

The Tandy Model 2000

A
compromise
between
IBM PC
compatibility
and high
performance

BY MARK S. JENNINGS

After six months of intensively using the Tandy 2000 alongside an IBM PC, I can say without reservation that the 2000 is the superior computer. It is noticeably faster and has better display options, a superior keyboard, higher disk-storage capacity, and more room for expansion. You should choose between the two computers based on whether you are willing to accept the limited availability of software and hardware in order to gain much higher performance.

SYSTEM OVERVIEW

The Tandy 2000 is a low-profile unit with a thin, detachable keyboard. You can set either a monochrome or RGB (red-green-blue) monitor on top of the system unit, or Tandy will sell you a stand to mount the system unit vertically on the floor.

Tandy used plastic as the main construction material; RF (radio frequency) shielding is accomplished with foil lining and metal access covers. I'm not big on plastic, but it makes the 2000 lighter than the IBM PC. The color is an attractive eggshell white.

A small but important feature of the 2000 is a front-panel reset button. Some people complain that hardware reset buttons cause accidents; however, the 2000's reset button is deeply recessed on the unit's front panel to prevent problems. A hardware reset button ensures that you can always reboot the system, even after a serious software crash. You can also use the IBM PC's Control-Alternate-Delete combination to boot the 2000.

The basic 2000 system includes 128K bytes of RAM (random-access read/write memory), dual 5¼-inch floppy-disk drives, a monochrome display adapter, a parallel port, and a serial port. Adding Tandy's VM-1 monochrome monitor produces a working system for about \$3000 list. You can substitute a 10-megabyte hard-disk drive for one of the floppies; this system (with monochrome monitor) lists for approximately \$4500. Monochrome graphics requires an expansion board, and if you want

color graphics you'll need a memory-chip upgrade kit and Tandy's CM-1 RGB monitor. All told, a two-floppy, color graphics system runs about \$4200.

INTERNAL LAYOUT

A large main circuit board lies horizontally at the base of the 2000's system unit. Cables interconnect the main board to the power supply and disk drives. While the 2000 has slots for expansion boards, these boards do not connect directly to the main board. Instead, a small expansion bus board rises vertically from a connector on the left side of the main board (see photo on "At a Glance" page). Expansion boards slide in horizontally from the back and connect to the expansion bus board. Four expansion board slots are provided.

This method of plugging in expansion boards has several advantages. First, you do not need to open the computer's case to plug in a board—just pop two plastic clips on the back panel of the computer, slide the board in until it seats, and re-pop the clips. You don't even need a screwdriver. Second, the entire rear edge of the expansion board can have I/O (input/output) connectors. This alleviates the "connector space squeeze" that afflicts IBM PCs with multifunction expansion boards. Third, keeping the expansion connectors on a separate board allows plenty of space for big connectors. The 2000 uses a 96-pin three-tiered Euroconnector rather than the usual card-edge connector. The relatively large number of pins provides designers of expansion boards with more flexibility.

A disadvantage of the 2000's arrangement is that you need two connectors instead of one to connect each expansion board to the main board, perhaps degrading reliability a bit.

PROCESSOR

The 2000 uses the Intel 80186, an improved descendant of the 8086/8088 micropro-

(continued)

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processors used by the IBM PC and most other MS-DOS computers. Compared to the 8088 as used in the IBM PC, the 80186 has a faster clock speed (8 MHz versus 4.77 MHz), uses a full 16-bit data bus, and includes a number of functions for which the 8088 requires extra support chips. All these improvements do not compromise software compatibility; the 80186 can execute the full 8086/8088 instruction set and has a few new instructions of its own. The 80186 has one drawback: limited availability. Intel can't produce enough to meet demand.

Do these features translate into improved performance? Yes and no. Operations that are "processor-intensive" (such as recalculating a spreadsheet) run about two to three times faster on the 2000 than on the IBM PC. This peeps up certain programs. The "At a Glance" benchmarks indicate the performance improvement you can expect in this area.

Unfortunately, the effective operating speed of many programs is limited by disk I/O speed rather than processor speed. There is little significant difference in disk I/O speed between the 2000 and the IBM PC as shown in the benchmark graphs. This means that programs that read and write disk files extensively (most compilers) will

not show as much of a performance increase when run on the 2000.

The key to fast execution of a program that does extensive disk I/O is to use a hard disk or, better yet, a RAM disk. The 2000 has a hard-disk option but doesn't yet have RAM-disk software. Tandy has contracted for the development of a RAM-disk package and it might be available by the time you read this. Until a 2000 RAM disk is available, an IBM PC with a RAM disk can outpace a 2000 when running programs with heavy disk I/O.

If your program requires floating-point arithmetic operations, a numeric coprocessor (such as the Intel 8087) can be the key to fast execution. The 80186 can use the 8087 but it needs the 82188 controller chip to coordinate. Unfortunately, the 82188 is in short supply and Tandy doesn't expect to release a coprocessor option until early 1985. It won't require any expansion slots; the coprocessor option will be a small board that plugs, piggyback style, onto the main board. With this option, the 2000 should be among the fastest number crunchers available short of a VAX.

MEMORY

The basic 2000 comes with 128K bytes of RAM chips mounted on a small piggyback board that connects

to the main board (see photo 1). You add the next 128K with another small piggyback board. After this, you add memory with expansion boards that use the expansion bus; each board comes with 128K bytes and sockets for another 128K. Two expansion boards give a total maximum memory size of 768K bytes, as compared to the IBM PC's maximum memory limit of 640K.

Another interesting feature of the 2000 is its RAM-based character fonts. While the IBM PC stores the pixel maps defining each character font in ROM (read-only memory), the 2000 stores the maps in dedicated static RAM on the main board. This simplifies redefinition of character fonts. (But don't expect to see proportional spacing on the 2000's display like that of Apple's Macintosh and Lisa; the 2000's display system is still basically character-oriented.)

In general, the 2000 avoids the use of ROM, using only 16K bytes for boot-up. The 2000 loads the BIOS (basic input/output system) to RAM from disk rather than using ROM as the IBM PC does. This lets Tandy make frequent changes to the BIOS; however, this flexibility might lead to software problems unless Tandy makes sure that each new version of the BIOS is completely compatible with previous versions. The problem has already surfaced in Tandy's version of SuperCalc3, which uses a BIOS that is incompatible with earlier versions. You have to reboot the system before and after running SuperCalc3 in order to run other programs. Tandy has acknowledged the problem and claims to be working on a solution.

Another area where the 2000 uses RAM rather than ROM is in its GW-BASIC interpreter. The 2000 loads the entire interpreter into RAM from disk, whereas the IBM PC includes the core of its BASIC interpreter in ROM.

The 2000's heavy use of RAM for the operating system tends to eat into the RAM available for programs. Equipped with only the basic 128K bytes of RAM, a 2000 has only about 75K bytes of RAM left after loading

(continued)

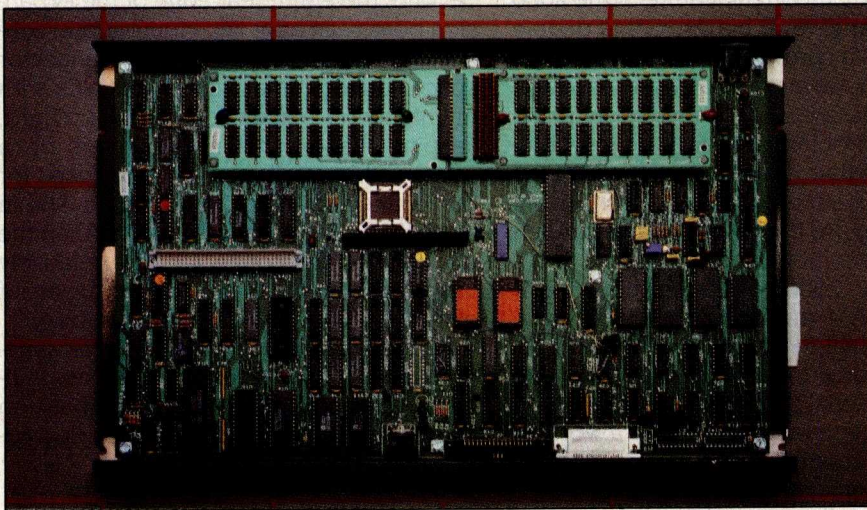


Photo 1: The 2000's main circuit board with standard and optional piggyback boards installed, each with 128K bytes of RAM. The large white connector on the left is for the expansion bus board.

AT A GLANCE

Name

Tandy Model 2000

Manufacturer

Tandy Corporation
1500 One Tandy Center
Fort Worth, TX 76102
(817) 338-2390

Components

Size: 19 by 6 by 16 inches (system unit), 16.3 by 1.2 by 7.9 inches (keyboard)

Weight: 23 pounds (system unit), 2.8 pounds (keyboard)

Processor: Intel 80186

Memory: 128K bytes standard, up to 768K bytes optional

Display: 12-inch green phosphor or 14-inch RGB, nonstandard input

Keyboard: Detachable with 90 keys, standard layout, 12 function keys, separate cursor control and numeric keypad

Mass storage: Two 5¼-inch, 720K-byte, floppy-disk drives

Expansion: Four slots, nonstandard

I/O interfaces: RS-232C serial port, parallel printer port

Software

MS-DOS 2.02, GW-BASIC interpreter

Optional Hardware

| | |
|---|--------|
| Monochrome graphics | \$449 |
| Color-graphics chip kit | \$199 |
| Mouse | \$100 |
| Mouse/clock controller | \$120 |
| Monochrome monitor | \$249 |
| Color monitor | \$799 |
| 128K RAM expansion kit | \$299 |
| External 256K expansion board (with 128K) | \$499 |
| Internal 10-Mb hard disk | \$1699 |

Documentation

Introduction to the Model

2000: 69 pages

MS-DOS Manual: 291 pages

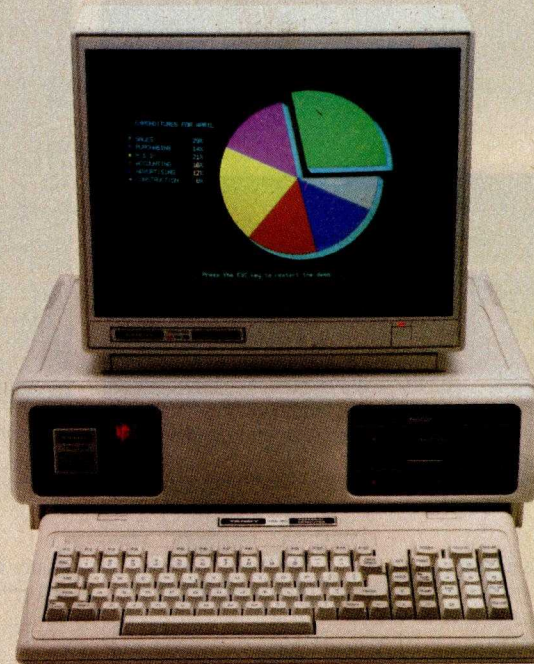
BASIC Manual: 366 pages

Reference Guide to the Model

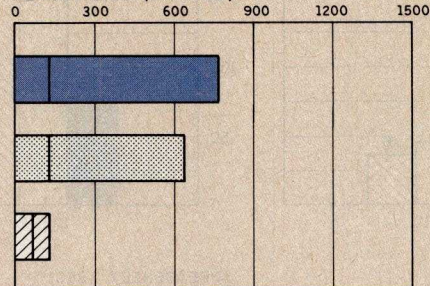
2000: 51 pages

Prices

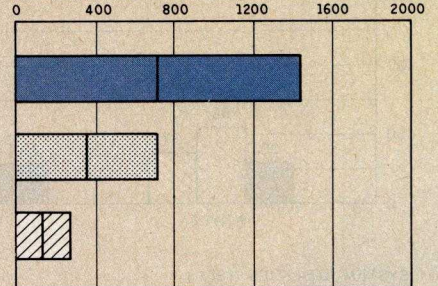
| | |
|--|--------|
| Base system price | \$2750 |
| Monochrome system with 256K, color/graphics capability | \$3946 |
| Color system with 256K | \$4496 |



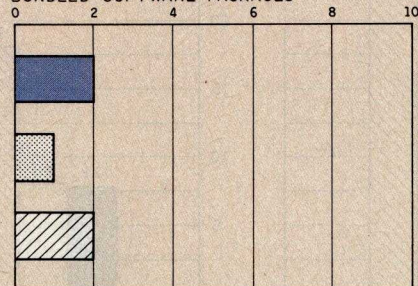
MEMORY SIZE (K BYTES)



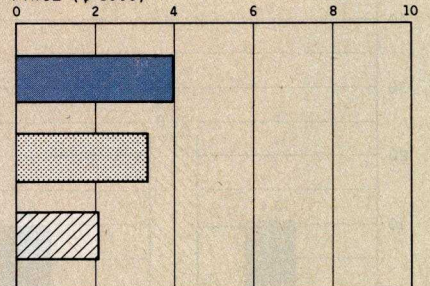
DISK STORAGE (K BYTES)



BUNDLED SOFTWARE PACKAGES



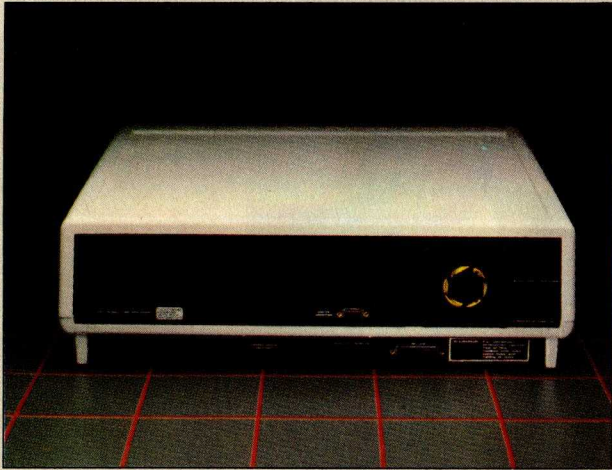
PRICE (\$ 1000)



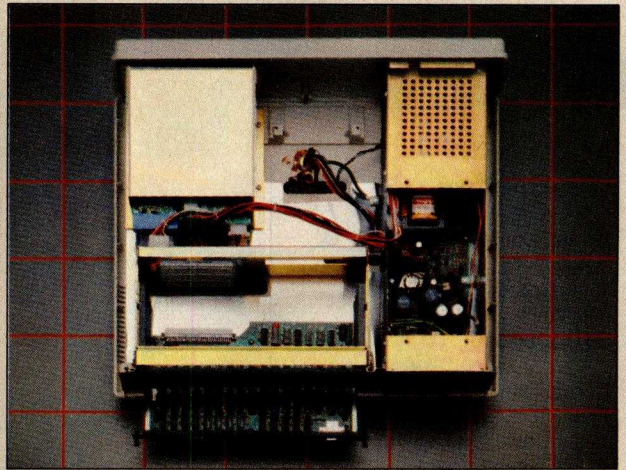
■ TANDY 2000 ■ IBM PC ■ APPLE IIe

The Memory Size graph shows the standard and optional memory available for the computers under comparison. The Disk Storage graph shows the highest capacity of one and two floppy-disk drives for each system. The Bundled Software graph shows the number of software packages included with each system.

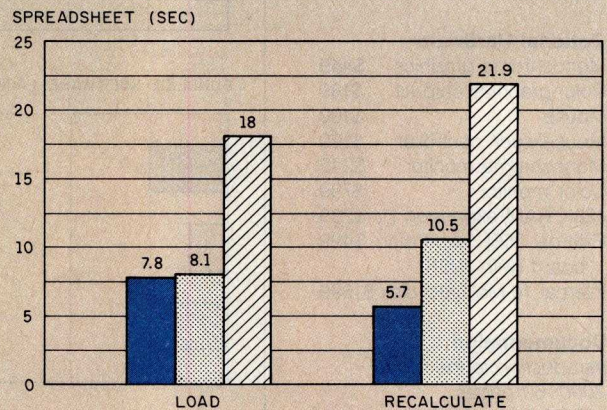
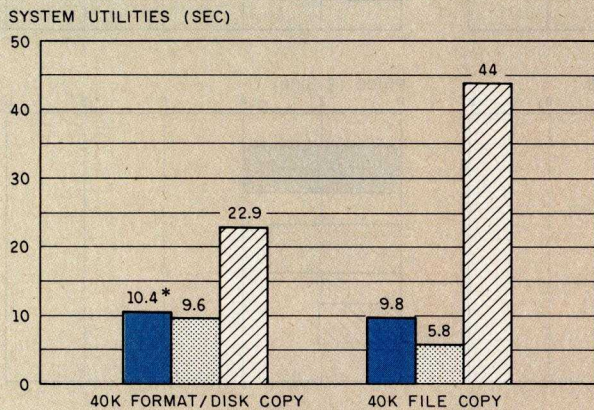
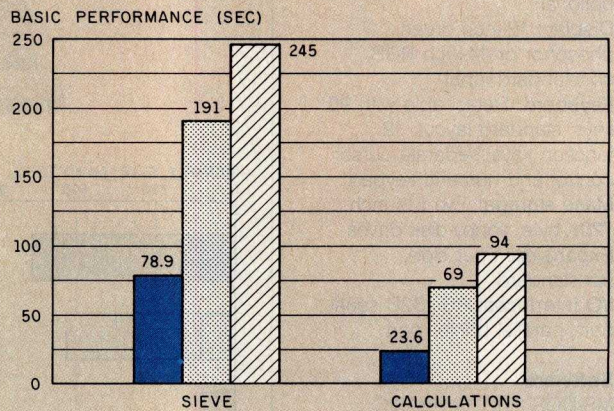
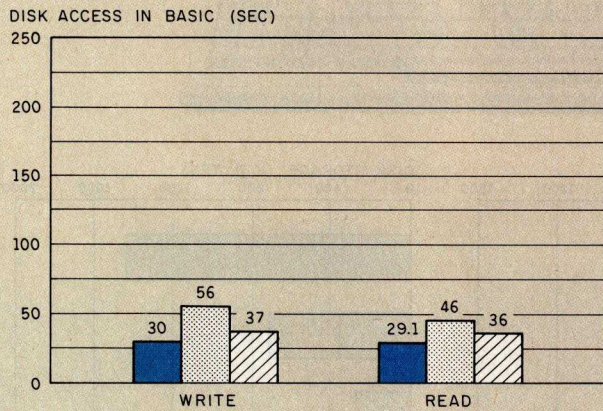
The Price graph shows the list price of a system with two high-capacity floppy-disk drives, a monochrome monitor, graphics and color-display capability, a printer port and a serial port, 256K bytes of memory (64K for 8-bit systems), the standard operating systems for the computers, and their standard BASIC interpreters.



The back panel of the Tandy 2000. The serial and parallel ports are along the bottom.



Removing the 2000's top reveals the disk drives (top left), power supply (right), and expansion bus (bottom left).



TANDY 2000
 IBM PC
 APPLE IIe

In the Disk Access in BASIC graph, a 64K-byte sequential text file was written to a blank floppy disk, then read. (For the program listings see June BYTE, page 327, and October, page 33.) The Sieve column shows how long it takes to run one iteration of the Sieve of Eratosthenes. The Calculations column shows how long it takes to do 10,000 multiplication and division operations using single-precision numbers. The System Utilities graph shows how long it takes to format and copy a disk (adjusted time for 40K bytes of disk data) and

to transfer a 40K-byte file using the system utilities. The Spreadsheet graph shows how long the computers took to load and recalculate a 25- by 25-cell spreadsheet where each cell equals 1,001 times the cell to its left. The spreadsheet program used was Microsoft Multiplan. The tests for the Apple IIe were done with the ProDOS operating system (except for the spreadsheet test, which was done with DOS 3.3). The IBM PC was tested with PC-DOS 2.0. *Note: Format and Disk Copy are separate operations on the Tandy 2000.

the operating system. This is insufficient for most programs; most users will want to upgrade their 2000s to at least 256K.

DISPLAY

The Tandy 2000 offers a number of options for different combinations of text, monochrome graphics, and color graphics. A text system requires only the VM-1 green monitor—no expansion board. This is a superb system for word processing. Characters are crisply formed with an 8- by 16-pixel matrix against a dark background. This display is slightly superior to the IBM PC's excellent monochrome display.

By adding a graphics expansion board, you can display 640- by 400-pixel monochrome graphics on the VM-1. For color, you need a memory-chip upgrade for this board, as well as the CM-1 RGB monitor. This provides for 640 by 400 graphics in 8 colors (selected from 16 possible colors). This color system looks spectacular—easily producing the most attractive color displays I have seen on a mass-market microcomputer. The resolution, focus, and color rendition (particularly yellow) are excellent.

Unfortunately, the 2000's color graphics are seriously flawed. When operating in the graphics mode, the computer displays text at a snail's pace, more than nullifying its speed advantage over other systems. An odd hardware configuration is to blame. With a text-only system or when using the monochrome-graphics option, the 2000 uses a high-speed 9007 CRT controller chip that scrolls text very quickly. But when the color-graphics chips are added, the 9007 can no longer be used to generate text in the graphics mode. Instead, text must be laboriously generated in software.

The text display in color-graphics mode is very slow. I wrote a short BASIC program that displays the words "Hello, BYTE" on the screen 100 times. It ran in less than 2 seconds on a text-only 2000 but took over 30 seconds on a color-graphics

system. I obtained similar results when I performed the test in Pascal.

With programs that switch back and forth between text and color-graphics modes, such as Lotus 1-2-3, this performance penalty will go largely unnoticed. But programs that stay in the graphics mode continuously, such as the BASIC interpreter, will be severely hampered when run with the color-graphics system.

If you know that you will not be using any graphics, you can reconfigure the 2000 as a text-only system. The manual tells you to tap the F12 key when the disk drive flashes during the boot-up procedure, and if this doesn't work, to "repeat the procedure, tapping the key as quickly as possible." I tried and could reconfigure my system (some of the time) by furiously hitting the F12 key for several seconds during the boot-up process. It turns out that the manual is wrong—you're supposed to hit the F12 key when the Caps and Num Lock indicators on the keyboard flash. This reconfigures the system and provides normal text display speed, but it limits you to text display until you reboot the system. Even when you know how to do it, this is an inconvenient way to reconfigure the system.

One aspect of the 2000 that I like is that it doesn't require a separate monitor if you want both high-quality

text and graphics. The graphics systems (monochrome or color) display text with the same resolution offered by the text-only system. And the 2000's RGB monitor is acceptable for text display (although definitely not as good as the monochrome monitor).

Another drawback: both the VM-1 and CM-1 monitors are specifically designed to work with the 2000 and won't work with any other computer system. Conversely, no other monitors will work with the 2000.

KEYBOARD

The 2000's keyboard (photo 2) is a strong point. The layout is conventional; Tandy wisely avoided IBM's controversial placement of an extra key near the left shift key. The cursor controls are arranged separately from the numeric keypad in an upside-down "T" arrangement. The Caps and Num Lock toggles have status lights so you won't forget when they're on.

Another nice feature is a Hold key that stops display scrolling; the IBM PC requires a difficult combination of Ctrl and Num Lock to do the same thing. Unfortunately, the 2000's Hold key is right above the up-arrow cursor key where it is too easy to hit accidentally. Finally, the 2000 has 12 function keys that are arranged horizontally across the top of the key-

(continued)



Photo 2: The Tandy 2000 keyboard features 12 function keys, Caps and Num Lock keys with lighted indicators, and a large Enter key.

*The Tandy 2000's
HFORMAT command
can keep you from
accidentally trashing
the entire contents of
your hard disk.*

board instead of vertically on the left side. This arrangement is better than IBM's for associating the keys with on-screen menus.

Keyboard touch is very subjective. I find the 2000's touch to be nearly perfect—fairly light but not "nervous." One aspect many will appreciate is the lack of clicky-clackety noise from the keyboard.

DISK STORAGE

The basic 2000 comes with two half-height, 5¼-inch, Mitsubishi M4853 floppy-disk drives. Disk-storage capacity on the 2000 is twice that of the IBM PC (720K versus 360K), a result of doubling the number of tracks (and track density) from 40 to 80 tracks per disk. This makes a world of difference for many uses of the machine. The 2000's drives are quiet and the disk ejection mechanism works well. One complaint—as in its earlier computers, Tandy put the A drive on the bottom and the B drive on the top.

The hard-disk 2000 system substitutes a Tandon TM502, dual-platter, 5¼-inch, 10-megabyte Winchester hard-disk drive for one of the floppies. A hard-disk system that retains both floppies is not currently supported but probably will be eventually.

SOFTWARE

For this review, I used Tandy's recently released MS-DOS version 2.02. The differences between the 2000's and the IBM PC's MS-DOS implementations are fairly minor. The 2000's FORMAT command has a few extra options and the commands for copying and comparing disks are slightly different. For example, DISKCOPY

does not automatically include FORMAT—they are two separate steps.

One small but important feature of the 2000's MS-DOS is the use of separate commands for formatting a floppy and a hard disk. The IBM PC uses the same command to format both and can cause you to accidentally trash the entire contents of the hard disk. The 2000 uses a completely separate command (HFORMAT) that is much less likely to cause this problem.

One MS-DOS command conspicuous by its absence from the 2000 is MODE. On the IBM PC, you can use this command to switch display modes, configure parallel/serial ports, and redirect output from the parallel port to the serial port. Without this command, accessing the 2000's serial port directly from the operating system is difficult. The lack of any redirection provision also hurts; it virtually requires that you have a printer with a parallel interface. Tandy has apparently recognized the need to address this problem: the company says it has a new version of MS-DOS coming that includes a MODE command.

Tandy should also include some diagnostics with the basic 2000 system. The MS-DOS disk does not contain any diagnostics programs, and I could find no reference to diagnostics in any of Tandy's documentation.

Microsoft's GW-BASIC interpreter is included with the 2000 system. The Tandy 2000 differs from the IBM PC in that the interpreter is implemented as a single program (BASIC.EXE), which includes graphics commands. The 2000's BASIC automatically senses whether you have installed the graphics expansion board. If you have, the graphics routines work; otherwise, you get a syntax error whenever you attempt to execute a statement that uses a graphics routine.

Although the 2000 has more options for color and resolution than the IBM PC, the 2000's BASIC includes the lower-resolution modes that the IBM PC uses. All other things being equal, most IBM PC BASIC programs

should run on the 2000 without changes.

APPLICATION SOFTWARE

The question most people ask about application software for the 2000 is "Will it run Lotus 1-2-3?" With the recent release of a 2000 version of the popular Lotus program, Tandy can now respond with a definitive yes.

Model 2000 owners have four basic ways to get the application software they need. First, Tandy markets many mainstream MS-DOS products under its own label, customized and optimized for the 2000 with documentation in the standard 2000 gray binders. A second option is Tandy's Express Order program. With this system, you order the software you want from a catalog at your local Radio Shack Computer Center. Within two or three days, the software is express shipped to your dealer so you can pick it up. Programs ordered through the Express Order program will usually be "generic" MS-DOS and might or might not take advantage of certain 2000 features.

A third option is the Reviewed Software catalog, which lists software that Tandy has tested and knows will work on the 2000. You order the software directly from the vendor or through a distributor. The fourth option is to buy IBM PC programs, some of which will work fine while others won't even load from disk.

I was able to briefly test Tandy 2000 versions of 1-2-3, Multiplan, SuperCalc3, MultiMate, dBASE II, WordPerfect, and all the Microsoft compilers and assemblers. All performed well on the 2000 and most seemed significantly faster and more responsive than the IBM PC versions.

Certainly the most impressive of these packages is 1-2-3. The software is extremely quick and responsive on the 2000. Because the 2000's hardware configuration is more stable, fewer ancillary files hang around on the disks and you do not need to configure the system to get it up and running. I was displaying spectacular seven-color bar charts with 640- by

(continued)

Most sophisticated application programs go outside the operating system to implement special features.

400-pixel resolution three minutes after taking 1-2-3 out of the box.

IBM PC COMPATIBILITY

Because the 2000 runs MS-DOS and uses a software-compatible microprocessor, it offers some compatibility with IBM PC software. To run IBM PC software, the Tandy 2000 must be able to read PC disks, i.e., have the same disk format. Furthermore, the software itself must interact with the 2000's hardware through MS-DOS system calls or through compatible BIOS calls.

As for disk-format compatibility, numerous reviewers have commented that the 2000 can read but not write to IBM PC disks. This is not entirely true. What the 2000 could not do, until recently, was *format* an IBM PC disk. To write a file to an IBM PC disk, the disk had to be formatted on an IBM PC. Thereafter, the 2000 could read, write, and erase files just as if the disk were formatted on the 2000.

Apparently, however, this formatting limitation has been alleviated. Tandy is now including an extra formatting program (PC Maker) that allows the 2000 to format IBM PC disks. According to Tandy, all registered 2000 owners will receive this upgrade.

Granted, I have had some minor erratic problems in getting the 2000 to read a file written by an IBM PC and vice versa. After transferring hundreds of files (text and binary) between the 2000 and an IBM PC, I have yet to be thwarted—although a few transfers have been a bit stubborn. Part of the problem might be due to individual head alignment and rotation speed variations in the disk drives; the bottom drive on my 2000 seems to read and write to IBM PC disks much more reliably than the top

drive. Also, disks that are relatively "fragmented" (due to repeatedly writing and erasing files) are less likely to work. So far, using the bottom drive on the 2000 and a newly formatted IBM PC disk has been a sure-fire way of transferring any file.

Suppose you've put your favorite IBM PC program on a disk that the 2000 can read. Will it run? That depends on how the program communicates with the computer hardware.

If the program calls the PC hardware directly, it will definitely not run; the memory maps and I/O ports of the 2000 and the IBM PC are very different. This rules out copy-protected programs, programs that write directly to display memory (e.g., some programs with high-speed graphics), and many communications programs.

If the program communicates with the hardware through the BIOS, it will probably run. However, the 2000 uses a different system for character attributes and graphics that can cause incompatibility. One programmer's utility that I use in my work uses the BIOS to play around with different combinations of color and character attributes (bold, underline, blinking) depending on whether it is run on a monochrome or color system. This program does not work properly on the 2000. It is a fact of life that most sophisticated application programs go outside the operating system to implement special features.

As for IBM PC hardware compatibility, there is none. The expansion bus used on the 2000 is completely different from the IBM PC's. Aftermarket hardware vendors will need to develop completely separate products for the 2000.

I called the major IBM PC aftermarket board developers (Tecmar, AST Research, and Quadram) and asked them if they had any plans to develop products for the 2000. For the most part, their attitude was "wait and see."

DOCUMENTATION

The 2000 comes with four pieces of documentation. *Introduction to the Model*

2000 is aimed at novice users; it presents a short overview of the system. The MS-DOS and BASIC manuals are much larger and are similar in size and format to the IBM PC's DOS and BASIC manuals. Finally, Tandy provides a pocket-reference guide to the system. For some reason, however, Tandy doesn't put the loose-leaf MS-DOS and BASIC manuals in slipcases; this tends to add to bookcase clutter.

Overall the 2000's manuals, while attractive and easy to use, are less than complete. A great deal of technical information is left out of the MS-DOS manual. For example, it devotes a scant two pages to the subjects of configuring a system and device drivers. The 2000's manual is also missing key documentation of batch commands. Finally, the general manual, *Introduction to the Model 2000*, is much less comprehensive than IBM's *Guide to Operations*.

Some information missing from the standard manuals is in the recently released technical manuals: *Programmer's Reference* and *Technical Reference*. The programmer's reference manual gives information on how to access MS-DOS and the BIOS from assembly language. The technical reference manual provides detailed information about the 2000's hardware. It covers every circuit in great detail and even includes manufacturers' data sheets for most of the critical chips in the system. Unfortunately, the technical manual seldom presents any overview information that puts the details in perspective; I found it nearly impossible to read.

SERVICE AND SUPPORT

With well over 1000 Radio Shack Computer Centers (of which about 400 have complete service facilities), the 2000 is well supported in the field. My 2000 has performed flawlessly, so I have no direct experience with Radio Shack's service department. I have heard that it is above the industry average.

Tandy provides a customer service support number to help with hardware and software problems. I called

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The Tandy 2000 breaks no new ground; it is a refinement of the basic IBM PC system.

it with some typical problems and was favorably impressed. I also called Tandy's headquarters in January 1984 when the 2000 had been on the market for a few weeks. I had not yet purchased the computer and had a number of technical questions. After getting passed around for a few minutes, I was able to talk to a knowledgeable technical person. This is something I have been unable to do with IBM and Apple.

GRIPES

Tandy seems to have an aversion to DIP (dual-inline package) switches; changing the 2000's hardware configuration often requires cutting traces on circuit boards. For example, adding the color-graphics chip kit to the graphics expansion board requires cutting a trace. Adding a numeric co-processor will involve major surgery; the technical reference manual mentions cutting several traces on the non-visible side of the main board. How expensive can it be to add a DIP switch or a couple of pins that can be jumpered?

Perhaps Tandy wants to discourage customers from installing options on their own. The thought of cutting into a circuit board will scare many customers down to their local Computer Center. This hypothesis is confirmed by other aspects of the 2000's design. Adding the 128K-byte internal memory board requires you to take the bottom cover off the computer. Tandy doesn't like you to do this; a prominent seal warns about loss of warranty coverage. If you have it done at a Computer Center, you pay \$15. I would have preferred that Tandy include 256K in the basic computer or, better yet, put in sockets to let you install your own memory chips.

I think that requiring a separate (and expensive) internal memory board has more to do with marketing than with engineering. Tandy aggressively prices the basic 128K, two-floppy system at \$2750. Adding the monochrome monitor raises the price of a working system to \$3000—quite a bargain considering how much computer you are getting.

Tandy makes money by selling the add-ons people inevitably buy. If you decide you want a 512K color system, you will need to add the graphics board (\$450), color-graphics chip kit (\$200), RGB monitor (\$550 more than the monochrome), 128K internal memory board (\$300), 128K external memory board (\$500), and a 128K chip kit (\$300). Suddenly, your \$3000 computer costs \$5300. Some of these prices seem a bit high.

A gripe list wouldn't be complete without mentioning the constant scheduling slips that have plagued the entire 2000 program. I know that all computer manufacturers are optimistic in predicting when items will be on the market, but Tandy has pushed optimistic scheduling to new extremes. I especially dislike the way Tandy lists items in its catalog that are not available. For example, MultiMate was listed as available in a January 1984 catalog; it finally appeared in June. Any prospective 2000 purchaser should beware of Tandy's "Real Soon Now" promises.

CONCLUSIONS

Unlike Apple's Macintosh, the 2000 breaks no new ground; it is a refinement of the basic IBM PC system. If you want an "IBM PC type" computer, you have three basic choices: you can go with Big Blue, you can save a little money and buy an IBM PC-compatible, or you can buy a higher-performance version of the IBM PC.

The 2000 is definitely the computer to consider for the last option. In nearly every measurable way, the 2000 is superior to the IBM PC. And when higher-performance software comes into wider use, the 2000's advantages will become even more evident. ■