to the value of mixed-language environments. The massive amount of directly addressable RAM (random-access read/write memory) on the S9000 greatly simplifies other aspects of programming and offers flexibility not available on the PDP-11.

The PDP-11 restricts processes to 32K bytes of address space. Since this is insufficient even for a single data set (8K points $\times$ 8 bytes/point = > 64K bytes), the PDP-11 versions of RNMR were heavily overlaid and included an internal virtual-memory subsystem. None of this was necessary on the S9000. In fact, I/O optimization was largely irrelevant because most data could be maintained in core throughout execution. Because little disk I/O is necessary and we use an array processor for most data manipulation, the response time is much faster on the S9000 than it is on any of the PDP-11 systems or our VAX 11/730.

The bit-mapped graphics display of the S9000 (figure 3) has proved its value in our application. This is the one place where a significant amount of assembly-language code was written (a package developed in collaboration with Richard

Mushlin and Jim Cooper at IBM Instruments). By addressing the screen RAM directly and using address-register manipulations, we are able to scale and display a data set with full-screen resolution (768 by 480 points) in less than 200 ms. For interactive tuning of the spectrometers, such speed is critical. On the PDP-11 and VAX systems, the graphics display must be addressed over an external port, and a display update takes one to two seconds.

THE SKY MNK-V ARRAY PROCESSOR

To achieve the processing power we needed for interactive data analysis, we included the SKY MNK-V array processor from SKY Computers in our S9000s (see photo 2). NMR is nearly an ideal application for array processing because most of our computations involve manipulations on large linear arrays of data. The SKY product is a pipelined floating-point processor, which can increase the speed of floating-point arithmetic on the S9000 by a factor of more than 100. Physically, it is a single PC board that plugs into the VERSA-bus, and it operates as an intelligent I/O device. Rather than dedicating RAM to the array processor, the SKY board shares memory with the host 68000, performing DMA transfers to get data as needed. This architecture meshes well with the S9000 and its very large RAM. It also simplifies and reduces the cost of the array processor.

SKY provides a library of vector-manipulation routines, including integer-to-floating conversions, vector-vector and vector-scalar arithmetic, matrix-manipulation primitives, FFTs (fast Fourier transforms), convolutions, and polynomial evaluation. The company also offers an extended library with vector trig functions, exponentials, square roots, and more matrix-manipulation tools.

Accessing the array processor efficiently is easy if you want to perform functions provided in SKY's library. For example, a Fourier transform (FT) is a common mathematical transformation used in signal processing and image analysis. In simple terms, it converts from waves in a time series to frequencies in a spectrum. The FORTRAN code necessary to perform an FT with the SKY array processor is as follows:

```
CALL VFFT(vec__in,incr__in,vec__out,incr__out,len)
CALL VWAIT
```

where vec__in is the input data, incr__in is the increment between data points in the input vector, vec__out and incr__out specify the output vector, and len gives the number points.

The increment specifications are a rather clever feature allowing you to access a matrix of data in either rows or columns without transposing it. For imaging and other multi-dimensional applications, this can save a lot of unnecessary data shuffling. The VWAIT call tells the host to wait for the array processor to finish before proceeding. The array processor is able to act on its own through the FT, but, of course, the results will not be valid until it is done. Since the FT might take a few milliseconds, you might want to do some other work with the host while waiting. In that case, you can delay the VWAIT call.

Does the SKY board give us much processing power? You
(continued)

bet. A 1024-point complex FFT takes only 82 ms, including a bit reversal and swap needed to set up the data for the FFT (both are in the SKY library). The same FFT on a VAX 11/780 with DEC's FP accelerator takes 230 ms (FFTCC from the IMSL subroutine library). We could do better by coding the FFT in assembly language, but the advantage of the VAX is supposed to be ease of programming.

Optimizing use of an array processor is not the same as optimizing your typical computation. To get some feeling for why, let's examine the processing times required (table 1).

The SKY board achieves its speed by pipelining. In other words, the different parts of several floating-point calculations are overlapped in dedicated hardware instead of waiting for each operation to complete sequentially. This makes arithmetic processing of numbers faster than the rate at which data can be moved in or out of the SKY board. To speed up processing, a second level of pipelining is used in I/O operations. Data movement on and off the array processors is handled by DMA controllers, which operate independently of the arithmetic processor. The slowest step is actually keeping everything coordinated.

To optimize performance, the name of the game is to maximize the computation done per instruction by using long vectors of data. You also want to get as much done between the times you must stop and wait for completion. Resynchronization waits must be introduced any time you need to use the result of an array-processor calculation in the host. A third goal is to minimize the amount of I/O needed to complete a given calculation. Arithmetic on complex numbers is thus comparatively cheap (twice the time of a real operation rather than the usual factor of about six).

Using the on-board scratch-pad memory can also decrease I/O delays. To see how this is done, consider a simple problem—multiplying a vector by a matrix. The crudest algorithm would be to follow a typical pencil and paper approach

```
For i = 1 to n_rows
  Vector_multiply ( Row_i * Vec_in => Temp )
  Vec_out(i) = Sum_of_elements ( Temp )
End loop
```

where the matrix is represented by a series of row vectors Row_1 to Row_n. Vec_in is the input vector, and Vec_out is the result. The crude algorithm would require four vector moves and two instruction packets per row. You can double the speed by using the dot-product routine that SKY provides to combine the two operations.

```
For i = 1 to n_rows
  Vec_out(i) = Dot ( Row_i, Vec_in )
End loop
```

This still requires moving two vectors per row into the SKY board. You can gain another factor of two by using the scratch pad.

```
Move ( Vec_in => scratch_pad )
For i = 1 to n_rows
  Vec_out(i) = Dot ( Row_i, scratch_pad )
End loop
```

Note that even in the most efficient algorithm, the speed of the calculation is determined by the I/O delays, not the speed of the floating-point operations. Array-processor performance figures quoted in millions of floating-point operations per second (MFLOPs) ignore this fact and might be quite misleading.

Unfortunately, to use the scratch pad you have to delve into SKY's "Advanced Programming" routines and worry about a lot of details the standard library takes care of for you. It is analogous to assembly language versus FORTRAN. Chances are you will not have to worry about this, though, as the second algorithm will run a length 100 real vector through a 100-by-100 matrix in about a tenth of a second.

You must compromise when using an array processor. Array processors work well with computations that involve linear access to arrays of data, but they will not help with sorts, parsing, or algorithms with complex control branching. The SKY array processor, like most low- to moderate-cost units, works only on single-precision floating-point numbers. If you need double precision, you are out of luck. Similarly, the SKY board will do fast integer-to-floating conversions, but if you want the calculation done in integer format, it will not help you. (Of course, the 68000 is pretty fast by itself for integer work.) The SKY libraries offer a good set of basic operations, but functions not supported by the library require more work.

The S9000 is not the only computer SKY supports. SKY array processors are available for the Multibus and DEC's Q-bus, as well as the VERSAbus, all for about \$6000. In addition, they have a slower, less expensive floating-point processor that supports double-precision arithmetic. SKY has subroutine libraries that operate under many different operating systems, including several flavors of UNIX.

PROGRAM DEVELOPMENT

Bringing up 20,000 lines of code on a new machine is no small task, and programs will continue to evolve once they are running. The capabilities of the S9000 as a program-development station are, therefore, almost as relevant to the project as its ability to run the program in the first place.

CSOS is the operating system IBM supplies with the S9000. While IBM does offer XENIX (a Microsoft UNIX derivative), CSOS remains the focus of most of its development work. CSOS is not a finished product, yet it comes to market at a time of great opportunity. CP/M and MS-DOS clearly do not exploit all the power available in a processor like the 68000. Nor is UNIX the be-all and end-all of operating sys-

(continued)

Table 1: Basic steps and times for optimizing an array.

Operation	Time*
Send commands asynchronously	290 μ sec
Wait for completion	235 μ sec
Tell the SKY board to repeat the last command	20 μ sec
Move a word of data (on or off the SKY board)	1 μ sec
Floating-point divide of on-board data	7 μ sec
Add, multiply, or compare on-board data	0 μ sec†

*Times were calculated by performing the relevant operation 1000 times on a length 1000 vector and dividing the number of seconds needed to perform the task by one million. Command-processing times were obtained by extrapolating to zero-length vectors.

†These operations are pipelined and are faster than data movement.

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tems. UNIX is full of bizarre and obscure abbreviations, its file system is not particularly robust, the framework of intertask communications is limited, it has no asynchronous I/O facilities, and it is unable to service many real-time applications. CSOS needs some work, but it might be a better alternative to these systems.

CSOS includes a solid basic environment for multitask programming. It supports assigned priorities, interrupts, and asynchronous event handling, and it provides useful timer and semaphore managers for synchronization and communication tasks. Asynchronous I/O is fully supported and functional to the disks, terminal ports, and GPIB port. Device drivers follow a uniform format, making device-independent code easy to write.

The major limitation of CSOS is its lack of a dynamic loader, which is related to the S9000's lack of memory-management hardware. The lack of a dynamic loader is critical because it prevents you from running multiple copies of the same image simultaneously. In particular, you cannot run a second copy of the command interpreter to do multiuser or batch-mode processing, despite the S9000's ability to support two or three interactive users or batch-mode processing while a user is editing.

The user interface in CSOS also needs work. All commands must be uppercase, and abbreviations are not allowed. It has no facilities for defining command symbols or for redirecting input or output streams. Logical name handling is static and limited to disk devices. Although it does have a minimal shell script facility, it will only execute a list of commands in strict sequence. It contains no branching, loops, or error status, and calling one shell script from another is illegal. At least it will process command arguments and substitute them in the shell script as directed. Many of the utilities are not set up to execute directly from a command line. Instead of parsing the command line for options and switches, they prompt you for the information. Hence, they cannot be incorporated into automated shell scripts.

It is not fair to compare the S9000 to the VAX, but I am going to do it anyway. All of the features mentioned above are available in VAX/VMS, and they are useful. The IBM people tell me that these are all cosmetic, and in a dedicated application, your program will replace CSOS as the real user interface. Cosmetic or not, it's nice to work in the VAX/VMS environment.

The CSOS file system is another weak spot. CSOS has all the tools to create a hierarchical directory structure (as in UNIX or VMS), but IBM has not done it. On a floppy disk, having all your files in a single directory is not too much of a bother, but this is not acceptable with a 10-megabyte hard disk. The IBM directory utility does not help matters. It dumps the file names in random order on the screen and does not even bother to compress blanks between the file name and the extension. Alphabetic listings are provided as an option, but they are abysmally slow. I ended up writing my own directory utility because I got tired of waiting for IBM's.

The CSOS intertask communication channels are not very helpful because they do not support asynchronous I/O. Since asynchronous operation is the basic reason for undertaking multitask program development, this is a fairly significant limitation. You can use semaphores to coordinate asynchro-

nous message exchange through shared memory, which is a good alternative to the CSOS intertask channels. No default memory protections are applied, so all of the RAM is, in effect, global-shared memory. Memory protection is available, but it is undocumented at present.

If cost is a consideration, CSOS will run on a bare-bones S9000 (central-processor board alone with no peripherals). In contrast, the XENIX operating system requires hard disks, a memory-management unit, and additional RAM.

In summary, CSOS provides the basic tools expected of a real-time multitask operating system and has performed solidly for us. In the final analysis, I am able to do things in CSOS that would be impossible under UNIX or many other operating systems. CSOS is not yet a finished product, and future releases of the user interface will probably be much better. (The current version 1.1 is worlds better than the 1.0 release.)

DOCUMENTATION

Software is only as good as its documentation. The documentation that came with our first S9000 was poor, especially coming from a company like IBM. In version 1.1 of the operating system, IBM has gone a long way toward repairing its most glaring faults. The language reference manuals are reasonable, although they are not exceptional in clarity or scope. The basic installation guide, operator's manual, and diagnostics are clear and complete. The organization of the manuals could use some work. For example, most error codes are documented in one appendix, while others are scattered through the manuals. Since you may not know precisely which utility generated an error code, finding its description can be difficult.

IBM includes step-by-step instructions on how to rip the guts out of your S9000 and put it all back together again, which is important because we have handled most of our servicing by shipping boards back and forth to IBM's Instrument Service Center in Danbury, Connecticut.

The internals and hardware documentation were nonexistent at the outset, but that seems to be changing. I don't know why IBM people are so secretive about the workings of their computers. Even prying loose a list of I/O addresses was painful. (IBM now includes it in the documentation.) The S9000 is called "a laboratory computer." In a laboratory setting, you must frequently interface weird things to the computer. Without documentation, there is no way to do this. Scientists are also a curious bunch, and many of us just want to know what is going on inside our boxes. As a collaborative research site, we normally have access to internals documentation that is not available to the average customer. In IBM's case, schematics are never available.

EDITORS

IBM supplies two editors for the S9000. The first, ED, comes with CSOS and was written by the S9000 group. They should not have bothered. The keyboard layout is illogical, the command set is primitive, and there are no macro or key-redefinition facilities with which to expand it. In a candid moment, even the IBM staffers will admit that ED is painful to use.

The second editor, PE, is the IBM PC Personal Editor ported

(continued)



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to the S9000. It offers a more varied command set and the ability to edit multiple files simultaneously. Most important, it has user-definable initialization and key-definition facilities, which allow you to create macros, associate them with keystrokes, set tabs and margins, and so forth. The initialization file supplied by IBM is limited and for some unknown reason, tries to make PE look like ED.

With a little work, you can create a respectable editor with a rich command set, help facilities, and just about any other features you might want. My version of the editor defines

keystroke-motion, text-movement, and text-deletion commands, which operate by character, word, or line. In a couple of keystrokes, I can move blocks of text and do text justification. I built in several customized program-development modes for each of the languages to do automatic indenting and setup of skeleton comment blocks.

THE CSOS COMPILERS

The high-level languages of the S9000 are one of its strong points. IBM offers Pascal, C, and FORTRAN as a package of



Photo 3: A closer look at the keyboard for the S9000.

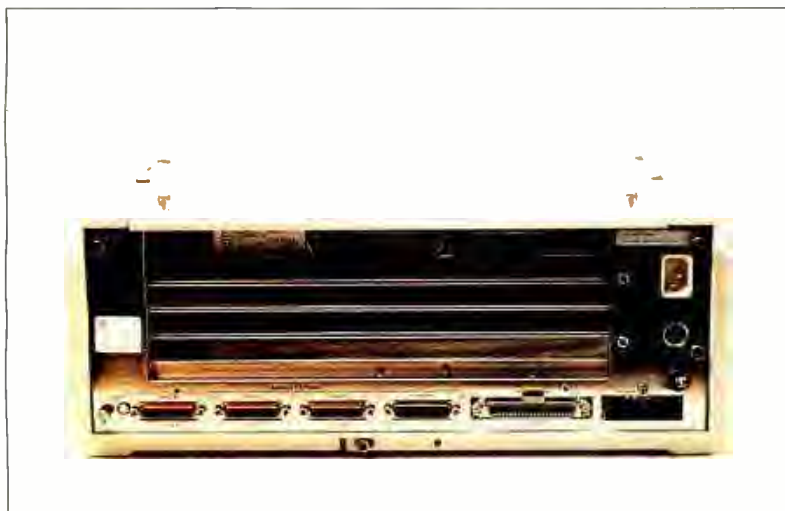


Photo 4: A rear view of the interface for the S9000.

Integrating the S9000

With four operational NMR spectrometers and three more in various stages of construction, the National Magnet Lab supports a reasonable-sized labwide computing facility. We have a VAX, two PDP-11s, and four S9000s. To optimize utilization of resources, we have developed a data-communication network tying these processors together. In this way, a single tape drive, a line printer, an electrostatic printer/plotter, and the big disk on the VAX are made available to all users, and data may be processed on an available processor while another is running a spectrometer.

This is not your average office-mail network. Mail messages and text files are typically a few hundred to a thousand bytes of data. We deal with 50K-byte to 10-megabyte data sets, and we would like to pass them around as quickly as possible. We implemented our data network on the IEEE-488 GPIB bus and achieve high data-transmission rates (200K bytes per second disk to disk) without sacrificing standardization.

Because we have seven computers from two manufacturers and run four operating systems (VAX/VMS, RSX-11, CSOS, and XENIX), you might wonder how we ever got our software running. This is a significant question. I/O interfaces are different for each of these operating systems, and even the disk file formats vary. RSX-11 (the DEC PDP-11 operating system) uses fixed-length records or variable-length records with fixed headers. CSOS and XENIX use fixed-record data files or stream text files with records delimited by carriage return characters. The VAX uses all sorts of formats.

First, we decided that we did not need to couple the network tightly into the various operating systems. We needed

mutually supported languages. You can write routines in any language and call them from almost any other. They all use the same code generator, and they share a common object file format, object librarian, and linker. BASIC is supported on the S9000 (see BYTE, February 1984), but it is not compatible with the other languages. IBM has committed itself to supporting the CSOS compilers on its XENIX systems, so code should be freely transportable.

The ability to mix languages is extremely valuable because, like it or not, no perfect programming language exists. Pascal might be great at providing a clean control flow, but doing

arithmetic on complex numbers can get a bit cumbersome, and I/O is limited. FORTRAN is good at coding math and has a rich I/O library, but whoever wrote FORTRAN specifications forgot about pointers and data structures.

Pascal is the "native" language of the S9000. Its compiler is the fastest, and it produces the most compact code. Much of the system software is written in Pascal. The S9000 Pascal is a variant of UCSD Pascal with nice UNIT and INTERFACE features built in. String handling is also done well. Although I was born and bred a FORTRAN programmer (real program-

(continued)

into a Laboratory Computing System

high data-transmission rates, but making the link transparent to the user was not really a requirement. Therefore, we decided to deal with the links as file servers. We also simplified the control structure by using the VAX as the central node of a star architecture. Our application rarely requires communication between peripheral nodes, but when it is necessary, it can be routed through the VAX.

We also attempted to keep programming modular. A file server sends raw data. It does not worry about what format the data is in or how such formats might be transformed. The network operates independently of file formats, and no special provisions are necessary to transmit text versus binary data. Another reason for this setup is speed. Disk I/O is done with block I/O, and the network transmits data about as fast as any of the disks are able to deliver it. We do not have time to mess around with reformatting.

At each node on the network, a small program monitors the network and delivers file data as requested. These programs must respond to only four basic command packets—open a file, close a file, read data, and write data—so they are fairly straightforward. The major complications involve error handling. To function reliably, the network must withstand a variety of insults, including system crashes at the individual nodes and timeouts that occur when the low-priority bus monitor gets locked out by a higher-priority job. The network monitors must also recover gracefully from requests to access nonexistent or inaccessible files and from file read/write errors. Debugging the attachment of a new node monitor is much easier if the network is resistant to internal protocol errors. We elected to enforce a strict handshaking protocol in which every command packet

generates a return status packet. In this way, both parties involved in an errant transaction will be signaled to take corrective action.

Most of the file reformatting is handled on the VAX. Since the RSX-11 file system is a subset of the VAX's, all PDP-11 files can be sent directly to the VAX without modification. With its variety of formats, the VAX I/O services are able to read and reformat most of the CSOS and XENIX files.

Data-format conversions remain a problem. The two largest computer companies on earth cannot agree on how to represent an integer in binary format. Digital Equipment Corp. (DEC) counts bytes from right to left, while IBM counts them from left to right. Floating-point numbers are even worse. The S9000 uses the IEEE standard format. On paper, DEC's form looks pretty close, but then the bytes are reordered, and there is an offset difference in the exponent. Operating on raw binary data, there is no general way to determine what reformatting must be done because you do not know what type of data you have. There are two solutions to the data-reformatting problem. The first is to transmit ASCII data (at least the S9000 and DEC agree on that). The second option is to write custom data-transformation routines that operate on specific binary data files and know about their internal structure. The latter approach is inconvenient but necessary when speed is a consideration.

We implemented our network on National Instruments' (NI) IEEE-488 (GPIB) bus, a standard bus originally designed for the control of electronic instrumentation. The bus permits asynchronous byte parallel transmission at rates of up to 500K bytes per second. The S9000 supports the GPIB bus as a built-in feature. A number of interface cards are

available for the Unibus and Multibus. We chose NI interfaces for the DEC computers. NI supplies good software support, and its hardware has been quite reliable. The S9000 port, on the other hand, was an unending source of frustration. Initially DMA did not work at all and was prone to causing crashes later on. The more sophisticated aspects of the device driver had bugs, and in slave mode, it dropped bytes of data. IBM seems to have finally solved the hardware problems. XENIX on the S9000 will only attach to the bus as a master. Since you cannot have two masters on the bus simultaneously and the VAX is already acting as controller, this creates a problem. We deal with it by buffering the XENIX system through a custom box that acts as a slave on two independent GPIB buses. This is hardly ideal.

The GPIB bus does impose some limitations on the network. Principle among these is distance. IEEE specifications allow for a maximum of 20 meters of cable. In practice, we are able to exceed this a little, but it is still necessary to have all the computers in the same or adjacent rooms. NI sells repeaters that allow links over a kilometer, but they cost \$2000 a shot and reduce the data-transmission rates to 150K bytes per second.

A second interactive network sprang up spontaneously around the lab. This is based on RS-232C lines and terminal-emulator programs. A terminal emulator is a program that echoes I/O from your keyboard and a terminal line and from the line back to your screen. By connecting the terminal line to another computer or modem, you can log in and run on another computer without ever leaving your own host. If the terminal emulator can copy text files to and from the line, you have a functional and absolutely general network.

The 68000 instruction set is powerful, and the addressing modes are quite rich, with a variety of PC and address-register offset and indexing options. . . . The 68000 is a 16-bit processor with 24-bit addressing and some 32-bit instructions.

mers don't write Pascal), this compiler converted me.

FORTRAN 77 is fully supported on the S9000, and the FORTRAN compiler has proved to be reliable and reasonably quick. For a number of reasons, FORTRAN is not quite as compact or efficient as Pascal. The FORTRAN run-time library is an addition to the Pascal library, so the linked images are a little bigger. FORTRAN uses static rather than dynamic storage allocation, so data space is also not as efficiently used as it is in Pascal. Finally, by default, FORTRAN uses long-word integers (4 bytes), while Pascal uses short words (2 bytes). Unless you ask for short-word integers, the compiler will have to generate the additional code and storage needed to deal with long words.

FORTRAN has several pseudostandard features that the S9000 FORTRAN does not support. These include bit-wise logical operations on integers, variant argument lists, interchange of character and numeric data in argument lists, the free use of long variable names, hexadecimal and octal format conversions, and the ability to get record lengths on variable-length reads. None of these are part of the FORTRAN standard, but they are useful, and many FORTRAN compilers do support them (including, for example, the VAX FORTRAN 77). You can obtain bit-wise logical operators by equivalencing to logical variables and record lengths on variable-length reads by dropping into Pascal or assembly language, but you will have to live without the rest.

My experience with the S9000 C compiler is relatively limited. It seems to be reliable, but like many versions of C, the linked image files are enormous (the C printf function links most of the I/O library to every program). In evaluating a compiler for scientific work, it is important to remember that the C language specification requires that all floating-point operations be performed in double precision. Single-precision arithmetic might be slow on a microcomputer, but double precision is ridiculous. On the S9000, the stack-handling conventions of the C compiler and the Pascal and FORTRAN compilers disagree. You can call C routines from Pascal if you declare them to be C externals, but you cannot call them from FORTRAN.

The 68000 assembler, ASM, is an interesting development.

It has structured control flow. That's right, you can place IF THEN ELSE constructs, DO WHILEs, and REPEAT UNTILs directly into your assembly-language code. It also supports the usual macro facilities and other directives. Nothing will ever make assembly language into Pascal, but these features can be quite useful in avoiding the usual catastrophic jumble of assembly code.

The 68000 instruction set is powerful, and the addressing modes are quite rich, with a variety of PC and address-register offset and indexing options. After working with the 68000, I was a bit disappointed when I went back to the VAX to code a short routine. The 68000 is a 16-bit processor with 24-bit addressing and some 32-bit instructions. It is not a full 32-bit processor. In particular, multiplies and divides on 32-bit integers must be broken down to 16-bit operations. The VAX offers a full 32-bit instruction set and offset indirect addressing (the address stored in the memory location pointed to by a register plus offset). The latter is very useful in argument lists and is not available in the 68000.

The S9000 language system has a couple of annoying limitations. It is impossible to access or initialize FORTRAN common blocks in assembly language, and you cannot code real numbers in ASM data statements. On many other systems (such as the VAX), you can use assembly language to great advantage in initialization data structures with bit masks, pointers, and functions on which FORTRAN stumbles. The subroutine call-sequence convention is also not great. Arguments are pushed onto the stack rather than into a separate register as an argument pointer. This prevents optimization through the use of prebuilt argument lists. It also makes it easy to corrupt the stack. Pascal's rigid type checking avoids most such problems, but in FORTRAN it is easy to put the wrong number of arguments in a call statement or to substitute a character string for a numeric data type, either of which will crash the system. A minor bug in the S9000 linker forces you to link assembly code into the beginning of a large program if it is going to call globally defined subroutines. If your program code does not exceed 32K bytes, or if your assembly-language subroutines make only local subroutine calls, you will never have to worry about it.

IBM has recently released a real symbolic debugger, which works with all the compiled languages. You can load a program, run it, check trace points, break at specific points including line numbers, examine variables by name, and trace back through subroutine calls. This is a very useful little tool to have around.

When I began my work, there was no way to get a machine-code listing of the compiler output. A disassembler now exists and should be available soon.

EXPANSION CAPABILITIES

In assessing any computer system, expansion capability is a consideration. IBM offers a number of peripheral devices for the S9000, including printers, 5¼-inch and 8-inch floppy disks, up to 40 megabytes of hard-disk capacity, two A/D (analog/ digital) converters (high precision and high speed), and support for up to 5 megabytes of RAM. The hard disks are based on standard interfaces, so alternative vendors might have products available if you buy one IBM disk and

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THE S9000

want to add more later. The S9000 comes with the IEEE-488 GPIB port, a parallel printer port, and three RS-232C ports, all of which could be used to add peripherals.

The standard S9000 backplane will support five expansion slots. The hard-disk controller occupies one, and you can put up to 1 megabyte of memory into each of the others. In our application, the SKY array processor fills one slot. The S9000 is based on a derivative of the Motorola VERSAbus, but IBM modified several critical features. If you are going to look at nonIBM VERSAbus equipment, tell the vendor you intend to use it with an S9000 and see if he will support it.

CONCLUSIONS

The S9000 is a supermicro available in a reasonable and complete product package. It sports a real-time multitasking operating system, excellent compilers, and the backing of the biggest name in the game. By adding an array processor from SKY Computers, we were able to achieve truly spectacular number-crunching capabilities and have been able to integrate the S9000 into a major scientific data-processing application.

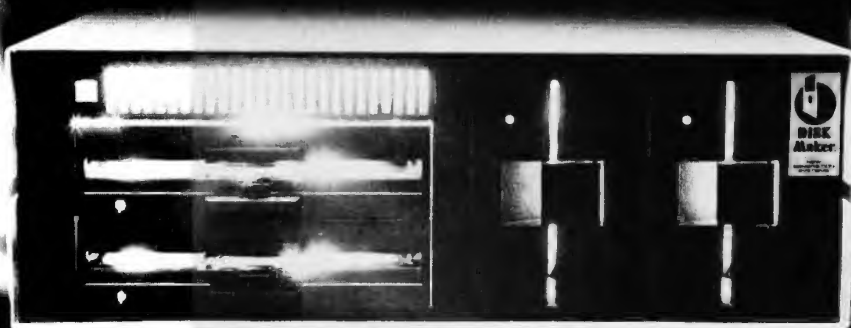
Would I recommend the S9000? As a dedicated processor, yes. It is a powerful computer, and its large memory is a real advantage in running large programs. CSOS supports real-time work that would be impossible under UNIX, and once

the applications software is written, you do not have to deal with the CSOS user interface. I did not like all the hardware glitches we ran into, but most have been cured, and the service has been excellent. The bottom line is that we have an inexpensive machine that does the calculations we need very quickly.

Would I recommend the S9000 as a general-purpose scientific computer? My major word of caution applies to micros in general. Be aware that raw number-crunching power is not the only thing you need in a general-purpose computer. Think about program development, data communication, peripheral devices, and access to knowledgeable people before you buy any system. The S9000 with CSOS offers an excellent set of compilers and will provide a good single-user operating environment. The S9000 will probably be a pretty good XENIX system with multiuser support, but IBM has to deliver the machines first.

Whether or not the S9000 is the super-PC of 1984, the MIT NMR project does demonstrate that, properly equipped, a microcomputer can take on real-world computing tasks with demanding computational requirements and handle them with finesse. The world of minicomputers and even super-minicomputers should take good notice. Because after all, the supermicrocomputers are only going to continue getting better and better. ■

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BY LARRY AUGUSTIN

THE MAINFRAME CONNECTION: IBM'S 3270 PC

High-quality graphics and multihost communications characterize IBM's 3270 PC

The remarkable market success of the IBM PC not only created an industry standard, but brought the PC under widespread scrutiny. It soon became painfully obvious that the PC was lacking in one major area—it couldn't talk to IBM mainframes. Sure, it could operate as a dumb terminal at 1200 bps (bits per second), but many computers can do that. It could also transfer files at 1200 bps (if you don't mind the wait), but again, that's nothing special. What was needed was a way to use the PC's intelligence in conjunction with that of a host mainframe, a way to make the two work together, not just transfer data back and forth.

Other manufacturers quickly saw the gap that IBM left open. They realized that the key to making PCs and mainframes talk swiftly was improving the data rate. You simply couldn't do much at asynchronous communications data rates: they're just too slow. The solution was to communicate over the standard IBM 3270 terminal interface. Third-party manufacturers began to develop 3278 terminal interface cards for the PC. As the number of 3278 interface cards increased, so did the potential of the PC as an intelligent workstation.

IBM is now in the workstation market with a series of new PCs designed to operate as workstations. The 3270 PC is the top of this new line of terminals.

The IBM 3270 PC plugs directly into an existing IBM mainframe 3270 interface. Its features allow simultaneous operation as both a PC running PC-DOS and as a 3278 Display Station Model 2, 3, 4, or 5. When used with the 3270 PC color display, it provides high-resolution color graphics. All this is packed into what looks like a standard PC XT chassis (including a 10-megabyte hard disk).



Photo 1: A shared screen on the new IBM 3270 PC. Four host programs can run at one time.

SESSIONS AND WINDOWS

The 3270 PC has a number of special features. The first of these, a session, is one of a set of areas in which your machine can operate. IBM windows manage different sessions and let you view several sessions running simultaneously on the screen. To tie all the sessions together, two types of intersession communication are possible: window-to-window copying and file transfer.

There are three types of sessions: host sessions, regular sessions, and notepad sessions. A host session involves connection to a System 370 host computer as a 3278 terminal. By means of its Distributed Function Terminal (DFT mode), the 3270 PC allows you to have as many as four host sessions active simultaneously, while being connected to the host through a single port. The DFT

mode requires some special software for the host's communications controller. In other words, although you have only a single terminal, you can log on to the host using as many as four different identifiers simultaneously. The second type of session is in the normal PC-DOS. There is nothing unusual about this session; it's exactly the same DOS (version 2.0 or greater) as on the IBM PC. The notepad session involves notepads, which are simply screen-sized places that can be used to make notes and save reminders, places to store temporary information. For instance, it is

(continued)

Larry Augustin (856 Twin Oaks Dr., Dayton, OH 45431) just graduated from the University of Notre Dame with a degree in electrical engineering. He will enter a master's degree program at Stanford University in the fall.

Two intersession communications are possible: window-to-window copying and file transfer.

possible to copy a directory of your files to a notepad for quick and easy reference. You can have as many as two active notepad sessions.

Sessions are managed by the use of windows. A window is a partial view into a much larger picture (see photo 1). A window can be as large as the full screen or as small as a single character. The 3278-2 terminal's display is 80 columns by 25 rows. By using windows, only a portion of that full screen is displayed at any one time. For example, assume that you had logged on to a host using four different identification numbers. Normally, this would require four separate terminals, but with the 3270 you can create four separate windows on one monitor. Each of these windows can be configured to take up one-fourth of the physical monitor, or approximately 40 columns by 12 rows. In each window part of the full screen of data associated with each connection to the host can be displayed. To view all the screen activity of a particular host, you can pan a window from side to side using the cursor movement keys. You can pan character by character or even pixel by pixel if your 3270 PC is equipped with the All Points Addressable (APA) adapter.

By pressing a key, you can jump from one window to the next. Pressing another key allows you to expand any window to the full screen size. Pressing the same key again returns the window to normal size. You can modify or save the size, position, foreground color, and background color of windows with only a few keystrokes.

The last feature I'll discuss here is intersession communications. As previously mentioned, the 3270 PC offers two communications techniques: window-to-window copying and file transfer.

Window-to-window copying is exactly what it sounds like. A block is first

marked in a source window and then a destination is marked in another (target) window. The process is very similar to the block copy of IBM's Personal Editor. But there is one major restriction on the target session: You cannot copy to a window running a PC-DOS session. When you are copying window to window, you are, in fact, copying to the screen of the terminal associated with that session, and therefore, you are subject to certain restrictions. For instance, in copying to a host session you are copying to the screen of a 3278 terminal and cannot copy onto protected fields. In general, if you cannot edit a portion of a screen, you also cannot copy to it. Table 1 summarizes the various source and target possibilities.

In the tests that I performed, I was able to copy blocks of text (limited by the screen size) from the PC's Personal Editor screen to the host's XEDIT screen (XEDIT is the System Product Editor running under VM/CMS). Since the extended character set of the PC allows you to display a wide variety of symbols, I copied some of the more unusual ones (happy faces, musical notes, etc.) to a host session with XEDIT running. All characters copied successfully; any characters not normally part of the EBCDIC (extended binary-coded-decimal interchange code) were copied as blanks.

By using the SEND and RECEIVE commands, you can transfer files between PC-DOS sessions and host sessions. Sending a file transfers it from a personal computer DOS session to a host session. Receiving a file means transferring it from a host session to a personal computer DOS session. In order to transfer files between sessions, you'll need special software on your mainframe. This software was unavailable

to me at the time I wrote this article.

SOFTWARE FOR THE 3270 PC

The 3270 PC requires a number of pieces of software. The first of these is the IBM 3270 PC control program. The control program is an integral part of the 3270 PC. Without it, the machine can operate only as an IBM PC: no windowing, notepads, or host sessions. Along with the control program come a number of helpful, but not absolutely necessary, programs for saving screen profiles, restoring screen profiles, transferring files, and performing other handy chores. The control program does include the SEND and RECEIVE commands.

This control program is a complicated piece of software, not an "insert-and-go" program. Because it must handle a wide variety of communications controller hardware, it must be configured to each user's computer. You must first build a system disk from a program provided with the 3270. This configurator and its associated software may reside on a hard disk, but the system disk is built on a floppy disk. You can then copy the custom control program to the hard disk if desired.

To load the custom control program, you need a special program loader that causes the system to reboot. This, of course, causes your AUTOEXEC.BAT file to execute again, a potential source of trouble if you want your AUTOEXEC file to load the control program (visions of a system stuck infinitely rebooting itself). IBM was smart enough to foresee this possibility, and if the reboot is caused by the control program loader in an AUTOEXEC file, the loader knows enough not to reboot a second time.

The configurator itself is relatively easy to use, thanks to a series of help panels, but the control program requires that a number of parameters be fixed at the outset, which can reduce the flexibility of your 3270 PC. For example, once the control program is configured, the number and type of available sessions are fixed. If your system is configured with one notepad session, then the only way to add another notepad session is to reconfigure the control program. One caution: both the configurator and the control program

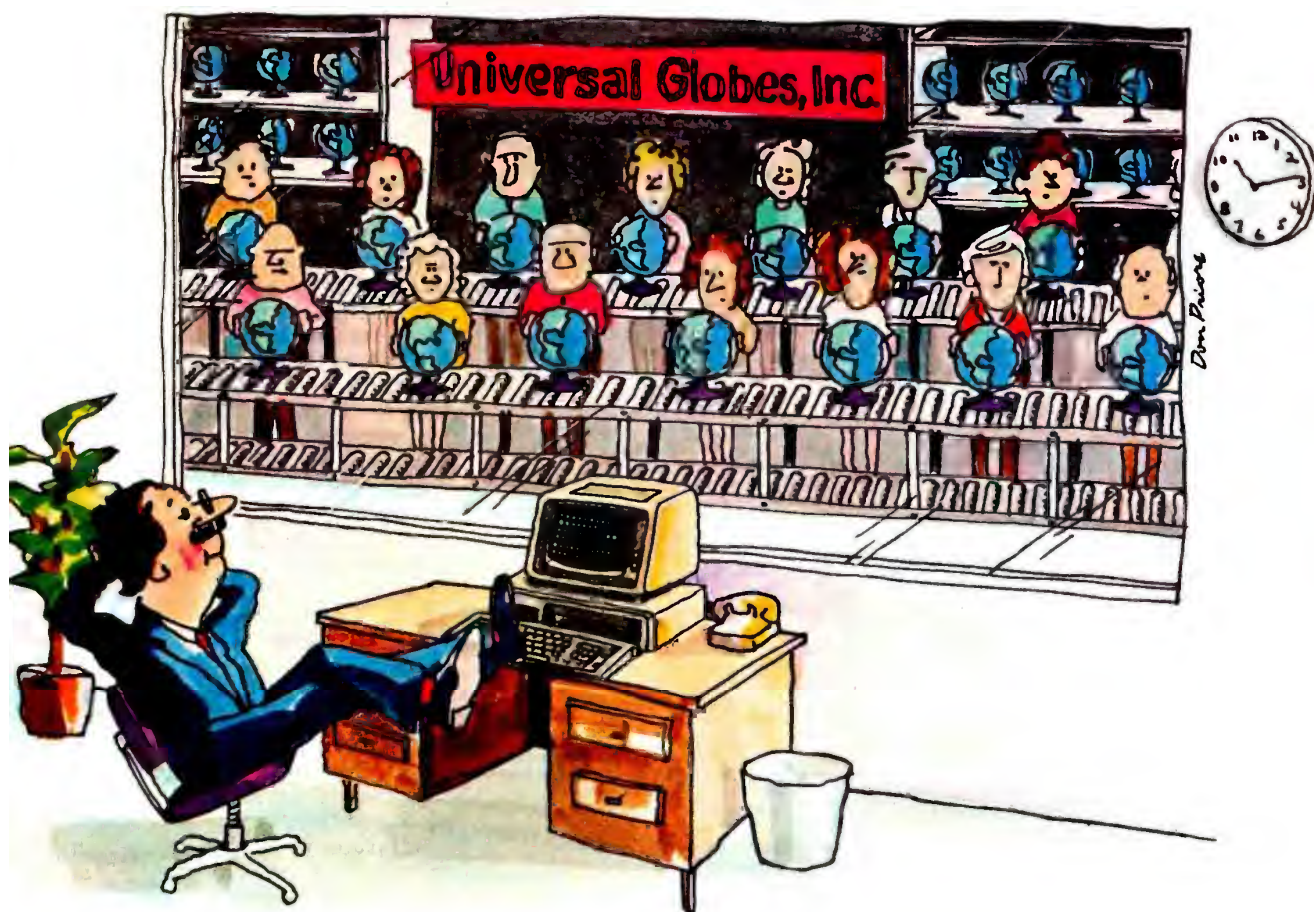
(continued)

Table 1: Window-to-window copying and restrictions.

Target Window Type	Source Window Type			
	Host 3278	Host 3278	PC-DOS	Notepad
Host (3278)	Y	Y	Y	Y
PC-DOS	N	N	N	N
Notepad	Y	Y	Y	Y

Y - Yes, copy is allowed
N - No, copy is illegal

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THE 3270 PC

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require a great deal of memory. Don't try to reconfigure your control program if you are already operating under the old control program. Before reconfiguring, reset your computer with DOS only.

The control program can be updated by IBM's Patch Installation Service, a program that runs under DOS to install or remove changes to the control program. It also provides a historical record of the revisions and applied patches. The original software, as I received it from IBM, already had a history of three applied patches.

A number of additional programs provide extra functions. Most notable of these are Save and Restore. The IND-SAVE command allows you to save (in a file) screen profiles, notepad contents, and auto-key recordings. (Auto-keying enables you to program a key to replay a series of keystrokes, usually a pattern that you use often. For instance, you can program a key to replay your log-on statement to the host, allowing you to log on using only a single keystroke.) The INDRSTR command allows you to restore the screen, notepad, or auto-key recording from the saved file. A screen profile describes the size, position, color, and windows configured on your computer. When the control program is loaded, these are set to the defaults. Saving and restoring allows you to recreate easily your own personal screen profile. If you occasionally need to save information typed on notepads, saving and restoring makes this possible as well. By using Save and Restore, you can keep track of auto-key programs from session to session.

Two pieces of software installed on the host are necessary for you to realize the full potential of the 3270 PC. The first is a modification to the 3274 communications controller software on your host. The second is the send and receive software necessary for file transfer.

To operate multiple host sessions on the 3270 PC, you'll also need a special update to the 3274 communications controller software. (I wrote this overview from my experience with the 3270 PC running only a single host session. Notre Dame does not yet have the necessary host software.) As mentioned earlier, file transfer also requires the installation of a module on the host. Neither of these pieces of software is

necessary to the 3270 PC for you to begin its operation as a terminal, but they do add to its already long list of impressive features.

ADDITIONAL 3270 PC HARDWARE

At first glance, the 3270 PC Model 5271-6 (models 2 and 4 are available without the 10-megabyte hard disk) resembles an IBM PC XT with a special keyboard and monitor. Internally, IBM has added three cards and possibly made some changes to the system board as well. The three cards that make up the heart of the 3270 PC are the Display Adapter, the Distributed Function Communications Adapter, and the Keyboard/Timer Adapter. The Display

Adapter can drive either the 3270 PC color display or the IBM monochrome monitor. In addition to these necessary cards, two special function cards are available to help drive the display: the All Points Addressable (APA) Adapter mentioned earlier and the Programmed Symbols (PS) Adapter.

The most impressive combination of these pieces is the Display Adapter driving the 3270 PC color display. Anyone who has used the typical IBM PC color monitor will appreciate the high resolution and brilliant color of this display. When used only for text, the quality of its displayed characters is as good as the IBM monochrome monitor. If you add color, the screen suffers no loss of resolution. Programs such as IBM's Pro-

fessional Editor and the Norton Utilities take on a whole new look when used with this monitor.

Not as noticeable at first, but equally impressive, is the 3270's Distributed Function Communications Adapter. This card controls the 3270 PC's host interface and makes multiple host sessions possible with the appropriate mainframe software.

The Keyboard/Timer card appears to satisfy some timing requirements in the I/O (input/output) channel or to provide timing information to the display and communications cards. It also drives the monster keyboard available for the 3270 PC. The keyboard combines all the functions of a 3278 terminal keyboard

(continued)

Programming Languages for the IBM 3270 PC By T. Lowell Wolf

The IBM 3270 PC is very similar to the IBM PC. PC-DOS 2.0 makes the operating environment highly compatible with IBM PC software. An important key to the operation of the 3270 PC is the control program that operates in conjunction with DOS to support its windows. You can define as many as 10 screen configurations and then save them as PC-DOS files that you can invoke on command. You can print the screen, or any window, on a local or remote printer. The 3270 PC also provides a Help function to display active functions and sessions, as well as a tutorial to explain and simulate system features. Send and receive functions enable you to exchange data between the host and the PC. Path names are supported, as is the option to convert from ASCII to EBCDIC. Most DOS applications designed to use the IBM monochrome display controller will be compatible. PC-DOS software that uses the IBM graphics display controller, however, will not run in the PC-DOS window.

IBM has licensed a number of programming-language products for the 3270 PC from Digital Research Inc. Chances are you'll choose a programming language based on your experience. In the 3270 mainframe-oriented environment, the choices are typically as follows:

Level II COBOL: This full ANSI '74 implementation has passed the U.S. Federal Compiler Test at "high" level. COBOL is chosen most often by large companies

because of its portability.

PL/I: Based on ANSI Subset G standard, PL/I is often used by scientific and general-purpose mainframe and minicomputer programmers.

Assembly language: Though assembly language maximizes computer performance, assembly-language programming should be minimized to avoid machine dependencies.

Other languages are more popular with recent graduates and programmers with minicomputer or microcomputer orientations:

C: A full implementation of the Kernighan and Ritchie UNIX standard. C is a high-performance language that still retains portability.

Pascal/MT+: A native code compiler based on the ISO standard. Pascal/MT+ is used for software development on CP/M and CP/M-86 machines. Pascal remains a classic teaching language in computer science curricula.

CBASIC: Like Pascal/MT+, the CBASIC compiler has been used extensively by independent software vendors for years in both 8-bit and 16-bit environments. CBASIC offers the commercial extensions required for sophisticated spreadsheet and accounting applications.

In addition to compilers, IBM licensed a number of programmer productivity aids from Digital Research. For applications involving extensive data file manipulation, Access Manager provides a multi-

keyed ISAM (indexed sequential-access method). Access Manager can be used through high-level subroutine calls from all compiled languages except COBOL, which includes ISAM as a language construct.

Display Manager makes it possible to develop interactive program screens without the tedious work of defining numerous print/read statements. An interactive editor is used to type literals directly on the screen "mask." Form-filling applications are quickly implemented with an additional bonus that the subroutine library calling procedure results in less actual code than normally required for print statements.

IBM also offers the DRI object module librarian, linkage editor, and symbolic debugger.

The IBM 3270 PC offers an inexpensive option for offloading busy mainframe development systems. COBOL shops will find that Level II COBOL (developed by Micro Focus) observes the same standards and conventions used by the IBM mainframe COBOL compilers. Coupled with the Animator interactive symbolic COBOL debugger, Forms II screen and forms generator (this produces COBOL source code), the 3270 PC becomes an excellent environment for the development of mainframe COBOL programs.

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and a standard PC keyboard, with mixed success. For instance, the keyboard offers two sets of cursor keys, one for use as a PC and the other for use as a terminal. When you are operating it as a terminal, you use the PC's cursor keys as a numeric pad. The feel of the keyboard is excellent, and if you like the feel of the PC's keyboard, you will like

this one even better. But it is huge (22 by 9 inches), easily dwarfing the PCjr's.

Can an IBM PC XT be upgraded to a 3270 PC merely by installing these three cards? I performed a number of experiments to see exactly how compatible the two computers' chassis are. Unfortunately, no circuit or timing diagrams are available for the cards or system unit

of the 3270 PC, so I was forced to rely upon a few simple tests. I removed the Display Adapter and Keyboard/Timer card from the 3270 PC and placed them in a regular XT chassis. When I started the XT, I received check-out diagnostic errors, but was able to finish booting the computer with no problems. Every time I rebooted the XT, it issued diagnostic errors, but the monitor seemed to operate correctly from that point on. I had to install the Keyboard/Timer card as well. When it was not present, the color display failed to operate. Because of both its name and the fact that it must be installed in slot J8, which has special timing requirements on a normal XT, I suspect that this card affects timing in the I/O channel.

In addition, I also installed the communications adapter in an XT chassis and turned on the system. Because the control program is necessary to drive the card, I installed it at boot time as well. The results were similar to what I described above. The operating system issued a diagnostic message, but appeared to operate normally thereafter. The Keyboard/Timer card was again necessary.

Certainly, the check-out diagnostic errors indicate some differences between the two units, but the fact that the cards seem to operate normally thereafter indicates that there is hope. A detailed analysis of the circuit and timing diagrams of the cards and the 3270 PC (both unavailable at this time) should eventually reveal the answer.

The APA and PS Adapters add functions to the color graphics monitor. The APA card allows you to control the graphics monitor. It must be plugged into a slot next to the Display Adapter and connects to the latter with a special edge connector. In high-resolution, full-screen, two-color graphics mode, the APA Adapter is capable of displaying 252,000 picture elements (PELs) in a 720 by 350 pixel matrix. Without this card, the graphics monitor is not pixel-addressable. The APA Adapter also supports the PC color graphics monitor resolution of 320 by 200 pixels (64,000 PELs), allowing many programs written for that monitor to run on the 3270 PC. The PS Adapter allows you to use 3270 programmed symbols in host applications. It stores as many as six symbol sets on the 3270. It too must be

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THE 3270 PC

I have used 3278 terminal emulators before, but none that operated with the reliability and ease of the 3270 PC.

adjacent to the Display Adapter and connects via two edge connectors to the adapter.

One limitation affecting both the PS and APA adapters is the number of slots in the computer's chassis. Slots in the chassis of a Model 5271-6 are assigned as follows:

- * 1 — Distributed Function Communications Adapter
- 2 — Free (Possible upgrade to APA or PS Adapter)
- * 3 — Display Adapter
- 4 — Memory Expansion Adapter
- * 5 — Fixed-Disk Adapter
- * 6 — Floppy-Disk Adapter
- 7 — Printer Adapter
- * 8 — Keyboard/Timer Adapter

Notice that there is only one free slot. Because of this, either the PS or APA Adapter card, but not both, can be supported. The items marked with an asterisk are essential to the computer. Although you can remove the memory-expansion card, without this extra memory-configuring the more complex versions of the control program are impossible. Slot 7 is a short slot, so removing the printer adapter won't provide the necessary space.

SUMMARY

The 3270 PC introduces high-resolution graphics and a simple connection to an IBM mainframe. I have used 3278 terminal emulators before, but none that operated with the reliability and ease of the 3270 PC. The computer interfaces quite naturally with the host. The resolution and brightness of the color monitor are truly amazing. If you demand high-quality graphics or need host-to-PC communication, the 3270 Personal Computer is a must. ■

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MODEMS: THE NEXT GENERATION

New modems, with call-progress signal detection, alternate voice and data using smart interfaces

I'm a Telecommunications junkie. I think of the local Telenet number as my own, checking in daily for my electronic mail. I use my modem several times a day, and I'm an active participant in several computer teleconferences. I pay attention to modem technology.

I examined six modems designed to work with the IBM PC and compatibles (table 1): five in-board modems and a sixth free-standing modem that attaches to any RS-232C port—it will work with just about any computer.

I chose to review the Hayes Smartmodem 1200B because it seems to be the most popular modem in this marketplace. I selected the others on the basis of their claims for new technology or because they seemed well matched to the IBM PC. There are, however, many other modems on the market that will work with the PC.

WHAT I'M LOOKING FOR IN A MODEM

Currently, I look for an affordable modem with easy connections to both the phone and my computer. A modem should provide alternate voice and data modes and be able to switch between them. Finally, I need feedback, a way of monitoring the modem as it dials and connects to a remote modem.

First, let's talk about price. All of these new modems are hundreds of dollars less than the fancy Vadics (\$895 for the

VA212) that I use. No one should have to spend more than about \$500 for a 1200-bps (bits per second) modem today. Perfectly serviceable 1200-bps sets are selling for less than \$300.

Next, I want easy connections. I want to be able to use either an ordinary single-line residence phone with an RJ11c (modular) plug or a typical six-button office set. Can it connect to an office PBX (Private Branch Exchange)? That may be an important question for some users.

I want either a smart cable/connector for a free-standing modem or a no-complications fit into a computer expansion slot for an in-board modem. This can be a problem with the narrow slots on an IBM PC XT.

How will the modem affect my voice calls? I have one phone line in my office, as many businesses do, so I need to use it for both voice and data. Can I switch between the two modes without having the phone hang up on me? Can I use the modem to dial my voice calls? Can I turn my modem and computer into an attack dialer (one that automatically redials a busy line until it makes connection)?

The problem is at the answer end, where often you have no way of telling if an incoming call is voice or data. I've cursed when I've finally gotten through on a voice call and heard only that high-pitched tone of a computer expecting data. But I've been on the other end

too, picking up my phone with a friendly hello when the incoming call is data expecting my computer modem's answer tone. What's necessary is a quick and convenient way for the answering user to switch modes.

And finally, feedback (in tech jargon, "line status sensing" or "call-progress signal detection"). During dialing, I want to hear and see what is happening. Is there a busy signal? Is that voice response at the other end? How many rings before answering? When nothing is happening on my screen, I want the reassurance of knowing that the line is still in place, that "carrier" (an analog signal sent over the telephone network) has not been dropped.

Since some modems can report what's happening at the remote (called) location, the local computer's telecommunications software can branch to the appropriate logic path. For example, in at least some parts of the country, MCI and Sprint (long-distance calling services) can begin billing after a given number of rings, whether or not the call is successfully completed. Software could instruct the modem to hang up before exceeding the billing ring limit.

Another example: computers and modems are being set up to place a series of unattended calls, usually at low night rates. If a person answers, rather than another computer, the calling sequence can be disrupted and the calling computer might lock up. If the local modem can distinguish voice, busy, and no-answer signals at the remote end, local software could abort the call cleanly and move on to the next number.

With voice sensing, computers can control complex number sequences on the alternate long-distance services. Some of these services have voice responses in the middle of the dialing sequence; these voice responses request or acknowledge tone information. If the modem can recognize the voice signal in a timely way, the correct code can be sent by the local computer within the allowed time. Electronic banking is an application that uses combinations of tone entry and voice response to acknowledge transactions.

THE SOFTWARE GENERATION

The first time I saw the Prentice X100, I shuddered. I didn't see a light or a switch anywhere on it. How was I to tell

if carrier dropped? How was I to change from 1200 to 300 bps without a toggle switch?

Well, the X100 is tucked away on the floor behind my desk. All of its information comes to me in comprehensible words on the screen. I never have to turn my head away from the video in front of me. There are no blinking lights for me to interpret. If there is a vestigial twitch of my head toward a nonexistent

carrier-detect light, I ignore it.

No two modems came with the same software, although Novation comes bundled with Crosstalk (the IBM PC communications package), and Cermetek will sell you Crosstalk at a big discount, if you buy its modem. Bizcomp tells you how to configure its product for Crosstalk.

The software that did come bundled with each product (see table 1) varied

widely in performance, ease of use, flexibility, setup requirements, and documentation. However, there is a definite trend toward on-screen labeling of the function keys, with powerful command strings built into each key.

More and more manufacturers are settling on the Hayes instruction set in the ROM (read-only memory) firmware as a standard. In some cases, there is a superset or subset of the Hayes set. This de facto standard lets me use the same communications software and the same macros on different hardware.

I'll admit my perception of the different modems was strongly affected by the power and flexibility of the software I used with them. To wash out the software differences and focus on the hardware, and to write macros that use new feedback features such as call-progress signal detection, I used a small set of generic telecommunications software packages (table 1).

PRENTICE X100 POPCOM

My favorite modem is the X100 POPCOM from Prentice. It has all the features I want and works with all three of my computers (PC, PCjr, and Radio Shack Model 100). The innovative plug, the modem's small size, and the smart RS-232C interface make this the easiest free-standing modem to install that I've ever seen.

The RS-232C connector worked with every cable I tried—3-line, 25-line, straight-through, or crossed-transmit-and-receive data lines, even odd combinations of those cables. Prentice has figured out how to handle not only both modem data lines and computer data lines, but mixtures of the control signals as well.

Complete call-progress signal detection is another X100 feature I love. I wrote a macro that lets my telecommunications software branch as necessary and keeps me informed along the way. The combination of call-progress detection and voice/data switching lets me use the X100 as a "demon dialer." Attack dialing, in which your phone keeps trying a remote

(continued)

Mark Klein (8 Bay Rd., Newmarket, NH 03857) works for IE Systems, a communications software house in Newmarket, NH. He is a contributing editor to BYTE.



Photo 1: The thickness of the board configured with a speaker may concern you if you own an XT. From the top: Hayes, Microcom, Novation, Bizcomp, and Cermetek.

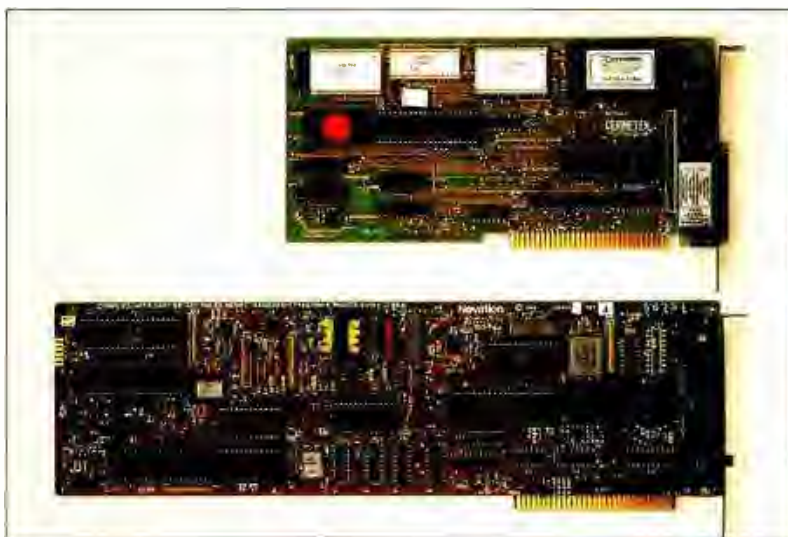


Photo 2: The length of the Cermetek compared to the Novation.

NEW-GENERATION MODEMS

Table 1: Modems surveyed.

Company	Modem Model	Software Supplied	Software Used	Suggested Retail Price
Prentice	X100 POPCOM	none	Acculink	\$475
Hayes	Smartmodem 1200B	Smartcom II	Smartcom II	\$599
Bizcomp	PC:Intellimodem	PC:Intellicom	Crosstalk	\$499
Novation	ACCESS 1-2-3	Crosstalk	Crosstalk	\$595
Cermetek	INFO-MATE 212PC	Modem-Mate	Acculink	\$480
Microcom	ERA 2	ERA 2	ERA 2	\$499

number until it completes a call, threatens to tie up our entire phone system, unless modems and auto-dialers can sense voice or busy signals. Some restrictions now apply to attack dialing; more will be forthcoming as the problem worsens.

When I have to make a call to a number that is likely to be busy, I let the X100 dial for me. When I hear the other party answer, I pick up the phone and begin talking. A pleasure! I even set the number of retries on busy to a value below the FCC limit of 15.

Voice/data switching eliminates the need for two phone lines when two people are sending files between their computers. Does this sound familiar?

"OK, I'm going to switch now. Mark? Mark? Mark, pick up the phone. Mark, are you there? My end is not working."

With an X100 at both ends, switching to voice mode is a cinch—just pick up the phone.

If you were in data mode, the X100 stops sending carrier, goes "on-hook," and sends the PHONE message to the local screen. The X100 at the other end senses the loss of carrier, but instead of hanging up like older modems, it holds the line for a software-specified length of time and turns on its speaker. Your not-so-frantic "Mark, pick up the phone" comes through loud and clear.

When the remote operator picks up his or her phone, the remote modem goes "on-hook," sends a PHONE message to the screen, and establishes voice connection. The X100s are out of the way. Of course, by reverting to data mode you can push the modems back to handshake mode again.

I put the X100 over one last hurdle. Since it has an RS-232C port, I connected the X100 to a Tektronix Model 834 bit-error-rate tester. I ran the test all afternoon and evening without seeing an error. Because the other modems I

was trying out are all in-board models, I have no basis for comparison, but the X100 looked good to me and has worked well.

BIZCOMP'S PC:INTELLIMODEM

Bizcomp's PC:Intellimodem is an in-board modem that supports the full range of call-progress signal detection and has an extensive instruction set. PC:Intellimodem senses voices and switches between voice and data.

I had two problems with the board, one minor and one annoying. The minor problem was with the PC:Intellicom software that was bundled with the modem. I addressed the modem as COM2:, which is the default setting from the factory. When I tried to run the software, I was unable to communicate with the modem. A quick call to the factory uncovered the bug: if another device was attached to COM1: (a common situation), and if cable from that device "jumped" some of the RS-232C control lines, then the program wouldn't work.

At the time of the Bizcomp trial, the Prentice X100 was plugged into COM1. As soon as I unplugged the COM1: cable, the PC:Intellicom software could communicate with the board. The software was written in BASIC, so when Bizcomp sent me a two-line patch, the fix was easy. While I was waiting for the mail to bring the patch, I used Crosstalk to drive the modem, with no problems.

The feedback problem was more annoying. The PC:Intellimodem has a buzzer instead of a speaker. During auto-dialing, the buzzer was satisfactory, but whenever there was voice response, the "zzst" drove me up the wall.

Turning off the buzzer was another problem. The Intellicom software and Crosstalk turned on the buzzer during dialing and turned it off after the data

connection was established. (Crosstalk used a monitor-on dialing prefix that I gave it at setup, using instructions in the Bizcomp manual.) Evidently, both software packages left the buzzer active after hanging up the phone. In the midst of some other program, I picked up the phone only to hear that "zzst" from the buzzer with every word I spoke. Probably, I could write a script file with Crosstalk that would turn the buzzer off, but I didn't bother. Too much trouble.

A good feedback feature on the Intellimodem is a red LED (light-emitting diode) sticking out the back end of the board and visible from the rear of the computer. You can write software to switch that light to indicate the state of several of the RS-232C lines, including the ring indicator (RI), the data carrier detect (DCD), transmit data (TXD), and receive data (RXD). If you encountered a problem, knowing the status of those signals might help.

Another interesting design feature of the Bizcomp Intellimodem is a third RJ11 modular plug socket. Most modems have two, one for the telephone company line ("to wall") and one to the telephone ("to phone"). The third socket is for a telephone handset. With the Bizcomp software, a function key switches from data to voice and activates the handset. Bizcomp recommends using the handset and telephone company line sockets.

Trouble starts when you're working at your computer, using any program other than the communications software, and the phone rings. If you only have a handset in the top socket, and no phone in the second socket, Bizcomp tells you to exit from your applications program, call up the communications software, press the function key, and then use the handset to answer the call. Do they really expect someone to go through that rigamarole? The manual suggests that if you are expecting a phone call, you should plug a phone into the middle socket. Well, if the whole phone is there, who wants the handset, too? Seems cumbersome to me.

Overall, except for the buzzer, I like the PC:Intellimodem. Good communications software can get around the other problems, and it does have call-progress signal detection.

(continued)

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CERMETEK INFO-MATE 212PC

This modem is smaller than the others—nearly half the size of the full-length cards—with the lowest chip count of any of the board modems. It will fit easily into an IBM PC XT slot without bothering the board next door.

Cermetek shrank its board by using

some custom logic chips and by leaving off a speaker. By now, you know how I feel about having my sound. However, Cermetek almost makes up for this omission by including two valuable features.

First, a DB25 connector at the back end of the card can be turned into another RS-232C port when you're not

using the 212PC as a modem. You can select the modem or RS-232C port using software or a pair of the 10 option switches set with jumper connectors.

Four more option switches set the I/O (input/output) port address, so that the 212PC does not limit you to just COM1 and COM2. Some IBM-compatible computers have serial ports built into their motherboards, so that plug-in modems can't use those addresses. Cermetek also lets you address its board at 3F8 and 2F8 (hexadecimal). If your communications software can talk through these ports (special versions of Crosstalk can, as well as the Modem-Mate package that is bundled with the 212PC), you can sneak in an extra I/O port and bring a smile to the face of an RS-232C junkie.

Cermetek is an experienced modem manufacturer, and this is reflected in the sophistication of the command set. There are several test modes: analog loop, analog loop self-test, digital loop, remote digital loop, remote digital loop self-test, and end-to-end self-test. A "quiet" command, ZZZZ, silences the transmitter but keeps the modem off the hook. With INFO-MATE 212PCs at both ends, this command lets you use the telephone connection for voice in between data transmissions.

And finally, the 212PC has call-progress detection. The dialing commands are flexible. The modem can wait for a dial tone or wait for a fixed time without monitoring for a dial tone. Unless you specify tone or pulse dialing, the 212PC uses adaptive dialing. In this mode, unique to Cermetek, the modem automatically selects tone or pulse dialing according to what it senses on the line. After dialing is complete, status messages appear. Each R indicates a remote ring; V is for voice; B is for busy; W means that the other end answered, but at the wrong speed; and A indicates data call connection. Multiple status messages are allowed, and a response such as

221-4567RRRV
A

means that the number 221-4567 was dialed and rang three times, and then a voice was detected. The modem con-

(continued)

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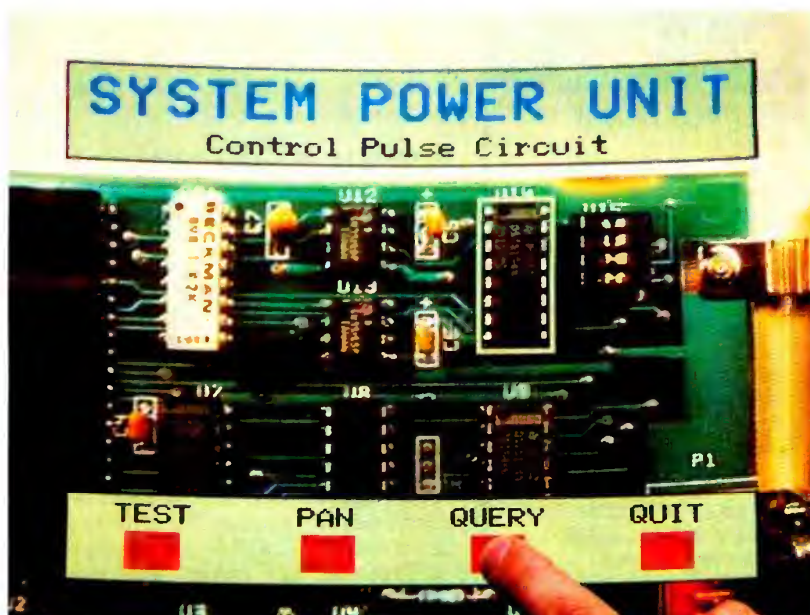
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NEW-GENERATION MODEMS

tinued monitoring and, finally, received an answer tone. Such a sequence could appear if the remote phone is answered manually and then switched into data mode.

Now, if the index in the manual only had page numbers next to the topics (an editor's oversight I'm sure) or if the modem just had a speaker. . . .

NOVATION ACCESS 1-2-3

Novation is clever. Using custom logic chips, it makes a board modem that has nearly half the chips of the Hayes, and only a few more than the Cermetek. The firm uses a full-length board, but it's thin and I still get my speaker. Tucked away on the lower corner is a three-prong connector, and Novation supplies a cable to hook its board to the speaker on the PC motherboard. Makes sense, doesn't it?

Novation bundles its board, the PC 1200B, with Crosstalk XVI, a powerful communications package. The combination is called ACCESS 1-2-3. The version of Crosstalk that comes with the package has some special features to take advantage of the hardware.

First, there is a Port 3 address, for IBM compatibles (Novation gives you one extra port). Second, there is some call-progress display. During dialing, the status line will show the presence of a busy signal or the absence of a dial tone. And there's the rub. I'm spoiled. I want the full call-progress detection of the X100.

The rest of the package is good. There are several test modes: hardware integrity, analog loopback, local digital loopback, and remote digital loopback. Novation has the usual two modular jacks for telephone handset and phone line. RJ11, RJ12, and RJ13 jacks, both C and W, will work. The command set is complete, and Crosstalk knows how to exercise the commands. This is a solid package, but not quite as state-of-the-art as some of the others.

MICROCOM ERA 2

The Microcom ERA 2 at first seems like a plain-vanilla, Hayes-compatible modem with no special call-progress detection. It uses the Hayes instruction set, has a speaker, and comes in a pretty box with a good manual. (The ERA 2 also is available as a stand-alone model, which I did not review.) But

because of Microcom's Network Protocol (MNP), it has some very special capabilities.

With Microcom's modems you can establish a reliable link between two computer systems for all the traffic between them. For this kind of dance, though, it takes two to tango. If The Source had an ERA 2 at its end, and I had one at mine, it could mean the end of that pesky line noise that often shows up on my screen as random characters when I'm in the midst of some crucial search.

Well, that low noise state may be coming. UNINET has several Microcom modems in place, accessible by local phone calls in Atlanta, Boston, Chicago, Dallas, Houston, New York, San Francisco, Washington, and other cities. Users with ERA 2 or modems incorporating MNP (such as the internal modem on the IBM PCjr) can use what Microcom calls Reliable Mode.

The ERA 2 is flexible about link protocol. You can set up the communications so that your modem tries to establish an MNP link, but will drop back into normal interactive mode if it is unable to make a Reliable Mode connection. Otherwise, the modem is straightforward.

Like the Hayes 1200B, it uses a Z8 microprocessor and has sockets for modular plugs from both the telephone company's wall line and the phone itself. The on-board speaker is very thin, but because about two-thirds of the components live on a piggyback board, the overall board is wide. Also, like the Hayes, it needs an empty slot next to it in an XT chassis.

From my viewpoint, if you work in an environment that needs accurate transaction processing despite a noisy line, installing Microcom modems at each end makes sense. If you can't control the remote end, there is little advantage to the ERA 2. If the MNP protocol continues to penetrate the market, the protocol may find more widespread use on the public data networks and common carriers. Until then, call-progress signal detection is more useful.

HAYES SMARTMODEM 1200B

This is the standard. A passenger in the seat next to me on the Eastern shuttle between Boston and New York was traveling with a Compaq. After he

watched me work with my Model 100 from Radio Shack, we started talking shop. I asked what modem he had inside his box. "Hayes," he answered, with a look that said, "Doesn't everyone get

a Hayes?"

The Hayes speaker on the board is large, making the modem wider than a regular PC board. But since the speaker is at the end of the board nearest the

front of the computer, the modem can occupy a slot next to a short card (such as the IBM floppy-disk controller) without the speaker's height affecting
(continued)

The Computer-Modem Dialogue

The RS-232C interface between the computer and modem uses a standard vocabulary. When a free-standing modem with an RS-232C port is connected by cable to the RS-232C (DCE) port on the computer (DTE), this vocabulary seems appropriate. But when the modem is on a board inside the computer, when no RS-232C port is in sight, and when the actual interface deviates from the RS-232C standard, more patience is required to unravel the signals. My math teacher from years ago would call this a clean-sheet-of-paper, cold-glass-of-lemonade, no-distractions job.

RS-232C signals fall into four groups: ground, data, control, and timing. Ground may include pins 1 and 7, but usually just 7. Data signals through pins 2 and 3 transmit and receive information. Timing signals are irrelevant here. It's the control signals we need to talk about: request to send (RTS), clear to send (CTS), data set ready (DSR), data terminal ready (DTR), ring indicator (RI), and data carrier detect (DCD).

Whether the modem is in-board or free standing, an 8250 UART (Universal Asynchronous Receiver-Transmitter) is between the modem processor and the computer's address, data, and control buses. The UART reformats bytes of data from parallel format (bits are side by side) to serial format (bits in a row) for transmitting. Each of the in-board modems has an 8250 on the printed-circuit board. A free-standing modem connects to an asynchronous communications board or multifunction board with an 8250 on it. If an 8250 or modem is to interface with the public-switched telephone network, four signals are required by the RS-232C standard: DSR, DTR, RI, and DCD.

DSR and DTR are equipment-readiness indicators. In contrast, the RTS/CTS pair is used as a channel-readiness indicator. DTR and DSR are used with automatic dialing and automatic answering equipment. For example, after the modem has dialed the call, established the connection, and is in data-transmission mode, DSR is turned on. The modem tells the computer that it's ready to go. Similarly, if the modem is connected to the telephone network and the computer

turns off DTR, the modem is disconnected from the communications channel.

That's how it's supposed to go in theory; understanding actual practice requires close reading of the manuals. For example, the Hayes 1200B ignores RTS, CTS, and DSR. When DTR is off you completely disable the modem so that it will accept neither commands nor auto-answers. DCD indicates the presence of carrier.

The Prentice X100 has a richer, more complex instruction and register set. Like the Hayes, it doesn't use RTS. But you can set three modem modes in software to define the control lines. Dumb Terminal mode holds DSR, DCD, and CTS true, so a simple three-wire cable can be used. Smart Modem mode can set CTS false when the local phone goes off the hook, allowing convenient voice/data switching. Also in this mode, DSR and DCD go false when carrier is lost. Bell 212 mode follows the conventions of AT&T modems, with CTS going true 200 milliseconds after carrier is detected.

The Cernetek 212PC has a hardware option switch, a jumper that chooses between normal RS-232C operation for CTS, DSR, and DCD, or having those signals forced to the same state as DTR.

What's the significance of this diversity? Manufacturers are choosing slightly different ways to implement the "smart" features on their modems. Users must decide which modems have the features they want, which communications software packages support those features, and how they must set up the modem so that the software can access the signals it needs. (Crosstalk, for instance, controls the DTR line and expects to see DCD true only when carrier is actually present. Modem features such as "DTR override" and "DCD forced true" must be disabled if Crosstalk is to work. Fortunately, the modem manuals have the information you need to do this; I used Crosstalk successfully with several of the new modems and with the 1200B.)

For more technical details, see *Data Communications for Microcomputers*, by E. A. Nichols, J. C. Nichols, and K. Musson (McGraw-Hill, 1982).

GLOSSARY

RTS—request to send, an RS-232C control signal sent from the computer to the modem, asking the modem for permission to transmit data (used with clear to send, CTS).

CTS—clear to send, an RS-232C control signal sent from the modem to the computer, saying that the modem is ready to receive data from the computer; sometimes indicates local phone is on or off hook.

DSR—data set ready, an RS-232C control signal sent from the modem to the computer, saying whether or not the modem is connected to the (telephone) communications channel (used with data terminal ready, DTR).

DTR—data terminal ready, an RS-232C control signal sent from the computer to the modem.

DCD—data carrier detect, an RS-232C control signal sent from the modem to the computer, indicating that carrier is present (used with DTR).

RI—ring indicator, an RS-232C control signal sent from the modem to the computer, indicating that the modem is receiving a ringing signal from the telephone network.

DCE—data communication equipment, such as a modem.

DTE—data terminal equipment, such as the IBM PC (RS-232C ports on the PC are configured as DTE).

Carrier—an analog signal sent over the telephone network.

Modulation—the process of modifying the carrier so that it varies according to changes in another analog signal (the modulating wave).

RXD—receive data.

TXD—transmit data.

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NEW-GENERATION MODEMS

the adjacent board.

The modem handles both single- and multiline connections. It can be addressed as either COM1 or COM2, but not as COM3 or higher. A register controls the testing feature of the 1200B. Hayes calls this "self-test," rather than "loopback." One setting of the register tests the originate mode, and one tests the answer mode.

The Hayes Smartmodem lacks call-progress detection. Without it, the modem cannot sense either busy signals or voice. It must be programmed to wait for carrier for a specified length of time. If carrier is not detected within the preset time, the modem hangs up (goes on hook). Hayes ships the modem with a default setting of 30 seconds, which to me seems to be a long time to tie up the phone line in an automatic dialing environment. Further, the 1200B cannot detect the presence of a dial tone. Instead, it waits a programmable length of time (the default setting is two seconds) and then assumes the dial tone is present. This usually works, but there could be problems when dialing through a cranky PBX.

The Smartmodem 1200B works well. It has a speaker for audible feedback, the Hayes instruction set, excellent documentation, a good reputation, and Smartcom II, a well-integrated communications package.

If you can get along without call-progress signal detection, then the Hayes Smartmodem is an OK choice.

SUMMARY

At least these modem manufacturers are not copycats. Each has built its product with a slightly different set of features, some using custom logic chips and a different board design.

Since several of the powerful, standard communications software packages will drive any of these modems, I have tried to steer clear of the software variable. Consider the software that comes bundled with the modem. For a typical installation, the call-progress detection features that are available and supported in software will be the most important factors in a buying decision. "Know what you need," and "try it before you buy it" are still wise maxims in the modem market. ■

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Ex. 1022, Page 255

BY JAY SIEGEL

MOVING DATA BETWEEN PCs AND MAINFRAMES

*Moving shared data around once you access it is still a problem
in an industry without standards*



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Ex. 1022, Page 256

Sooner or later all of us will be moving data, and not just from the word processor to the printer but from one applications program to another, between microcomputers, and in many cases to and from a mainframe.

During the seventies many major U.S. corporations relied on remote computer services for both information and applications software. The success of the microcomputer in the eighties may have slowed the rapid growth of these remote services, but it has also opened up new markets and opportunities. Many timesharing data vendors have introduced software that makes it easier for a microcomputer to access data on their mainframes. The major stumbling block to the proliferation of this service has been incompatible data structures among the different microcomputers.

I'll focus on the hows and whys of transporting data between programs and computers. I'll also outline some of the database services that I find helpful in my work.

Accessing a remote computer is relatively easy. What is not always as easy is downloading data from a remote computer to a microcomputer in a form that can be used in particular applications programs such as VisiCalc, SuperCalc, and Lotus 1-2-3.

TECHNICAL ISSUES: FORM AND STRUCTURE

Coding data electronically is at once an obvious and an elusive concept. Data has a format and structure that ties together the bits and bytes of computer information. This structure makes data meaningful and, correspondingly, difficult to move around between either programs or computers:

One program's data format is another program's gibberish.

The IBM PC stores data as 8 bits or 1 byte. A byte is a sequence of eight 0s and/or 1s, which makes for a total of 256 different combinations of 0s and 1s. These binary numbers can represent a computer chip's instructions or data (text and numbers). To represent text, such binary numbers must be translated into the letters, numbers, and symbols (such as commas, semicolons, and quotes) that compose data. These numbers are translated in most microcomputers using a nearly universal code called ASCII (American National Standard Code for Information Interchange). ASCII uses 7 bits and provides a translation for 128 characters: 54 letters (upper/lower-case), 10 digits (0 through 9), and assorted punctuation marks, symbols, and control codes.

IBM never joined the ASCII convention and adopted another coding scheme called EBCDIC for its mainframe computers. (Pronounced Eb-suh-dick, it stands for extended binary-coded decimal interchange code.) The difference between ASCII and EBCDIC is one of the first, but not the most significant, barriers to communications between IBM mainframes and microcomputers.

ASCII uses only 7 bits, while most microcomputers store information in 8-bit bytes. That small difference creates a major problem in moving data. Some applications programs use this "free," or unused bit, making it an integral part of

(continued)

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ILLUSTRATION BY SETH IABON

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the data for that program. WordStar uses this eighth bit in document files to format the text on the screen or for the printer.

IBM extended ASCII on the IBM PC to encompass this free bit and thereby increase the number of characters that can be coded and displayed to 256. IBM used the extra 128 characters to extend the set of symbols to include a musical note, a happy face, line graphics, foreign letters, and other symbols. IBM refers to this translation as Extended ASCII, a superset of standard ASCII.

Data files are of two types—stream or rectangular. A stream file is a simple sequential flow of bits. A stream file has no internal structure that can't be represented by specific ASCII characters: a centered heading or a paragraph separated by a blank line or indicated by indentation, for example. The data itself determines how the document ultimately looks when printed on a piece of paper. Essentially, you create that structure as you enter the information.

A rectangular data set has an internal structure that groups the data into subsets, often called fields, and the fields into records. A rectangular data file can be thought of as a matrix with the columns representing data fields and the rows records. This structure is identical with a spreadsheet's data structure. In fact, the relationship between the spreadsheet structure and rectangular data files will prove to be very important in many of the methods of moving data between microcomputers and downloading information.

ASCII provides a standard form for reading data. However, how the letters are grouped and whether or not digits are to be read as numbers or text are determined by the format of the file. There are basically two types of formats—fixed and free. Fixed formats define the data characteristics for specific locations in the data field: for example, columns 7 through 10 might be text and columns 11 through 12, numbers. The advantage of a fixed format is its precision. There is a negative side to this, however, as this precise description must be known by the program that is reading the data.

Free formats use delimiters to separate fields and identify text by surrounding it with quotes. The most common free format is the comma separated value (CSV) format, in which the comma is the delimiter separating fields and quote marks surround text.

DIF, which stands for Data Interchange Format, was developed by Software Arts, the creator of VisiCalc, as a standard ASCII format for interchanging data between applications programs. DIF was designed to handle spreadsheet data and can describe labels (text) and numbers along with their row and column location. (DIF was explained in detail in an article, "DIF: A Format for Data Exchange Between Applications Programs," November 1981 BYTE, page 174.) DIF cannot, however, convey the formulas or format instructions in a spreadsheet. Sorcim, the creator of SuperCalc, has developed SDI (Super Data Interchange), an extension of the DIF con-

Lotus's Symphony Offers Downloading Options

Symphony, the new product by Lotus Development Corporation (Cambridge, MA), the creator of 1-2-3, opens up new possibilities for downloading via the data-capture method. Symphony is an integrated product that provides spreadsheets, word processing, graphics, database management, and communications in a single environment.

The spreadsheet is the basic data structure (the metaphor, to use the current buzzword) for storing data. To download data from a remote source, Symphony uses the capture option to store data in a range in the spreadsheet. If the data is to be captured from a stream format file, then the range encompasses a single column of the spreadsheet. If the data is in rectangular format, then the range name will encompass two or more columns.

Symphony's communications module provides all of the standard options: the user can set word length, stop bits, modem speed, handshake protocol, etc. It also conforms to the XMODEM file-transfer protocol to directly transfer file from most of the major microcomputers.

However, the integration of the commu-

nications module with the other Symphony functions amplifies the program's capabilities. For instance, Symphony's expanded macro abilities make it possible to automate a complete telemarketing application. Given a prospect's name, the database manager locates the telephone number, which is then dialed automatically by the communications module. When the phone is answered, the modem is switched to voice mode, and the database manager displays a call report form on the screen to record the results of the phone call. This is then updated in the call report data range.

In Symphony, the central role of the spreadsheet in defining data has very important implications for downloading. In the communications mode, Symphony can capture to a range, which the user specifies, data that is being sent from the remote computer and displayed on the monitor. The format of the data captured is linked to the spreadsheet database structure. If the data to be transferred is one column wide, then the specified range will be a single column and data will be stored in stream format (variable-length

records, stored by rows within the single column).

However, if the data encompasses several columns, then a rectangular data structure is specified by using multiple columns. For example, if the data coming from the remote computer service is captured to a range containing eight columns, each of width 10, then the first 10 characters go into the first column, the next 10 into the second column, and so on.

Symphony's word processor can be used to clean up the downloaded information, if need be, to get rid of extraneous information or realign the data in the spreadsheet format. The word processor within Symphony cannot edit control characters, so there may be some minor problems with downloaded data.

Symphony is the first communications software program to give the user the option of defining the format of the downloaded data to be either stream or rectangular files. Symphony's spreadsheet data structure makes downloading via the data-capture method simple yet comprehensive.

cept to include spreadsheet formulas and format instructions. SDI lets you transfer a complete SuperCalc workspace in ASCII form.

DIF has attained the position of the de facto standard for exchanging data between programs. Most spreadsheet programs and several database-management programs can read DIF files.

COMMUNICATIONS SOFTWARE

Moving data between computers is most often done with communications software. Though it's possible to hook up two IBM PC microcomputers directly through their serial ports and transfer files between them using the COPY command, the process is much easier if you use communications software.

Communications software is a must in order to move data between your microcomputer and a remote computer service. Such software performs, primarily, two services: terminal emulation and file transfer.

The primary objective of a communications program is to turn your IBM PC into a "dumb terminal," one that can communicate with other computers through the serial port and over the telephone via a modem. However, good communications software turns the IBM PC into a "smart terminal," one that can upload and download files and handle a wide range of communications protocols.

Two fundamental issues affect the transfer of files (downloading/uploading) between computers: coordination and error checking. Most communications software can capture the information being sent from a remote computer as it is being displayed on the IBM PC's monitor. The captured data is then stored in a file on disk.

Pressing the Page Down key in PC-Talk III (developed as Freeware by The Headlands Press Inc.), for example, initiates data capture. The user will be asked for a filename, and all subsequent data displayed on the monitor is saved to the specified file. Pressing the Page Down key a second time signals PC-Talk III to stop capturing data and close the active file. Starting and finishing your transfer with the exact information requires coordination between your microcomputer and the remote computer.

Quite often unrelated information is captured in the beginning and at the end of the file. These unwanted characters can be edited out of the file later with your word processor.

The data-capture method of transferring information saves everything being sent between the two computers. If there is an error in the transmission, the garbled characters are indiscriminately saved in the file. When you are transferring text data, this is only a minor problem. However, when you transfer numerical data, a single garbled bit can change the entire meaning of the data file.

Direct file transfer solves the two problems inherent to the data-capture method, coordination and error checking, but the two computers must use the same file-transfer protocol. This protocol establishes the beginning and end of a file and usually includes an error-checking procedure. The XMODEM protocol developed by Ward Christensen is the de facto microcomputer standard for direct file transfer. The XMODEM protocol breaks the file into small blocks of data, calculates a numerical value for each block, which serves as a check value, and sends the check value along with each block to the receiving computer.

The receiving computer then calculates the characteristic of the block it has received and compares its own check value with the one it received along with the block of information. If the two values agree then the block is saved; if there is a difference the block is re-sent.

PC-Talk III adheres to the XMODEM protocol. By appending "="X" to the end of the name of the file to be transferred, you signal PC-Talk to wait until the sending or receiving computer activates the Page Up or Page Down key and then automatically transfers the file. Any errors in the block detected during transmission result in its being re-sent. Direct file transfer can occur between different software programs other than PC-Talk III as long as they support the same protocol.

TRANSFERRING DATA BETWEEN APPLICATIONS PROGRAMS

Most applications programs store their data in binary form and in a format that is convenient for the program. The only way another program can access that data is if it knows the original program's format. Most applications programs, for example, adopt a unique extension to their filenames—WKS for Lotus 1-2-3, CAL for SuperCalc, and VC for VisiCalc worksheet files. In other words, a SuperCalc file is saved differently from a Lotus file. A file called Forecast in Lotus will be saved:

(continued)

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FORECASTWKS; in SuperCalc it will be saved: FORECAST.CAL. Neither filename is readable by the other program. The solution to this data incompatibility is to produce a standard ASCII format version of the file to be transferred. Most applications programs allow this. Lotus, for example, provides two choices: it uses a utility program to produce a DIF file from the WKS file, or prints the data to disk producing a PRN (print) file in fixed ASCII format. One of the incongruities of Lotus 1-2-3 is that it can read (import) a free-format ASCII file, but it can produce only a fixed-format ASCII file. This is unfortunate since the free-format (CSV) file is one of the most common formats for data transfer between applications programs, both mainframe and microcomputer. SuperCalc's utility, SDI, transforms data to and from CAL and DIF and CSV files.

Ashton-Tate's database-management program dBASE II can both read and write free-format CSV files. A free-format ASCII file can be created from a dBASE file by copying that file using the Delimited With "" option. The dBASE II program uses the name of the data file and appends the extension TXT for the name of the ASCII file, which will be created in a CSV file. Either Lotus 1-2-3 or WordStar, using mail merge, can then read this file. Using the dBASE II Append From . . . Delimited option moves data from a CSV to a dBASE II data file. In version 2.4 on the IBM Personal Computer, the Delimited With "" option produces CSV files with the trailing blanks in any field eliminated. (Trailing blanks were not eliminated in earlier version of dBASE II.)

Moving data between word-processing programs can be

A Sampling of Remote Computer Services

Most remote computer services distribute public information electronically, along with proprietary information that they have gathered or licensed from other sources.

The following is a brief outline of remote vendor services from major financial suppliers with which I am familiar. I have purposely disregarded the traditional home-user services such as CompuServe, The Source, and Dow Jones, in favor of talking about business-oriented database vendors.

DIALOG INFORMATION SERVICES

Dialog Information Services provides on-line access to a wide range of databases containing materials on education, science, business and finance, current affairs, social sciences, law, medicine, the arts, and humanities.

The business and finance databases on Dialog include ABI/Inform and Disclosure II. ABI/Inform abstracts articles from more than 550 publications about business management and administration and offers 200,000 citations. The abstracts can be saved by your microcomputer in simple stream format via the data-capture method.

The Disclosure II database provides abstracts of reports filed with the Securities and Exchange Commission (SEC) by more than 8500 publicly owned companies. This information includes the 10-K and 10-Q financial reports, 8-K reports of unscheduled material events or corporate changes, 20-F financial reports, proxy statements, management discussions, and registration reports for new corporations. These reports are presented in a standard table format for

each company. However, capturing the data as a text file in stream format poses a problem, for in this form it cannot be entered easily into a spreadsheet program. Lotus Development's Symphony has a unique downloading procedure that should enable you to download the Dialog Disclosure II tables directly to a spreadsheet (see "Lotus's Symphony Offers Downloading Options," page 250).

Dialog charges by connect time, and the hourly rate depends on the database you access.

WHARTON ECONOMETRIC FORECASTING

Wharton Econometric Forecasting Associates provides a vast array of economic, financial, and demographic data covering both historical and forecasted periods. Formerly available only to timesharing services, Wharton's information is now accessible to microcomputer users in two forms: downloaded and on data disks for the IBM PC. "Download" is a Wharton program that runs on its mainframe and interacts with the microcomputer to manage the downloading process. It first asks for the series name to be downloaded, then creates a DIF (Data Interchange Format) file for that series or formats a printed report. It coordinates the display of the DIF file on your microcomputer's monitor so that it can be easily captured by the microcomputer and stored to disk. Almost all of the Wharton data can be downloaded. The Wharton Download program will work with any terminal emulation software that can communicate with a TSO (timesharing operation) system.

Wharton charges only for the connect time. There are no data transaction or

stripping charges.

I.P. SHARP

I.P. Sharp Associates is a Canadian-based company that provides a telecommunications network and remote computing services for Sharp APL, the first commercial timesharing system for APL (A Programming Language). Sharp also provides extensive databases containing more than 50 million reports of public data covering economic, financial, demographic, energy, and aviation data in different time periods.

Sharp downloads via Microcomm, a software package written in BASIC (with some modules written in assembly language), which runs on the IBM PC and costs \$50. Data is formatted in DIF files on the mainframe and downloaded to standard PC-DOS files, making the vast majority of Sharp's economic and financial data available to microcomputer users. Sharp charges only for connect time.

Microcomm is menu driven and completely automates the downloading process. You don't need to know APL as the program is a PC-DOS program and interacts with Sharp in standard ASCII format. However, you do have to be familiar with the Sharp system and the method for querying its databases in order to access the desired data.

DATA RESOURCES

Data Resources Inc. (DRI), one of the nation's largest suppliers of on-line economic data, sells its forecasting services by subscription. Forecasts are available about the national economy, state and regional areas, and specific industries and activities as well as many foreign countries. These

forecasts supplement the historical data available through DRI.

DRI has developed a microcomputer product called VisiLink (distributed by VisiCorp) to help the microcomputer owner access the DRI timesharing computer. Information is downloaded in packages called DataKits.

VisiLink DataKits are combinations of data and accompanying analyses focused on specific applications. DataKits are downloaded in ASCII in the VisiCalc worksheet format. The DataKit can be loaded directly into VisiCalc and the resulting worksheet saved as a DIF file transportable to many different applications programs. Furthermore, many applications programs can read VisiCalc worksheets directly.

Downloading data via the VisiCalc format enables DRI to transfer spreadsheet formulas as well as data, something not possible with DIF. In addition, VisiCalc is the only major spreadsheet program that stores its spreadsheet data and relationships in ASCII format.

DRI offers three kinds of DataKits: a data retriever pack, a data forecast pack, and an analysis (application) pack. The data retriever is designed for downloading a series of historical information from the DRI data banks. The user is limited to 24 quarterly reports (6 years) and 10 series in one kit. There is a fixed charge of \$3 per series in a retrieval DataKit. Forecast data is available in predefined DataKits grouped by areas of interest. You can choose one of three forecast scenarios: control (the forecast DRI considers the most likely), a best-case forecast, or worst-case forecast. Forecast DataKits are naturally more expensive than retrieval kits.

Analysis DataKits are for the following applications: product-line forecasting, cost analysis, financial statements, industry detail, etc. Prices of application DataKits vary and depend on the complexity of the forecast. They range from around \$75 to more than \$200.

CHASE ECONOMETRICS

Chase Econometrics, part of Chase Econometrics/Interactive Data Corp., a subsidiary of the Chase Manhattan Bank, also provides microcomputers access to its data. The downloading system is called CEDAF for Chase Econometrics Data Access Facility. CEDAF is part of an economics workstation sold by Chase Econometrics/IDC, which includes an IBM XT, Lotus 1-2-3, an econometric analysis

package, and other utilities. CEDAF is designed to download data for the applications programs on the workstation. It is not a stand-alone program.

The data banks can contain, literally, millions of time-period series, each one with a unique mnemonic. CEDAF contains a query language that allows the user to give an English-language description of the data requested to which the system responds with several series that satisfy the given descriptors. By adding more descriptors, the number of series drops until only a handful are left.

To use CEDAF you must install the workstation, be a subscriber to Chase Econometrics, and pay for the connect time and a data-transaction charge, which depends on the value of the data being downloaded.

Interactive Data Corporation currently has two microcomputer products: PC Screen and DataSheet. Both are dedicated applications packages that link the microcomputer into the IDC databases. These packages are designed to take full advantage of the microcomputers' full screen interface.

PC Screen works with a mainframe's Compustat financial data and, as its name implies, is a screening program used for investment analysis—especially mergers and acquisitions. PC Screen lets you set up screen criteria so that you can identify, quickly and easily, the companies within the Compustat file that meet your criteria.

DataSheet is designed for data sharing within large corporations.

ADP

ADP (Automatic Data Processing) provides on-line access to extensive databases for the financial analyst and the business economist: Compustat, Disclosure II, stocks, bonds, futures, foreign exchange, and the Townsend-Greenspan historical and forecast economic databases. ADP was one of the first value-added resellers of Lotus 1-2-3.

Downloading data on ADP with its program Datapath is a three-step process: first, you define the data to be downloaded by creating a range name in a Lotus 1-2-3 worksheet that starts with the underline character; for instance, GNP would be a range called GNP. Data ranges can be anywhere in the worksheet and can be referenced by formulas in other cells. In essence, one constructs an entire Lotus template.

Second, Datapath's terminal-emulation

mode automatically connects with the ADP network. The program asks for the name of the worksheet that defines the data to be downloaded.

Third, the data automatically is downloaded into the predefined Lotus worksheet. If the downloaded data is referred to by formulas in the worksheet, the entire worksheet will be calculated automatically. Thus, if investors are interested in a ratio analysis of a company's performance, they can build a Lotus 1-2-3 template and request from Disclosure II the balance-sheet for that company. Datapath will download the data to the 1-2-3 worksheet, and 1-2-3 will calculate the ratio formulas automatically.

ADP also offers an on-line Applications Library of predefined Lotus templates, similar to the DRI VisiLink product. Templates from the Applications Library cost from \$20 to \$100. A balance-sheet template costs \$20, while a ratio-analysis template costs on the order of \$40.

ADP charges a minimum of \$100 per month per corporate account (not per user within the account), a subscription fee for each database accessed, and a data-transaction charge that varies depending on the data being accessed.

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ADP Network Services
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Chase Econometrics/Interactive Data Corp.
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Waltham, MA 02154
(617) 890-1234

Data Resources Inc.
24 Hartwell Ave.
Lexington, MA 02173
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Dialog Information Services
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(415) 858-3810

I.P. Sharp Associates
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Toronto, Ontario
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(215) 386-9000

MOVING DATA

more difficult than you'd expect from programs designed to manipulate just words. Many word-processing programs do not store text in ASCII format. WordStar saves the document as a single stream file with a new line indicated by a single linefeed character, whereas, in ASCII format, a line is indicated by a pair of characters: the carriage return and linefeed combination. This creates a problem for moving ASCII files to and from WordStar. WordStar provides a nondocument editing option to create files in standard ASCII format. However, once you are in the nondocument mode, all of your editing must be done in this mode to maintain the file's ASCII format. Editing in the nondocument mode is neither as simple nor as convenient as in a WordStar document file.

Conversion programs are available in the public domain that convert WordStar files to standard ASCII and vice versa. These programs have been published in most of the magazines devoted to the IBM PC and are available from most user groups or from a number of bulletin boards.

MultiMate, a popular dedicated word-processing program, stores text in a special form that is more akin to a database manager than a word-processing program. MultiMate does provide a utility that will convert its documents to standard ASCII files and from ASCII to MultiMate files. However, this utility will not work with mail merge information—names and addresses to be merged with MultiMate form letters.

MOVING DATA BETWEEN MICROCOMPUTERS

The new integrated programs often diminish the need to transfer data between programs by simply offering more functions in a single program. However, transfer problems still exist between different microcomputers. Moving data between microcomputers that read the same disk format is a simple matter of physically moving the floppy disk from one computer to another. The IBM PC has established a de facto standard because of the widespread use of MS-DOS on many different microcomputers. (MS-DOS is Microsoft's disk operating system on which it based PC-DOS.) In addition, programs like Zeno Copy from Vertex Systems can read and write many different disk formats on the IBM PC.

Data files that are being transferred between computers to be used in the same applications program (for example, a WordStar document on a CP/M computer for editing on an IBM PC running PC-DOS, a mailing list in dBASE II, etc.) are best transferred as binary files using a transfer protocol such as XMODEM. Occasionally, you will run into a problem between the versions of the applications programs on the two systems. For instance, when transferring a binary SuperCalc workspace from an Osborne CP/M system running an early version of SuperCalc to an IBM PC with a later version, it is best to use the SDI format to transfer the entire worksheet as an ASCII file. If the SuperCalc version number differs, then you must use the appropriate (SDI) utility to convert the workspace to an ASCII file and transfer the file, and then use the same utility program on the second computer to reconvert the ASCII file into the application format.

With the increasing popularity of lap computers, moving data between computers will become more and more common. Most lap computers come with a word processor and communications software and often include a built-in modem. In such an environment, moving a word-processed document from the lap to the base computer is a straightforward matter. But, using it with the base station word-processing program may not be as easy as you would expect. The lap computer operates with ASCII files and will transfer standard ASCII files to the base station. The problem may be that the base station's word processor does not format ASCII files (WordStar, for example). In all likelihood the ASCII file will have to be converted to run with the base station's word-processing program.

Transferring documents from your lap computer to the desktop computer is a two-step process: first transfer the lap computer's ASCII file to the base computer, then transform the file to a WordStar or other word-processor format using a utility program written for that purpose. If your word processor stores files in standard ASCII format, this simplifies the transfer of document files between your lap and desktop computers.

MOVING DATA BETWEEN MAINFRAME AND MICROCOMPUTER

A wide range of timesharing databases are available to microcomputer users today. You can link your microcomputer to a timesharing vendor in three different ways for different purposes: you can capture information being displayed on your microcomputer's monitor; using vendor-provided downloading software, you can interlock with the vendor's timeshar-

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MOVING DATA

Occasionally, a captured file may have lines that end with only a linefeed character.

ing system, eliminating incompatibility problems; and you can use an applications program that the vendor may provide to link the microcomputer to the mainframe.

The microcomputer's communications software captures data from a remote computer, allowing you to save to disk what is being transmitted to the microcomputer. The transmitted file is in ASCII stream format and, in many cases, will have to be edited with a word processor to remove extraneous information. It may also need reformatting to make it acceptable to the targeted microcomputer applications program. Almost any word processor that can edit and store ASCII files will suffice. However, you may have to remove or add control characters, and many word processors are unable to edit control characters.

Occasionally, a captured file may have lines that end with only a linefeed character, not the carriage return/linefeed combination required for standard ASCII files. The remedy for this problem is to use a word processor to locate all occurrences of the lone linefeed character and replace them with the carriage return/linefeed combination. This cannot be done in WordStar but can be done in Edlin or PCWrite.

Some vendors offer dedicated downloading of data via a special communications software program designed to work only with their timesharing/database systems and sold as a microcomputer software product. With one of these packages running on the PC and connected to the respective vendor's remote computer service, nearly all of the problems connected with downloading discussed above are eliminated. The disadvantage of these systems is that they work only with the vendor that provides them. One of their major benefits is that they permit you to upload data from your microcomputer to the remote computer service. The dedicated software program contains the necessary information for the PC to link up with a special program on the mainframe to run the downloading procedure in reverse.

All of the data timesharing vendors have built their businesses by supplying value-added software that manipulates your data, increasing its usefulness to your business. Your microcomputer uploads data to the remote computer service, which runs its applications programs on your information and returns the results to your terminal. The advantage is that the communications process is transparent, and incompatible files don't exist.

Users do lose control over the remote computer and are permitted to download only information or results for which they've contracted. Usually, when contracting for such services, you are required to buy terminal equipment compatible with the remote service's communication protocol—an IBM or an Apple, for example. Because of IBM's increasing market share in the business segment of the economy, more and more remote services are using it as a standard. ■

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TESTING FOR IBM PC COMPATIBILITY

Determining how compatible a computer is compared to the IBM PC has now been simplified with two new programs

The IBM PCs and IBM XT^s have set an industry standard that has generated numerous IBM PC clones. The question always asked about a clone is, How compatible is it with the IBM PC? The answer, in turn, determines what hardware and software will be available for the clone. We at Award Software have developed a series of tests aimed at confirming a computer's compatibility with the IBM PC.

Figure 1 shows an architectural model of the IBM PC and IBM XT. It consists of four levels: hardware, low-level support routines (ROM BIOS), PC-DOS I/O (input/output) device drivers (IBM-BIO.COM), and the PC-DOS (IBM-DOS.COM) operating system. If the hardware were completely compatible, then IBM ROMs (read-only memory) and DOS (disk operating system) could be used on the computer. However,

copyright laws prohibit this approach, and a ROM BIOS (basic input/output system) must be implemented by the vendor (and must be sufficiently distinct from IBM's as some vendors have found out) to provide interfaces identical to the IBM ROM BIOS. Last, the MS-DOS IO.SYS module must be implemented (and again must be distinct enough to avoid copyright infringement) to provide a PC-DOS interface.

The three areas of compatibility testing addressed in this article are hardware, ROM BIOS, and PC-DOS interfaces. The hardware testing covers the major LSI (large-scale integration) chips (Intel 8088, 8259, 8255, NEC 765, etc.), I/O ports, and how the chips are inter-

(continued)

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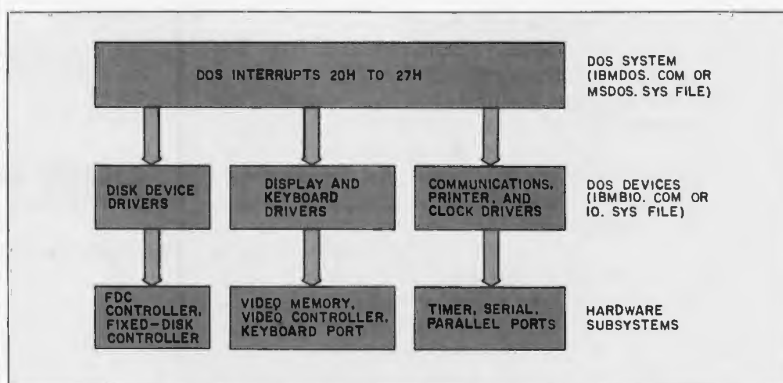


Figure 1: An architectural model of the IBM PC and XT.

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connected. The internal bus structure and timings are not addressed. The ROM BIOS is the set of primitive I/O software routines used to organize the hardware into a somewhat manageable form. The IBM PC and IBM XT ROM BIOS is a single-task/single-user I/O scheme. Even though interrupts are used, only one process is running at a time. (One exception does occur with the timer interrupt.) The PC-DOS is an IBM version of Microsoft's MS-DOS. This is the major operating system used on the IBM PC and XT.

Microcomputers found to have an exceptional degree of hardware and software compatibility with the IBM PC are Columbia, Compaq, Corona, Eagle, Mitsubishi, Stearns, and Seequa.

GENERAL TEST ASPECTS

PC-TEST includes 50 programs written in C to investigate the hardware and ROM BIOS interfaces. Each individual test is designed to look at a particular software interface and/or hardware subsystem. Listing 1 is an example listing, which checks the BIOS.

DOS-TEST has 40 C programs used to verify the PC-DOS implementation. It exercises all MS-DOS user-documented Interrupts and Function calls. It verifies IBM PC keyboard and video interfaces. It also verifies that all the IBM PC supported disk organizations are correct.

The motivation for developing PC-TEST and DOS-TEST was to validate implementations of IBM PC ROM BIOS and DOS BIOS developed by Award Software for IBM PC clones. Also one of our utilities, Crossdata, which transfers CP/M-80, CP/M-86, and Concurrent CP/M-86 files to PC-DOS files and back again, makes extensive use of the ROM BIOS interfaces. So to aid our porting of Crossdata and validating of IBM PC compatibility, PC-TEST and DOS-TEST were written. PC-TEST and DOS-TEST are currently available to interested OEMs (original equipment manufacturers).

PC-TEST and DOS-TEST were written to be run against an IBM PC or IBM XT. Some tests check whether the system conforms or not and draw a conclusion. Some tests require visual confirmation by the tester. All tests identify themselves and explain what the test is about and areas of testing. All tests report register clobbering when detected and

Listing 1: Example test case for IBM PC compatibility included in PC-TEST.

```

.....
-TEST ID- BIOS.DISPLAYIO.16 - BL_10_16
-PURPOSE- Test characters and attributes for black/white display
-VERSION- A
-TEST PROCEDURE- Program writes attributes for all characters. Tester verifies visually for
each character. Shown is each character for all b/w attributes and modes and the ordinal value
of the character for cross reference. Set 40 or 80 columns via mode command for test of 25
by 40 and 25 by 80 screen sizes.
.....

#include "srvrvr.c"

unsigned char curpage = 0;
int poscurs(y,x)
unsigned char x,y;
{
    srvah = 2; srvdh = y; srvdl = x; stv.bh = curpage;
    sint(0x10,0x7ff);
}

int clrexit()
{
    curpage = 0;
    srvah = 6; srval = 1; srvbh = 7; srvch = 0; srvc1 = 0;
    srvdh = 24; srvdl = 79; sysint(0x10,6,srv,6rrv);
    poscurs(24,0);
}

main ()
{
    unsigned char cont,c;
    unsigned int i,j,k;
    printf("TEST BIOSLOW.INT10.16 - Test of char/attribute video i/o
interrupt n");
    timestamp();
    printf("\nHit key to continue ");
    if ((tbdos(0x8) & 0xff) == 'c') cont = 1;
    else cont = 0;
    getkey();
    srvah = 6; srval = 0; srvbh = 7; srvch = 0; srvc1 = 0;
    srvdh = 24; srvdl = 79; sysint(0x10,6,srv,6rrv);
    poscurs(0,0);

    printf("Hit key to continue ");
    poscurs(2,0);
    printf("The character is shown with \n");
    printf("Intensity off/ blink off. then \n");
    printf("Intensity on/ blink off. then \n");
    printf("Intensity off/ blink on. then \n");
    printf("Intensity on/ blink on. ");
    poscurs(9,0);
    printf("BLACK CHAR ON BLACK \n");
    printf("UNDERLINE \n");
    printf("WHITE CHAR ON BLACK \n");
    printf("BLACK CHAR ON WHITE \n");
    printf("WHITE CHAR ON WHITE \n");

    for (i=0;i<256;i++) {
        for (j=0; j<5; j++) {
            switch (j) {
                case 0: c = 0; break;
                case 1: c = 1; break;
                case 2: c = 7; break;
                case 3: c = 0x70; break;
                case 4: c = 0x77; break;
            }

```

TESTING COMPATIBILITY

```

};
for (k=0; k<4; k++) {
    switch (k) {
        case 0: srv.bl = c; break;
        case 1: srv.bl = c | 8; break;
        case 2: srv.bl = c | 0x80; break;
        case 3: srv.bl = c | 0x88; break;
    }
    poscurs(9 + j, 20 + k * 2);
    srv.bh = 0; srv.cx = 1; srv.al = i; srv.ah = 9;
    sint(0x10, 0x7ff);
};
};
srv.ah = 11; srv.bh = 0; srv.bl = 0; sysint(0x10, &srv, &rrv);
poscurs(15, 0); printf("VAL %xH ", i);
poscurs(16, 0); printf("VAL %d ", j);
if (cont) {
    if (bds(0xb) & 0xff) break;
    else if ((bds(0x8) & 0xff) != 0) break;
};
clrscr();
}

```

report error values when results differ from those generated by an IBM PC. These tests are designed to be run by a systems programmer or technician who understands the internal structure of the IBM PC. The goal of the tests was to aid in determining where any incompatibility existed, not just that an incompatibility existed.

HARDWARE COMPATIBILITY TESTING

IBM PC and IBM XT hardware compatibility testing consists of verifying that the LSI chips and I/O addresses given in table 1 are the same. Also hardware compatibility requires that the monochrome and graphics memories exist at the proper addresses and that

the character and attribute (or pixel) memories have identical organization. PC-TEST checks hardware compatibility by looking for correct operations from the integrated chips that identify that the right chip is present at the proper I/O address. Display memory use is tested by putting patterns directly into the video memory and having the tester verify the pattern.

To run all IBM PC versions of interrupt-driven operating systems, such as QNX, Concurrent CP/M-86, etc., the above tests must pass. Otherwise you must obtain special versions of those operating systems. (Many times they do not exist.)

You can check I/O bus and timing compatibility by plugging in commercially available boards and verifying

their operation. Another method would be to take timing pictures using logic analyzers and verify them against an IBM PC or IBM XT.

ROM BIOS COMPATIBILITY TESTING

The ROM BIOS has two types of interface. The most commonly used and recommended one is via software interrupts. The other type is direct addressing of RAM (random-access read/write memory) used by the ROM BIOS (not recommended).

Using just software interrupts permits a wider range of computers upon which a particular software package will run. More computers are compatible in this area than the hardware area. Also, a number of computers use a different I/O and chip set to implement the system.

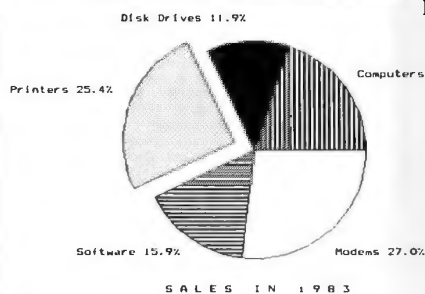
Table 2 lists the software interrupts provided by the IBM PC ROM BIOS. These software interrupts are passed parameters in registers. Some of the software interrupts use other interrupt vectors to obtain other parameters.

The major ROM BIOS functions used by software packages are the Video, Disk, Printer, Communications, Keyboard, Timer, and Equipment interrupts. These interfaces are described in the IBM Personal Computer and XT *Technical Reference Manuals'* ROM BIOS listings, Appendix A.

The Video interrupt (10 hexadecimal) provides 15 functions that allow for mode of screen display, cursor addressing, lightpen feedback, scrolling, teletype output, character and attribute read/write, graphics read/write, and

(continued)

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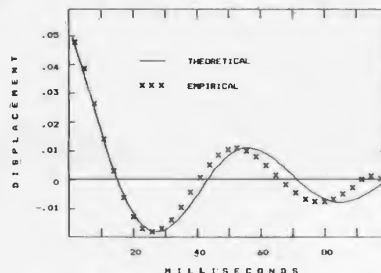
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palette and color selection. PC-TEST verifies all these uses in a series of 17 tests. Attribute values have been a particular problem on some implementations. However, all of the manufacturers of microcomputers we have examined have cleared up these problems.

The Disk interrupt (13 hexadecimal) provides five functions for floppy disks and 14 functions for fixed disks. Fixed-disk functions 9 through 14 are used by IBM for manufacturing and diagnostic testing and are not generally incorporated in software packages. Both the floppy and fixed disks use parameter tables at interrupt vector 1E hexadecimal and 41 hexadecimal, respectively. These are pointers to tables in ROM or RAM that describe motor timings, sectors per track, tracks per disk, and so on.

PC-TEST extensively tests these parameters because many software packages, like our Crossdata program, alter these parameters to read foreign disks. Also, these parameters are altered to implement many of the copy-protection schemes used to protect software from duplication on the IBM PC. This is the major area of incompatibility found on computers because a number of vendors have implemented higher-storage floppy-disk systems. These systems, in turn, exhibit internal timings and responses different from those of the IBM PC, and the copy-protection subsequently fails. Another major area of incompatibility is in error reporting. Some copy-protection schemes rely on certain error codes being reported by the IBM PC, and some systems do not

Table 1: Major hardware components of the IBM PC.

Identification	I/O addresses	Use
Intel 8088, 8086	—	Processor
NEC 765	3F4H, 3F5H	Floppy-disk controller
74LS Latch	3F2H	Floppy-disk secondary control
Intel 8255	60H, 61H, 62H, 63H	I/O ports for speaker, keyboard, equipment configuration, RAM parity enable
Intel 8253	40H - 43H	Real-time clock, speaker timer, DMA (direct memory access) refresh
Intel 8237	0 - 0FH	DMA controller
74LS Latches	80H - 83H	DMA page registers
Intel 8259	20H, 21H	Interrupt controller
74LS Latch	0A0 - 0AFH	NMI control
Fixed Disk	320H - 32FH	Fixed disk controller
Intel 8255	378H - 37AH, 3BCH - 3BEH, 278H - 27AH	Printer controllers
National 8250	2F8H - 2FEH, 3F8H - 3FEH	Serial communications chip
Motorola 6845 Latches	3D0H - 3DFH	Color/ graphics controller
Motorola 6845 Latches	3B0H - 3BFH	Monochrome display controller

initially report the error codes the same way as the PC.

The Printer interrupt (17 hexadecimal) provides three functions for as many as three parallel ports. PC-TEST verifies these functions for the specified logical parallel port and checks for compatibility in error-code reporting.

The communications interrupt (14 hexadecimal) provides four functions for as many as two serial communications ports. PC-TEST verifies these functions for the specified logical serial ports and checks for compatibility in error code reporting.

The major area of divergence for

microcomputers is in the keyboard-handling interrupt (16 hexadecimal). PC-TEST does an exhaustive keystroke test, with input from the tester, to ensure all shift states and keycode combinations occur. The test looks at the actual internal shift states as well as keycodes returned. Most of the computers listed earlier in the article as compatible pass these tests. Some initially failed to report proper internal shift states, but the failure has since been corrected. All reported the proper keycodes that are used by the vast majority of the software packages.

The Equipment interrupts (11 hexa-

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Table 2: ROM BIOS interrupt use in the IBM PC.

Interrupt	Use
0	Divide by zero from 8088/8086
1	Single step (used by DEBUG)
2	Nonmaskable (parity error)
3	Breakpoint (used by debugger)
4	Overflow
5	Print screen
6-7	Reserved
8-0FH	Hardware interrupts from 8259
10H	Video interrupt—15 functions available
11H	Equipment map
12H	Memory size
13H	Disk interrupt—6 floppy- and 14 fixed-disk functions
14H	Communications interrupt—4 functions
15H	Cassette
16H	Keyboard interrupt—3 functions
17H	Printer interrupt—3 functions
18H	ROM basic entry
19H	Bootstrap loader
1AH	Time-of-day interrupt—2 functions
1BH	Keyboard break interrupt
1CH	Timer tick interrupt
1DH	Video initialization parameter list pointer
1EH	Disk parameter list pointer
1FH	Graphics character pattern pointer
20H-3FH	DOS interrupts
40H	Disk interrupt reroute for fixed-disk systems
41H	Fixed-disk parameter list pointer
42H-FFH	Reserved or used by DOS, BASIC or user-supplied interrupts

decimal and 12 hexadecimal) tell the type of equipment and amount of memory available. PC-TEST reports the equipment list and the memory used. No problems were seen on the computers listed earlier.

The Timer interrupts (1A hexadecimal and 1C hexadecimal) yield a free running clock and a timer tick. PC-TEST programs verify the accuracy of the clock and the implementation of the timer.

Other interrupt vectors used are the 8259 interrupt chip vectors, trap and single-step interrupts, divide-by-zero interrupts, and print-screen interrupts. PC-TEST checks all of the above except the trap and single-step interrupts. They are most easily verified by using DEBUG. Again the microcomputers listed earlier provided no problems. However, the print-screen interrupt interferes with the Intel 188 processor chips, and systems that use the more advanced Intel processors may be incompatible.

PC-DOS COMPATIBILITY TESTING

Most software packages that do not

directly address the screen or use the ANSI (American National Standards Institute) escape sequences to address the screen do use the standard MS-DOS function calls. If the package does not use function keys, then it probably runs on any MS-DOS machine. However, most packages for the PC require screen addressing and function key codes. They use the Video software interrupt as the only lower-level machine interface (with perhaps an Equipment check) and use only standard MS-DOS calls. If the computer supports the Video interface, the screen character set, and the function key codes, then a large set of software packages will run on the machine.

One potential area of incompatibility is the inability to read and write all supported IBM PC floppy-disk layouts. These layouts are 48-tpi (tracks per inch), single- and double-sided, eight- and nine-sectored disks. This inability may be caused by having a 96-tpi drive and not being able to write on a 48-tpi disk or by not reading eight-sectored

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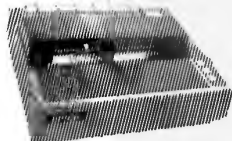
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TESTING COMPATIBILITY

formats at all.

Another area of incompatibility arises from the manufacturer not partitioning the fixed disk in the same manner as the IBM XT does. The IBM XT allows as many as four different bootable disk partitions. Each operating system may use one partition only. Thus a fixed disk may contain a DOS, CP/M-86, and/or Concurrent CP/M-86 partition.

The DOS-TEST programs check four areas of MS-DOS: the display, communications, printer, and keyboard characteristics; the disk organization; DOS interrupts; and the remainder of DOS functions that are invariant Microsoft functions.

The display testing consists of displaying the characters as shown in the IBM *Technical Reference Manual*, Appendix C. These tests use DOS interrupt 21 hexadecimal functions 2 and 6. The keyboard tests in DOS-TEST verify that the extended keycodes are identical. The physical keyboard layout may be different, but the ASCII (American National Standard Code for Information Interchange) and extended codes must be identical to pass the tests. The keyboard tests use DOS interrupt 21 hexadecimal functions 1, 6, 7, 8, A, B, and C. The other character device operations are tested via DOS interrupt 21 hexadecimal functions 3, 4, 5, and 9.

DOS-TEST includes programs for the testing of disk organization as noted above. Also, one program checks the fixed-disk partitioning. This test uses Disk ROM BIOS interrupts because the partition table exists outside of the system.

The remainder of the DOS-TEST programs exercise DOS interrupts 20 hexadecimal (program terminate), 22 hexadecimal (terminate address), 23 hexadecimal (control break exit address), 24 hexadecimal (critical error handling vector), 25 hexadecimal (absolute disk read), 26 hexadecimal (absolute disk write), 27 hexadecimal (terminate process and remain resident), and 21 hexadecimal (DOS function calls not included above).

Checking for IBM PC and IBM XT compatibility is tedious at best. PC-TEST and DOS-TEST were designed to be specific engineering test tools to pinpoint areas of compatibility and incompatibility. ■

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Smartmodem 1200 \$ 489

Smartmodem 1200B w/Smartcom II . \$ 419

Smartmodem-to-IBM 6 ft. Cable \$ 25

Smartcom II \$ 109

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Access 1-2-3 (w/Crosstalk XVI) \$ 379

TAC

Irma (Emulates 3278 Terminal) \$ Call

Irma Line (For Remote Emulation) ... \$ Call

We carry a wide variety of Mainframe Communication and Local Area Networks. For advice about which will suit your needs best give us a call and let us review them with you.

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MAYNARD ELECTRONICS

10MB Hard Disk WS-1 (XT Lookalike) . \$ 995

10MB Hard Disk WS-2 (XT Lookalike) . \$1195

DISKETTES

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MAYNARD ELECTRONICS

Standard Disk Controller \$ 115

with Parallel Port \$ 135

with Serial Port \$ 145

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Modular Memory Brd. w/64K to 576K. \$ 219

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SixPack Plus w/64K to 384K	\$ 269
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MegaPack w/128K or w/256K	\$ Call
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ORCHID TECHNOLOGY

Blossom w/64K to 384K	\$ 269
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TECMAR

Captain w/64K to 384K w/Software	\$ 269
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QUADRAM

Quadboard w/64K to 384K	\$ 279
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PRINTERS & PLOTTERS

C. ITOH

Starwriter Letter Quality 40 cps	\$1195
Printmaster Letter Quality 55 cps	\$ Call
Cut Sheet Feeder (Feeds 200 sheets)	\$ 445

EPSON

(All Printers include GRAPHTRAX-Plus)

RX-80 (120 cps, 80 cols)	\$ Call
RX-80 F/T (120 cps, 80 cols)	\$ Call
RX-100 F/T (100 cps, 132 cols)	\$ Call

FX-80 F/T (160 cps, 80 cols)	\$ Call
FX-100 F/T (160 cps, 132 cols)	\$ Call
Epson-IBM Cable	\$ 30

HEWLETT PACKARD

HP-7470A Two Pen Plotter	\$ Call
HP-7475 Six Pen Plotter	\$ Call
HP-IBM Cable (works w/Lotus 1-2-3)	\$ 50

NEC

NEC 3550 Letter Quality 35 cps	\$1699
NEC 2050 Letter Quality 18 cps	\$ 895
Bi-Directional Tractor	\$ 235
Cut Sheet Feeder (Feeds 200 Sheets)	\$ 445
NEC-IBM Cable	\$ 30

OKIDATA

Microline 83A (120 cps, 132 cols)	\$ 575
Microline 92 (160 cps, 80 cols)	\$ 445
Microline 93 (160 cps, 132 cols)	\$ 699
Microline 84 (200 cps, 132 cols)	\$ 879
Plug n' Play	\$ Call
Okidata-IBM Cable	\$ 30

SILVER-REED

EXP 550 (20 cps, 132 cols)	\$ 595
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AMDEK

Video 300 Green Screen	\$ 140
Video 300A Amber Screen	\$ Call

Video 310A IBM Monochrome in Amber	\$ 170
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PRINCETON GRAPHICS

HX-12 RGB Hi Resolution Color	\$ 499
Max-12 IBM Monochrome in Amber	\$ Call
SR-12 Hi Resolution Color	\$ Call

VIDEO—MONITOR BOARDS

HERCULES

Graphics Card	\$ 359
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Bi-Graphix I	\$ Call
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PARADISE SYSTEMS

Multidisplay	\$ 399
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PC+ PRODUCTS

Colorplus	\$ 419
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STB

Graphix Plus	\$ 299
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QUADRAM

Quadcolor I	\$ 199
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TECMAR

Graphics Master	\$ 499
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MISCELLANEOUS

Cables (all extension cables)	\$ Call
8087 Co-processor	\$ 199

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Deluxe Keyboard (KB 5151)	\$ Call
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KOALA—Touch Tablet w/Software

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KRAFT—Joystick

	\$ 49
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T.G.—Joystick

	\$ 49
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MICROSOFT—Mouse w/Software

	\$ 159
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MOUSE SYSTEMS—PC Mouse

	\$ Call
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SOFTWARE

ALPHA

Database Manager II	\$ 199
Apple—IBM Connection	\$ Call

ASHTON TATE

dBase II	\$ 285
dBase III	\$ Call
Friday	\$ 179
Framework	\$ Call

ATI

All Software Training Pkgs	\$ 55
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CENTRAL POINT SOFTWARE

Copy II PC	\$ 35
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FOX & GELLER

Quickcode	\$ 169
dGraph (Requires Graphics Card)	\$ Call
dUtil (Utilities For dBase II)	\$ 25
OZ (Management Control)	\$ Call
FINANCIER—Financier II	\$ 119
FUNK—Sideways	\$ 49
HAYES—Smartcom II	\$ 109
IMSI—4 Point Graphics (Rated #1)	\$ 119

INDIVIDUAL SOFTWARE

Tutorial Set (IBM PC/XT and DOS)	\$ 79
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INFORMATION UNLIMITED SOFTWARE

EasyWriter II System (See Specials)	\$ 195
Accounts Receivable	\$ 299
Accounts Payable	\$ 299
General Ledger	\$ 299
Payroll	\$ 369

INFOCOM—Zork I, II, III	\$ 29
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LATTICE

C-Compiler	\$ 299
C-Food Smorgasboard	\$ 110

LIFETREE

Volkswriter	\$ 115
Volkswriter Deluxe w/TextMerge	\$ 179

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Master Type (Best Typing Tutor)	\$ 39
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LOTUS DEVELOPMENT

Lotus 1-2-3 (Version 1A)	\$ Call
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Symphony Upgrade	\$ Call

MICRO DATA BASE SYSTEMS

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MICROSOFT

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Flight Simulator	\$ 35
Multiplan (New Version)	\$ 149
Multi-Tool Word	\$ 249
Multi-Tool Word w/Mouse	\$ 299
Pascal Compiler	\$ 250

MICROPRO

Wordstar w/Tutorial on Disk	\$ 259
Wordstar/MailMerge/CorrectStar/StarIndex (ProPack)	\$ 369

MICRORIM

R.base 4000	\$ 299
Clout	\$ 139

MICROSTUF

Crosstalk XVI (for Hayes Smartmodem)	\$ 109
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MORGAN COMPUTING

Trace 86 (Assembly Language Debug)	\$ 99
Ted (Program Editor)	\$ 79
Professional Basic (170K Work Space w/8087 Support)	\$ 259

MULTIMATE INTERNATIONAL

Multimate (See Specials)	\$ 295
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PETER NORTON

Norton Utilities	\$ 55
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POWER BASE SYSTEMS

Power Base	\$ 269
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ROSESOFT

Prokey (Newest Version)	\$ 95
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SOFTWARE ARTS

TK!Solver	\$ 299
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SOFTWARE PRODUCTS

Open Access	\$ 399
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SATELLITE SOFTWARE INTERNATIONAL

Word Perfect (includes Speller)	\$ 279
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SORCIM

Supercalc 3	\$ 219
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SOFTWARE PUBLISHING

PFS/File	\$ 95
PFS/Graph	\$ 95
PFS/Write	\$ 95
PFS/Report	\$ 79

TALL TREE SYSTEMS

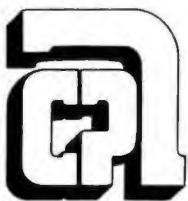
J-Format 2.0	\$ 40
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WORDTECH SYSTEMS

dB/Compiler (True dBase II Compiler)	\$ 450
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WANG PUBLICATION

Random House Proof Reader 50K speller	\$ 45
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Circle 13 on inquiry card.

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Ex. 1022, Page 273

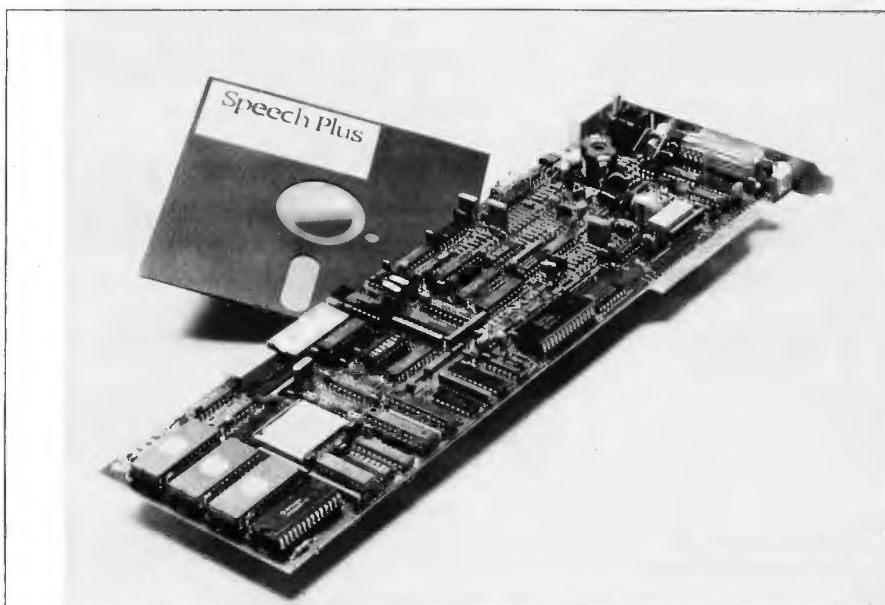
W·H·A·T'S N·E·W

PERIPHERALS

CallText Permits Data Access Over Telephone

CallText 5000 is a text-to-speech converter and telephone interface that lets you access text data in voice by means of a Touch-Tone telephone. It provides voice output with unlimited vocabulary, and you can program it to answer the telephone, initiate calls, obtain text data from a host computer, and supply text in voice to a caller. CallText converts serial ASCII English text to speech in real time and automatically answer incoming calls. It has an on-board speaker and I/O drivers callable from BASIC, C, and assembly-language programs running under MS-DOS. Priced at \$2700, it connects to the telephone network through a modular jack and to the computer through an RS-232C serial port. Contact Speech Plus Inc., 461 North Bernardo Ave., Mountain View, CA 94043. (415) 964-7023.

Circle 252 on inquiry card.



Disk Subsystems Use Kodak Drives

Data Technology's TeamMate line of disk subsystems for the IBM PC are based on Eastman Kodak's 3.3-megabyte (unformatted) flexible disk technology. The TeamMate subsystems offer 2.78 megabytes of on-line formatted storage capacity, and they can serve as a Winchester backup. TeamMate configura-

tions include internal- or external-mount Kodak drives, two external drives, or a combined 10-megabyte Winchester drive with the Kodak drive for backup. The software controllers are transparent, providing easy installation without software drivers or formatted disks. For storage and retrieval, the drives

use a closed-loop servo tracking system. A user-initiated command will switch the motor speed for reading either 48- or 96-tpi media. Prices begin at \$895. Contact Data Technology Corp., 2775 Northwestern Parkway, Santa Clara, CA 95051. (408) 496-0434.

Circle 253 on inquiry card.

Hard-Disk Subsystems

Micro-Design markets a line of hard-disk subsystems for IBM PC, PC-compatibles, Apples, and Radio Shack computers. Its Data and SQ series incorporate removable 5-megabyte cartridges, on-line access and off-line storage, and expandability. Microprocessors handle the interface to the computer and

embedded servo mechanisms ensure position accuracy when reading or writing data. The line includes units that mix removable and fixed storage media, with storage capacities ranging as high as 22 megabytes. Prices for the Data series begin at \$2995; the SQ series starts at \$1795. The Pro

Series of 10-, 20-, and 33-megabyte models are available for internal installation or in IBM-style cases. Prices start at \$1299. Contact Micro-Design, 6301 Manchaca Rd., Austin, TX 78745. (800) 531-5002; in Texas, (512) 441-7890.

Circle 255 on inquiry card.

Multifunction Card Has Real-Time Clock

Seattle Computer's RAM+6 multifunction card gives IBM PC users a time-of-day clock with battery backup, room for up to 348K bytes of RAM, and ports for a parallel printer, an RS-232C serial device, and game connection. Memory options for RAM+6 include 64K, 128K, 192K, 256K, 320K, and 348K bytes. This board is provided with software that lets you designate a portion of memory to be used for disk emulation. Another software package lets you assign up to 64K bytes of memory, in 1K-byte increments, as a printer buffer. RAM+6 prices begin at \$395 with 64K bytes of memory. Contact Seattle Computer, IBM PC Products, 1114 Industry Dr., Seattle, WA 98188. (800) 426-8936; in Washington, (206) 575-1830.

Circle 256 on inquiry card.

SOFTWARE

Single-Board Modem Fits in PC

The single-board MultiModem PC fits inside the IBM PC and does not require a serial card. An auto-dial/auto-answer 300/1200-bps communications system. MultiModem has an internal speaker for call-progress monitoring. Its commands are Hayes Smartmodem 1200/1200B compatible. It comes with communications software that provides automatic log-on, diagnostics, error-protecting file-transfer protocol, log-on macro

encryption for password security, and the ability to copy communications to the printer, disk, or both while on-line. MultiModem and its software can be configured as either COM1, COM2, COM3, or COM4. With documentation, it's \$549. Contact Multi-Tech Systems Inc., 82 Second Ave. SE, New Brighton, MN 55112, (612) 631-3550.

Circle 251 on inquiry card.

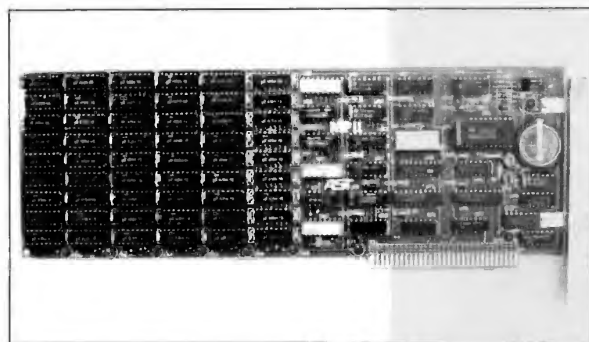
PC-to-Mainframe Connection

The Quad3278 plugs into the IBM PC and creates an IBM PC-to-mainframe connection. This hardware/software package will permit the PC, PC XT, and PC-compatibles to communicate with an IBM mainframe via a 3270 coaxial network. It provides 3278 Information Display emulation and a screen-capture ability that lets you retrieve, store, and print pages of infor-

mation from the mainframe. You can toggle back and forth between PC stand-alone and mainframe modes. With documentation, it sells for \$1195. A starter kit, which includes 100 feet of coaxial cable, is \$95. Contact Quadram Corp., 4355 International Blvd., Norcross, GA 30093, (404) 923-6666.

Circle 254 on inquiry card.

Memory Board Has Clock/Calendar

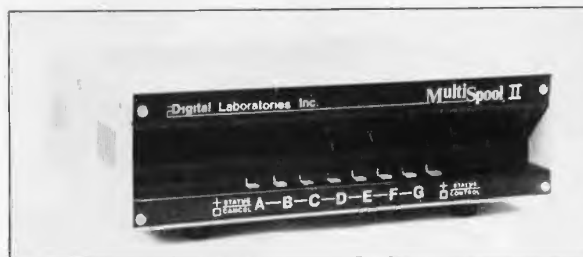


AST Research calls its MPII a "no frills" expansion card for the IBM PC XT. The MPII comes with 64K bytes of dynamic RAM, utility software, and a clock/calendar. Its memory capacity is upgradable to 348K bytes in 64K-byte increments. The price for the MPII ranges

from \$345 to \$845, depending on memory. The 64K-byte increments are \$100. A version without the clock/calendar is available. Contact AST Research Inc., 2121 Alton Ave., Irvine, CA 92714, (714) 863-1333.

Circle 257 on inquiry card.

System Allows Sharing of Printers



Digital Laboratories is selling a family of printer-sharing systems for microcomputers, minicomputers, and mainframes. The MultiSpool Printer Sharing Systems can route the output from as many as 17 computers

to as many as 5 serial or parallel printers. Prices begin at \$595. Information is available from Digital Laboratories Inc., 600 Pleasant St., Watertown, MA 02172, (617) 924-1680.

Circle 269 on inquiry card.

APL Interpreter Written in C

Portable Software has announced the availability of PortaAPL, an APL interpreter written in C for easy portability between different computers. Currently, interpreters are available for the IBM PC, Sanyo PC, DEC VAX, and Motorola 68000. The implementation is identical on all machines, and a system command is available for porting workspaces to different types of computers. PortaAPL does not support shared

variables, but it does include a full-screen editor. It has an ASCII character set option and a Host File System option. PortaAPL provides access to machine-language functions. The price for the IBM PC version of PortaAPL is \$195. Source and OEM licenses are available. Contact Portable Software, 60 Aberdeen Ave., Cambridge, MA 02138, (617) 547-2918.

Circle 280 on inquiry card.

Spellbinder for PCjr, Compatible Machines

Lexisoft is offering version 5.3 of Spellbinder for the IBM PC, PCjr, and compatibles. This version includes a spelling and grammar checker, automatic hyphenation, footnoting, augmented forms-handling, and a revised manual. The program also interfaces with database-management, spreadsheet, and accounting programs. The suggested retail price is \$495. Information is available from Lexisoft Inc., POB 1378, Davis, CA 95617, (916) 758-3630.

Circle 264 on inquiry card.

Want to Program in Plain English?

Plain English is claimed to be the first programming language using simple English language commands such as "save by customer number in accounts receivable and repeat." The language runs under all MS- and PC-DOS systems and includes four accounting modules as example programs. List price is \$595. Contact Common Language Systems Inc., 100 East Sybelia Ave., Maitland, FL 32751, (305) 628-5973.

Circle 262 on inquiry card.

(continued)

SOFTWARE

Planner Software Fills Address Book



Personal Planner is a program for keeping name and telephone lists and printing them on Recordplate forms for use in an address book. The program also can produce form letters using the address list. It runs on all IBM PC models, in-

cluding PCjr. and compatibles. List price is \$99, including the address book and 100 Recordplate forms. Contact National Microware, 2102 Business Center Dr., Irvine, CA 92715. (714) 752-2344. Circle 263 on inquiry card.

Make Your IBM Into a DEC

The EM100 is a software program for the IBM PC, PC XT, and Portable PC that allows those computers to communicate with DEC hosts as VT100 terminals. EM100 sells for \$225. Information is available from Diversified Computer Systems, POB 7575, Boulder, CO 80306. (303) 443-6255.

Circle 258 on inquiry card.

dBasell Program Tracks Prospects

Prospects Unlimited keeps files of information on customers and prospects for salespeople. It also can be used as a tickler file, time manager, and label generator. It is written in dBasell and sells for \$349. For information, make contact with ACS Consultants, Suite 207, 199 California Dr., Millbrae, CA 94030. (415) 697-3861. Circle 271 on inquiry card.

Mini-based Editor Ported to IBM PC

UniPress Software has developed a Gosling EMACS screen editor for the IBM PC. The company says that the MS-DOS version is a full-function Gosling EMACS, including full-screen editing, multiple windows, full keybindings, automatic parentheses checking, extensibility through macros,

and a built-in compiled MLISP programming language. Cost is \$375 for a binary version and \$995 for source code. A minimum of 384K bytes of RAM is required. For information contact UniPress Software Inc., 1164 Raritan Ave., Highland Park, NJ 08904. (201) 985-8000. Circle 259 on inquiry card.

PC Article Database Free of Charge

LETUS A-B-C, a database containing abstracts of articles and letters from major IBM PC magazines, is available without charge under the user-supported software concept. The database covers all articles and letters from the 1982 and 1983 editions of *Softalk*, *PC*, *PC Age*, *PC World*, and *PC Tech Journal*. It includes articles on the IBM Personal Computer that appeared in *BYTE* magazine. Designed to be used with PC-File, LETUS A-B-C lets you

search the database by any keyword, subject, title, or author. You can obtain LETUS A-B-C by sending three double-sided double-density floppy disks in a self-addressed, stamped mailer to LETUS A-B-C, 3790 El Camino Real, #2006, Palo Alto, CA 94306. (415) 493-4306. (A donation of \$10 per disk is requested.) You can also remit \$40 and the disks will be mailed to you. Circle 279 on inquiry card.

Database Program Supports LANs

Metafile version 8.0, a relational database system, claims compatibility with most PC local-area networks, including PCnet, Novell Sharenet, and 3COM. The program, which costs \$995, allows users to share logical and physical devices such as hard-disk drives and letter-

quality printers among several computers. Transaction-level locking is used for data integrity. For information, make contact with Sensor-based Systems, 1701 East Lake Ave., Glenview, IL 60025. (800)323-3731; in IL (312) 724-0310.

Circle 268 on inquiry card.



A Clean Slate for Commercials

Clean Slate is designed to estimate and control costs of film and video-tape commercials. It costs \$795 and runs on any IBM PC or compatible computer and can be modified for special requirements. Information is available from InfoCus Systems, POB 556, Middle Village, NY 11379. (212) 849-9672.

Circle 273 on inquiry card.

Modular Software for Businesses

Interactive Business System is a set of interrelated modules that can handle accounts receivable, accounts payable, inventory control, payroll, fixed assets, and general ledger. The complete system retails for \$795; demonstration disks and manual are available for \$25 from Performance Engineered Programming, 3970 Syme Dr., Carlsbad, CA 92008. (619) 434-6023. Circle 267 on inquiry card.

SOFTWARE

Calculator Program

Evergreen Software Products' PC-Calculator performs all the standard functions of a desktop calculator as well as solving trigonometric, statistical, and financial problems. The program can support a line printer. PC-Calculator will run on any IBM PC or compatible with at least 96K bytes of memory. It retails for \$39.95. Contact Evergreen Software Products, POB 438, Lancaster, NY 14086, (716) 683-4603.

Circle 277 on inquiry card.

Mapping Program Uses Standard Information

Atlas is an interactive, menu-driven program from Strategic Location Planning for generating maps and data displays based on state, county, congressional district, advertising region, census tract, or custom data. It requires PC-DOS 2.0, 192K bytes of RAM, and an HP-7470A or HP-7475A plotter or a dot-matrix graphics printer. Price is \$225, and information is available from Strategic Locations Planning, 2471 Golf Links Circle, Santa Clara, CA 95050, (408) 247-1956.

Circle 270 on inquiry card.

Integrated Systems Can Run on PCjr

IOAS-3 is an integrated software package for the IBM PC, PC XT, PCjr, and compatibles that sells for \$199. It includes a database manager, IDM-X; a spreadsheet, SS-X; and a word processor, WORD-X. Minimum memory needed is 128K bytes, and any version of PC-DOS can be used. The system comes in three versions: IBM PC XT, PCjr with monitors, and PCjr with television display. It supports both monochrome display and color monitors. For information, contact Micro Architect Inc., 6 Great Pine Ave., Burlington, MA 01803, (617) 273-5658.

Circle 260 on inquiry card.

Baby 34 Lets RP GII Programs Run on PC

Baby 34 is a software system that allows programs in the RPG II language to run on the IBM PC and PC XT. Available for \$2500 to \$3000, depending on options. Baby 34 provides for program conversion between the PC and the IBM System 34 by use of the data exchange utility (DEU). Also included are an operations control language (OCL), an RPG II compiler, RPG II run-time support, a screen-format generator, source entry utility (SEU), and RPG II sort. A data file utility is optional. Contact May-Craft Information Systems Inc., 4312 Beltwood Parkway South, Dallas, TX 75234, (800) 527-7456; in Texas, (214) 392-3766.

Circle 276 on inquiry card.



Cope with Linear and Integer Programming

Management Analytic Support has announced the release of Cope, a software package for solving linear and integer programming problems on the IBM PC. Cope features conversational English interaction with the computer and menu-driven applications development. Variable names may be as long as 16 characters. Problems may be saved on disk, reloaded, and

modified from within Cope. Cope is available for three ranges of applications: 50 constraints by 100 variables, 100 by 200, and 150 by 300. The pricing is \$285, \$365, and \$475, respectively. Contact Management Analytic Support Inc., 6826 Dean Dr., McLean, VA 22101, (202) 293-1624.

Circle 274 on inquiry card.

Video Makers Get Help with Budgeting

The DataMogul Budget program is designed to prepare, revise, and print budgets for film and videotape production. It runs on all versions of the IBM PC and compatibles. Special forms are available for specific budgeting. The basic program lists for \$1100, and the forms range in prices from \$100 to \$500. Information is available from Quantum Films, Suite 24, 8344 Melrose Ave., Los Angeles, CA 90069, (213) 852-9661.

Circle 272 on inquiry card.

New Program Can Aid Mail-Order Businesses

Data Consulting Group has introduced its PC Mail Order System for the IBM PC and compatibles. The program allows logging details of sales, printing sales reports, printing labels and lists, maintaining inventory controls, and creating invoices. It sells for \$295. Information is available from Data Consulting Group, 12 Skylark Dr., #18, Larkspur, CA 94939, (415) 927-0990.

Circle 261 on inquiry card.



The Micromint Collection

Micromint. Supporting the varied projects that appear in Steve Ciarcia's monthly article in BYTE Magazine, "Ciarcia's Circuit Cellar." Offering a wide range of computers and peripherals designed to meet the exacting demands of the hobbyist as well as worldwide corporate clients.

TERM-MITE ST SMART TERMINAL BOARD

As featured in Ciarcia's Circuit Cellar
BYTE Magazine, January & February 1984

All you need to build a Smart Video Terminal equivalent to the types advertised for \$1,000.00 or more is a Term-Mite ST circuit board, scanned or parallel key-board, video monitor and power supply.

- Uses brand new Nat'l Semi NS455A Terminal Processor.
 - 24 lines by 80 characters, 25th reverse-video status.
 - Upper & lowercase, Line (block) graphics.
 - Selectable data rate, parity & display options.
 - Reverse video, half intensity, double height & width, underlined, blinking and/or blank character.
 - Separate sync or composite video output. Self Test.
- Term-Mite ST Video Display Terminal Board
BCC22 Assembled & Tested \$284.
BCC23 Complete Kit 244.

MPX-16 MICROCOMPUTER IBM PC COMPATIBLE



As featured on the cover of BYTE Magazine. Also
featured in Ciarcia's Circuit Cellar November,
December 1982 & January 1983

The Computer With A Split Personality
—Use it as an IBM PC look alike that directly boots
PC DOS 1.1, and accepts all expansion boards
designed for the IBM PC.

—Use it as a powerful 8088 single board computer
for all your OEM applications. Just add serial ter-
minal, disk drive and power supply. Directly boots
CP/M-86.

Buy the MPX-16 in the form that best meets your
needs or budget. As a bare board, as a wave soldered
board that contains all components less ICs, as an
assembled and tested circuit board or as a complete
system.

- Directly boots PC DOS 1.1 and CP/M-86.
- Most IBM PC software executes with no
modifications.
- IBM PC bus compatible + 9 expansion slots.
- Intel 8088 16-bit microprocessor.
- Optional Intel 8087 math coprocessor
- 256K bytes on board memory.
- Up to one megabyte of system memory.
- Up to 64K bytes of system ROM EPROM.
- 2 RS-232C Serial & 3 Parallel I/O ports.
- Disk controller for 5 1/4" or 8" drives.
- Sixteen levels of vectored interrupts.

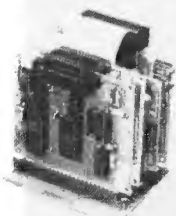
MPX-16 Circuit Board Assembled w/64K RAM.....	\$1,200.
OEM 100 quantity price.....	900.
MPX-16 Circuit Board Assembled w/256K RAM.....	1,400.
MPX-16 Semi-Kit (wave soldered circuit board w/all components) Less ICs.....	595.
Complete Kit of ICs w/256K RAM.....	595.
MPX-16 Unpopulated (bare) PC Board.....	300.
CP/M-86 Operating System + Manuals.....	80.
MPX-16 Switching Power Supply.....	300.
MPX-16 Technical Reference Manual.....	50.
MPX-16 Metal Enclosure with Fan.....	300.
Tandon TM 100-2 Double Sided Density Drive.....	300.
IBM PC Keyboard Interface Adapter.....	100.

Shipping & handling additional on all
MPX-16 orders.

IBM PC is a trademark of International Business Machines Inc.
CP/M-86 is a trademark of Digital Research Inc.
Z8 is a trademark of Zilog Inc.

Circle 112 on inquiry card.

Z8 BASIC SYSTEM CONTROLLER NEW!!!



As featured in Ciarcia's Circuit Cellar.
BYTE Magazine, July & August 1981

The Z8 Basic System Controller is an updated version
of our popular BCC01. The price has been reduced
and features added. The entire computer is 4" by 4 1/2"
and includes a tiny BASIC interpreter, up to 6K bytes
of RAM and EPROM, one RS-232C serial port with
switchable baud rates and two parallel ports. BASIC
or machine language programming is accomplished
simply by connecting a CRT terminal. Programs can
be transferred to 2732 EPROMs with an optional
EPROM programmer for auto start applications. Addi-
tional Z8 peripheral boards include memory expan-
sion, serial and parallel I/O, real time clock, an A/D
Converter and an EPROM programmer.

- Uses Zilog Z8 single chip microprocessor.
- Data and address buses available for 124K memory.
- Can be battery operated.
- Cross assemblers for various computers.

BCC11 Assembled & Tested \$149.
New Low Price

Z8 MEMORY, I/O EXPANSION. CASSETTE INTERFACE

- 8K bytes of additional RAM or EPROM.
- Three additional 8 bit parallel ports.
- Cassette interface—300 baud K.C. Standard.
- Software real time clock.

BCC03 w/4K RAM Assembled & Tested \$150.
BCC04 w/8K RAM Assembled & Tested 180.

Z8 EPROM PROGRAMMER

- Transfer BASIC or Assembly Language application
programs from RAM to 2716 or 2732 EPROM
 - Comes with programming & utility routines on
EPROM.
 - Requires BCC03 Z8 Expansion Board for operation.
- BCC07 Assembled & Tested \$145.

Z8 ANALOG TO DIGITAL CONVERTER

- Uses Analog Devices 7581 IC, 8-channel 8-bit.
 - Adds process control capability to the Z8 system
 - Over 1,000 conversions per channel per second.
 - Monitors 8 analog signals in one of two 10v ranges.
- BCC13 Assembled & Tested \$140.

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 - Runs at 75 to 19,200 baud in all protocols.
 - Comes with listings of sample serial I/O routines.
- BCC08 Assembled & Tested \$160.

Z8 16K MEMORY EXPANSION BOARD

- Add up to 16K of additional memory, RAM or
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- Accepts 2016, 6116, 2716, or 2732 memory types.
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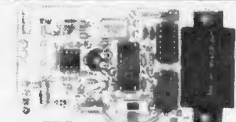
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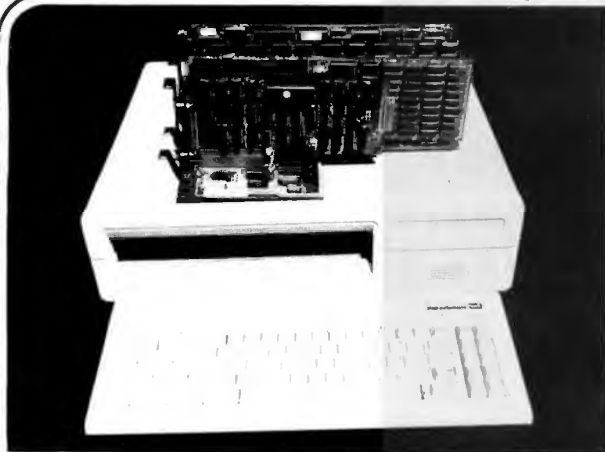
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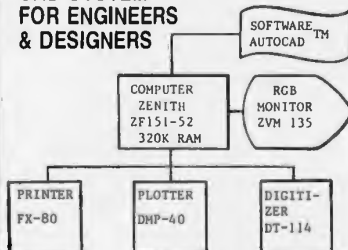
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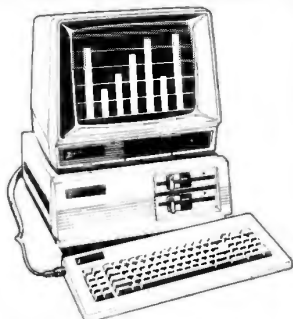
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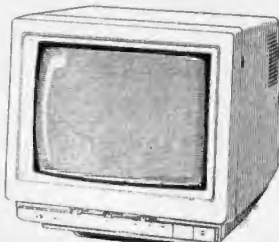
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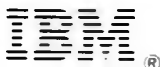
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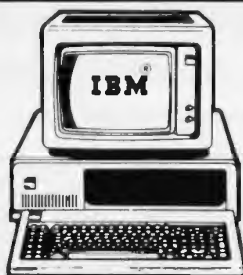
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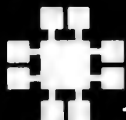
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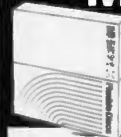
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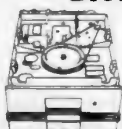
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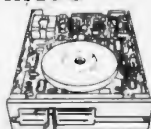
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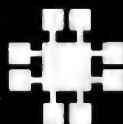
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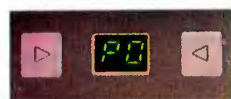
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