



# A Second Chance For Junior

*Analyzing IBM's revitalized PCjr personal computer*



By John M. Woram

It wasn't long ago that Big Blue—as IBM is so often called—startled the industry by introducing its 5150 series of computers. If the designation isn't immediately familiar to you, you're in good company. Even IBM itself seems to prefer calling them simply "PC." By now, almost everyone knows that, when capitalized, it stands for "IBM Personal Computer," though the "IBM" prefix is understood when the acronym PC is used.

The industrial giant apparently did its homework well, for in a few short years since its introduction, the series 51 . . . oops, I mean the PC, has become somewhat of a micro-standard. In fact, these days, if you own a Microsoft disk-operating-system (MS-DOS) machine that isn't PC-compatible, it's a handicap in the marketplace that better be made up for by some redeeming features.

About a year or so ago, the rumor mill had it that IBM was about to strike again by launching a scaled-down version of the PC that was code-named the "Peanut." This was supposed to be a popularly priced junior version for those who didn't need all the power of the PC itself. Based on the great popularity of the PC, the computing world could hardly wait for the new model. At last, a solid computer for the masses, people assumed.

Well, maybe not. In the first quarter of 1984, the Peanut—now officially dubbed the PCjr—began showing up on dealers' shelves. As of mid-summer, many of them were still sitting on those shelves. For if not quite still-born, Junior was nevertheless sickly. People took an instant dislike to its block-type "Chiclet"-style keys on the keyboard, which made touch-typing a chore. Equally distressing to prospective buyers was the perception that the Junior was deliberately crippled by its corporate parent. On top of the keyboard fiasco, the



Photos courtesy of IBM.

*IBM might have liked this photo to be of a business environment in light of the major changes in the new PCjr's memory and keyboard. PCjr is still a great games player, but business and educational use are now its forte.*

PCjr's image was damaged by a limited-capacity memory. The nitpickers then added the fact that it had only one built-in disk drive and all PC software wouldn't run on it.

To further complicate matters, neither IBM, their dealers or prospective customers seemed to have a clear idea of who the target customers were supposed to be. Was it for business applications? Was it for the general public? IBM indicated that it was for everyone at that time. But the business community was turned off by several factors. For one, Junior would not support IBM's own green-screen-type monochrome monitor; it had to be operated in conjunction with another type monochrome monitor, an RGB monitor, or a standard TV set. Furthermore, the manual that accompanied the machine was written in a style that seemed to appeal more to precocious sub-teenagers than to more mature customers. And then that wretched keyboard, among other deficiencies.

On the other side of the coin, the PCjr's comparatively high price also turned off the so-called mass market

and school purchases. The conclusion seemed to be that, despite superb color graphics and impressive musical capabilities, Junior was overpriced as a fun & games machine.

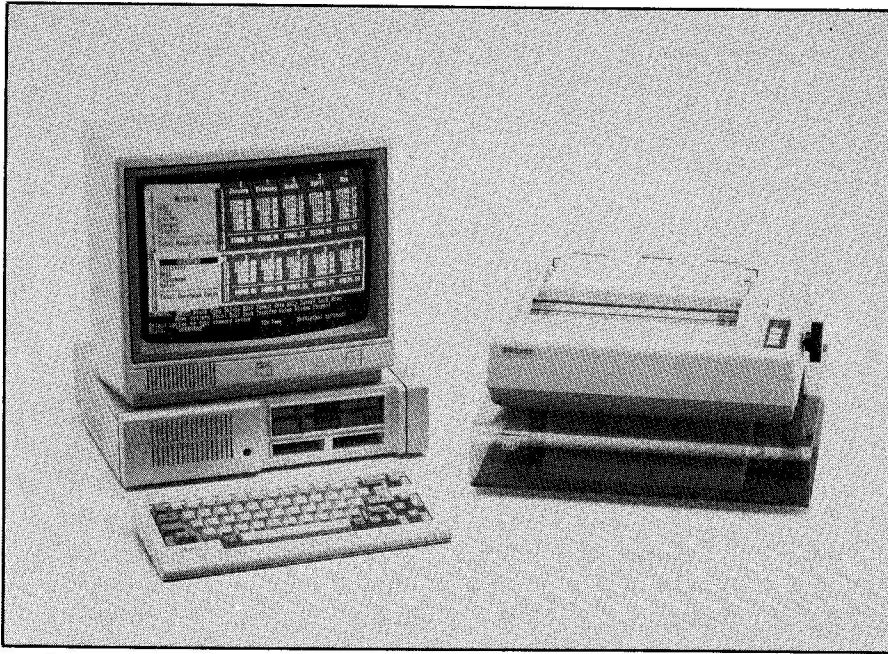
### *The Old & New*

IBM's original PCjr had a lot going for it, though. One could start off with a lower-priced "entry" model that included 64K of RAM memory, built-in 64K ROM, two ROM cartridge slots, cassette-based data storage, built-in color graphics, built-in serial port, lightpen and dual joystick input facilities, a complex sound generator, and the IBM-logo security blanket.

The foregoing was obviously not enough to attract too many buyers, though. But Junior can be taught a few new tricks, as IBM has proved.

Listening to the marketplace, IBM announced several important PCjr changes this past August, not the least of which is a spanking new keyboard, which we'll examine soon. Tipping its corporate hat to buyers of the earlier PCjr, IBM is giving them

## "PCjr now comes with 128K of memory."



The new IBM PCjr is shown here with its redesigned true typewriter-style keyboard. Shown atop the main computer unit at the left is the optional IBM Color Display video monitor, while at the right is shown the optional IBM PC Graphics Printer (dot matrix), seated atop a smoked acrylic plastic stand.

new keyboards at no charge! The new-style keyboard is standard issue for all PCjrs now made.

In another move, IBM severed its marketing thrust to just plain kids. The PCjr is now presented as a small business computer. Underscoring this, IBM no longer makes an "entry-level" PCjr. The basic PCjr now comes with 128K of user memory instead of 64K, and has a double-sided disk-drive built in. In effect, IBM retained its "enhanced" model and did away with the intro system.

As another bonus, IBM has introduced a new, optional 128K add-on memory expansion module. Up to three of the new external modules may be fitted to the right-hand side of the PCjr, after removing a plate, giving it a total of 512K bytes of memory. Since Junior doesn't have enough punch to drive more than one of these all by itself, a supplementary power supply is also available.

Before the recent change, IBM had not drawn much attention to Junior's expansion capabilities, and it re-

mained for others to publicize this important point. In fact, Big Blue is still not making a second disk drive available. But now with the new keyboard, more memory, and a growing list of third-party peripherals (including additional disk drives) Junior seems to have been given another chance at making it. So perhaps this is a good time for an updated look, along with a review of several of Junior's key features, such as the new keyboard, cartridge system, memory, disk drives and, of course, price (which was reduced).

### The Keyboard

The late, unlamented 62 Chiclets have been replaced by a *real* keyboard, with 62 full-sized sculpted keys with a nice fingertip feel to them. These represent a key-by-key replacement of the old board, with no changes in keystroke combinations for Control, Alternate and Function keys. For example, while the bigger PC has ten dedicated func-

tion keys on the left side of the keyboard, Junior has a single Function key (labelled Fn) in the upper right-hand corner. This is used in conjunction with the regular top-row numeric keys for Function key operation. Thus, two keystrokes (Fn, 2) take the place of the PC's single F2 key, and so on. Moreover, legends on the keys are right on their tops instead of above or below keys as in the "old" keyboard.

Direct keyboard entry of IBM's extended ASCII graphics characters must still be preceded by holding down the Alt key while pressing the Fn, letter-n keys. After doing so, hold down the Alt key again, while entering any three-digit extended ASCII code. When the Alt key is released, the appropriate graphics character appears on screen. Thus, pressing Alt-2,2,7 will display the Greek symbol  $\pi$ . This feature enables the user to enter lines such as PRINT " $\pi$ " instead of the less-informative PRINT CHR\$(227). While in this mode, the Shift key must be held down in order to use the Insert, Delete and cursor movement keys. Otherwise these keys act as a partial numeric keypad, in an incomplete imitation of the PC's dedicated numeric keypad.

Aside from these limitations, the new keyboard is a big step in the right direction, and should go a long way towards making Junior a viable product. Like its predecessor model, the new keyboard uses an infrared optical link to the PCjr system, and this feature may be defeated by using a direct-connection cable.

Contrasting the new keyboard with that of the PC's, it takes up less space since it has only 62 keys vs the PC's 83. Missing is a numeric keypad. The QWERTY keyboard follows the standard key layout, whereas the PC's keyboard is flawed by a small "Enter" and "Control" key that causes operators to make typing mistakes. This problem is compounded further on the PC by extraneous keys separating the afore-

## PCjr vs. PC

(Basic 64K-memory systems are no longer produced by IBM though some may still be for sale.)

PC	PCjr, with IBM add-ons	PCjr, with third-party peripherals, as noted
—64K Base System, with no disk drives—		
64K PC	\$1265	\$ 599 64K PCjr
Color Card	244	0 not needed
Total	\$1509	\$ 599 [\$910]
—128K System with two disk drives—		
64K PC, with two drives	\$2240	(2-drive PCjrs are still not available from IBM.) \$ 999 128K PCjr, one drive \$ 795 Legacy II second drive
64K more memory	100	0
Color Card	244	0
Printer Card	75	99 IBM
Total	\$2659	\$1893 [\$766]
—256K System with one disk drive—		
256K PC, with one drive	1995	\$ 999 128K PCjr 325 128K exp. \$ 999 128K PCjr, one drive 395 128K Tecmar jr-Captain
Color Card	244	0
Printer Card	75	99 IBM
Total	\$2314	\$1423 [\$891] \$1493 [\$821 savings]
—512K System with one disk drive—		
256K as above	\$2314	\$1423 as above \$1493 256K system above
64K exp. board	265	150 power supply 0
192K additional	300	325 128K exp. 395 128K Tecmar jr-Captain 275 128K Tecmar jr-Cadet
Total	\$2879	\$2223 [\$656] \$2163 [\$716]

### Notes:

- The PCjr does not require an additional card to drive any type of monitor.
- For more than 256K, the PCjr memory expansion requires an additional power supply.
- The Tecmar jr-Captain includes separate AC power. The jr-Cadet is powered by the jr-Captain.
- Interface cables and monitor are not included above.

Comparisons between different configurations of IBM PCjr and PC computers.

mentioned keys from the QWERTY keys, a mistake not duplicated on the PCjr's keyboard.

### The Cartridge System

Two ROM cartridge slots are supplied, each one of which can handle up to 32K bytes. Junior's Advanced BASIC language is supplied in a plug-in cartridge, and a variety of other programs are becoming available in this format. In fact, Lotus Development Corporation's extremely popular 1-2-3 software is now sold as a two-cartridge package for the PCjr.

Cartridge software should be appealing on at least two counts. First,

it's easy to use—just plug in and turn on. Second, it's difficult to impossible to make bootleg copies without doing a lot of heavy-duty assembly-language programming. Conceptually, you might be able to download a cartridge to a diskette, but the program will still refer to locations in the cartridge address area. So without the cartridge in place, it just won't work. That feature alone should be very attractive to some software writers, and add further support to Junior.

### Memory

Although IBM itself is a late-comer in supplying additional memory, several other companies have been sell-

ing add-on modules to boost Junior all the way to 640K. For example, Tecmar's jr-Captain and jr-Cadet expansion modules may also be attached to the right side of the PCjr chassis, and will hold 64K to 512K of add-on memory.

### Disk Drive

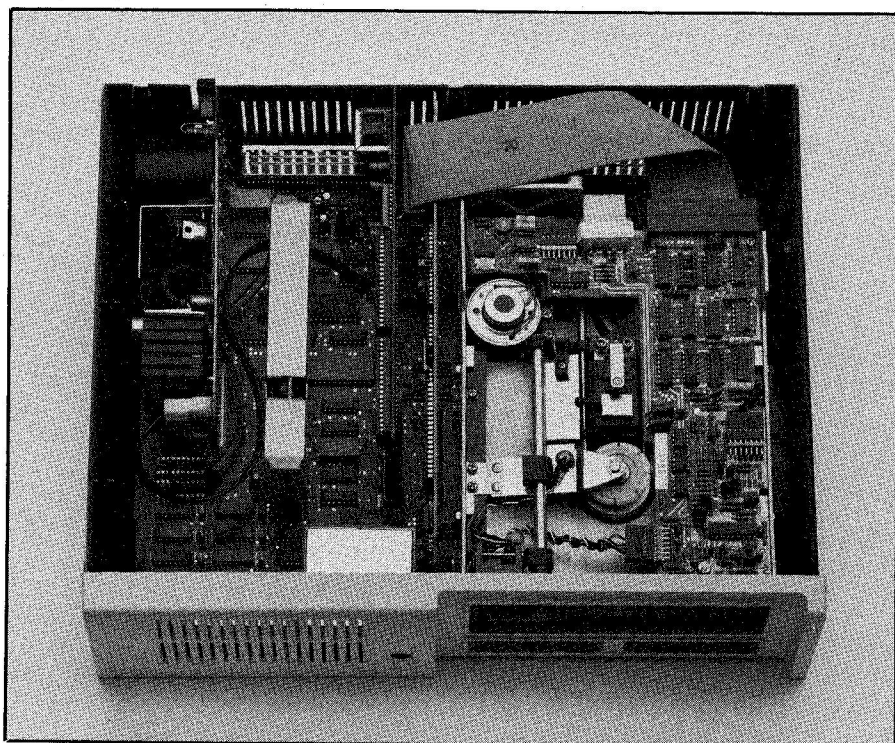
With IBM continuing to manufacture Juniors with no more than one disk drive, third-party suppliers are also filling this gap quite nicely, too. From Legacy Technologies, Ltd., the Legacy II module supplies a second disk drive, plus a controller that will handle both drives. A 10-Megabyte hard-disk is also available.

### The Bottom Line

At its introduction earlier this year, the 64K Junior had a \$669 price tag. This has been cut to \$599 "list"—if you can find any. IBM stopped manufacturing them as previously cited. The 128K version with a single-diskette drive started out at \$1269, but is now only \$999 in its improved state. To either of these prices, add \$30 for a TV connector cable, or \$20 for an RGB cable.

Along with the growing supply of add-ons from other companies, the new prices make for some interesting PC/PCjr cost comparisons. The chart below lists the components required to assemble several representative systems, starting out at the bare bones entry level and progressing up to a 512K system. The bracketed figure is the amount saved by purchasing a PCjr instead of a PC. In each case, provision has been made to drive a color monitor. The systems are assembled from IBM hardware supplemented by the two third-party suppliers mentioned above.

Before rushing out to buy all the items listed under the PCjr column, a few words of caution. Some add-ons preclude the use of others. For example, the Legacy II disk drive is physically configured in such a way that the Tecmar add-on memory won't fit,



*The left side of the PCjr's main unit contains the computer board with plug-in cards, the right side, the floppy-disk drive, below which are the cartridge slots.*

and vice versa. By no small coincidence, the Legacy II has its own expansion slots designed to accommodate other (presumably, from Legacy) add-ons. In other words, if you're planning to add memory and a second disk drive, make sure the products are compatible with each other and with the PCjr before buying.

As an alternative to adding a second disk drive, you may decide to add sufficient memory to set up an "electronic disk"—that is, a special section of memory used to simulate an actual disk drive. Such an electronic disk runs a lot faster than the real thing, and may very well obviate the need for another mechanical disk drive. Of course, the electronic disk vanishes when power is turned off, so you'll have to write its contents to a real disk before hitting the Off switch. By the way, IBM's expansion module and Tecmar's jr-Captain both come with the software required to set up an electronic disk drive.

Since IBM is still not making disk drives a part of its own catalog, it

might seem that they are still trying to restrict Junior to a marketplace that is positioned well below the PC. On the other hand, the company continues to encourage others to support the product, and as can be seen from the comparisons cited, there's a lot of money to be saved by buying a Junior instead of a PC, and then shopping elsewhere for some of the hardware and peripherals.

Getting back to Junior, here are a few more points that may be made for or against choosing it instead of its big brother PC equivalent. First, a few of the positive features:

### **Cartridge BASIC**

As noted earlier, some of Junior's BASIC comes in an easy-to-use plug-in cartridge, which adds several new keyboards to the language, such as NOISE, PLAY, PALETTE, PALETTE USING, and PCOPY. (The cartridge and BASIC manual costs \$75.) Briefly stated, NOISE offers various noise sources whose volume and duration

may also be specified; PLAY is used to compose three-part harmony; the PALETTE statements are used for enhanced color graphics, and PCOPY copies one screen page to another.

The new PLAY statement alone should be enough to keep you busy for hours. It may be followed by various parameters to specify such things as the note, octave, duration, legato, staccato, volume, tempo, rests, and so on. Furthermore, your tune may be placed in a "background buffer" so that it continues to play on while the rest of your program is being executed.

### **Color Graphics**

Like the PC, the PCjr sets aside 16K for color graphics video memory. But that's about as far as the comparison goes. The PC uses a dedicated color board whose memory address begins at hexadecimal B8000. With no separate color board, the PCjr borrows 16K off the top of the available 64K or 128K of system memory. Although the beginning of this block is not actually found at address B8000, Junior is configured in such a way that references to this address will be diverted to wherever the video memory actually resides. This means that color graphics programs written on the PC will be compatible with the PCjr computer.

However, Junior is also able to offer a full 16 colors in medium resolution, or 4 colors in high resolution, by stealing even more (32K) of the system's memory. This is needed for the last two of the three new screen modes, which are listed here:

SCREEN 4 Medium-resolution,  
4 colors

SCREEN 5 Medium-resolution,  
16 colors

SCREEN 6 High-resolution,  
4 colors

Before using SCREEN modes 5 and 6, a CLEAR,,32768 statement must be used to set aside the required 32K

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of memory. Programs using these screen modes will not run on the PC.

For programs requiring less than the default value of 16K, the CLEAR statement may also be used to free up some of this space. For example, the SCREEN 0, WIDTH 40 mode needs only 2K of memory.

Note that the PCjr allows one to use as much memory as available for graphics, whereas the PC and PCXT models are limited to 16K. Thus, smooth animation effects are achievable with the PCjr.

Now a few of the minuses . . .

### **Execution Time**

Junior is quite a bit slower in operation than the PC. Both machines use the popular 8088 microprocessor, but the jr. doesn't use direct-memory access (DMA), so data transfer rate suffers. Depending on the nature of your work, this may or may not matter much. For example, a home-brew

### **EDITORIAL** *(from page 4)*

transmissions. Microwave TV transmissions in the 2-gigahertz band is another new TV service authorized by the FCC. Called MMDS, for multichannel, multipoint distribution service, it can handle up to 30 transmission channels. This format is viewed by industry as the ultimate over-the-air pay TV system.

Topping the foregoing are improvements in home TV receivers, including better TV picture tubes (CRTs), comb filters for fuller luminance bandwidth, and so on. Stereo sound is another fillip to enhance overall "viewing" pleasure. And videocassette recorders make the TV field all the more exciting.

Modern Electronics will keep you in touch with the many aspects of television, you can be sure, while not neglecting other appealing areas of electronics and computers for work and for fun.



BASIC program to calculate elliptic integrals takes 56, 65, 78, and 94 seconds of Junior's time to crank out the first four columns in the table. The same chore needs only 32, 37, 44 and 52 seconds on the PC, which is an almost 2:1 improvement in execution time. This is perhaps a worst-case example; with most of the program time spent on internal calculations, the relatively long delay between each new screen display can become annoying. On a more screen-intensive type of program, the delays might be less obvious, or perhaps a lot less perceptible.

### **Word Processing**

For the PC, IBM's monochrome green screen is one of the cleanest displays around. For word-processing applications it's a lot easier to stare at than any color monitors, and most, if not all, other monitors. But as noted earlier, the PCjr will not support this screen, and so it must be used with either a TV set or another monitor. Although color graphics on a good RGB monitor are really impressive, few color monitors come close to the good old IBM green screen for displaying text only. So if word processing takes up a good part of your computing day, this may be an important consideration. (Also remember that Junior's color graphics eats up 16K of available memory, so a 128K system is really only a 112K system.) Text clarity can be improved by using a monochrome monitor of course, though IBM's, with its longer persistence phosphor design, can't be employed with the PCjr.

### **Power Supply**

As several third-party manufacturers—and now IBM, too—have shown us, the PCjr is readily expandable. However, Junior's own power supply doesn't have the strength to power much else beside the basic system. Therefore, many of the add-ons require, and of course come equipped, with their own separate power lines. And since the peripherals are all ex-

ternal devices, some fully-expanded Juniors take on the appearance of a micro-kluge; with add-ons tacked upon add-ons, the whole thing begins looking like a collection of second thoughts. Of course, this is strictly an aesthetic judgment and doesn't affect performance at all. The same thing can be said about Junior's fan, which makes it quite a bit noisier than the PC.

### **Conclusion**

Now although the folks at Big Blue may be a trifle stuffy at times, no one's ever accused them of being stupid. Surely they know very well that if Junior is perceived to be a viable product, others will leap on the bandwagon and begin to produce all sorts of enticing add-ons. A small fortune will be spent advertising these products, and most of the ads will have a PCjr prominently displayed. And if all goes well, software companies should love the concept of cartridge software. With the IBM logo on a well-supported and suitably-priced computer, an even larger segment of the market may finally be persuaded to get involved with computers. If so, everyone profits, especially IBM.

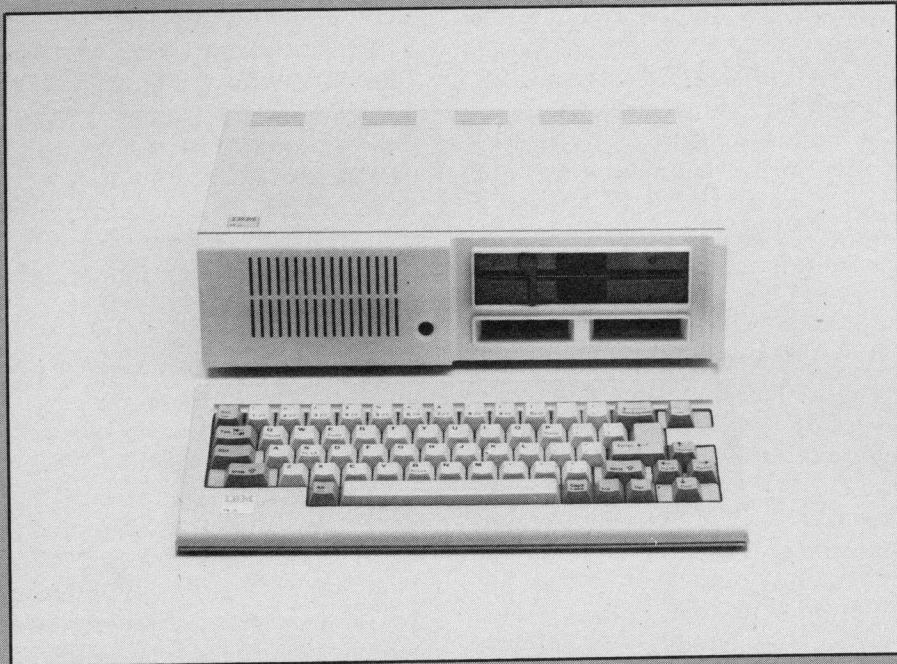
There's little doubt that Junior's new power and attractive prices will cause some downscale defections among prospective PC buyers. And perhaps we shall see some defections from PC as well to one of Big Blue's hard-disk models.

Scarcely a week had passed since the Junior keyboard/memory announcements when IBM was back in the news with its new PC-AT model challenging the smaller-capacity PC-XT hard-disk model. This is available with 512K internal memory, a 20 Megabyte hard-disk drive, a high-density 1.2-Megabyte 5 1/4 (!) floppy disk system, eight expansion slots, and a new keyboard all its own. So could it be that old Blue itself is engineering the eventual demise of the PC in favor of the PCjr at one end of the market and the PC-AT at the other? We shall see.

**ME**

CIRCLE 29 ON FREE INFORMATION CARD

## A Closer Look at Junior



The newly upgraded and price-reduced IBM PCjr is what the machine should have been in the first place. With its larger memory capacity, a "real" keyboard, and a realistic suggested selling price, the new Junior is now a machine to be reckoned with by other computer makers.

Although the keyboard weighs the same—25 ounces—it's a night-and-day comparison with the original one. The new keyboard can be directly used for serious typing purposes, whereas the earlier one could not. It has conventional size/shape keypads and has the feel that one expects for a machine in its price class. Key layout is the accepted QWERTY format (sorry, Dvorak key layout advocates), in traditional IBM "Selectric" form. The latter is not used for IBM's larger microcomputer models, to the delight of third-party keyboard makers such as Keytronic. Moreover, the large, inverted-L-shape "Enter" key is a welcome change from the other IBM PC's use of a too-small keypad key used for the same function.

With 62 keys compared to the PC's 83 keys, there's obviously more missing than just a numeric keypad. Junior requires the use of multiple keys to perform certain functions that are accomplished with separate keys on the PC. This makes for a smaller-size keyboard that takes up less space on a desk, though it's traded away somewhat by a slightly more burdensome operation. Function keys are lined up horizontally at the top of the keyboard in traditional style (again, this is violated with larger PCs, which position them at the left of the keyboard). They normally perform as numbers 0-9, but using a key there as a toggle, they turn into function keys F1-F10 for easy "List," "Run," "Load," etc., commands.

The separate keyboard can be made even more separate by using the Junior's infrared mode that eliminates the need for a direct connection to the main computer body. With obstacles blocking the signals and interference from other sources (such as a bevy of PCjr's used in a classroom), many people will find this feature to

be a mere frill. However, it's there for one to utilize, taking advantage of the keyboard's light weight to move it and to operate it on the user's lap. A Forrest Mims-type experimenter, though, will welcome this feature as a special opportunity to experiment with a variety of infrared-driven applications.

Key legends are now on top of the keys, where they belong, while programming audible key clicks for either on or (happily) off is retained.

Although the PCjr—previously a machine for all seasons, according to IBM's marketing people—is now implied to be less a computer for computer games than for adult work, it still defaults to 40-character-wide lines with double-size letters . . . the better to see on standard TV sets. For 80 columns, the user has to type "Width 80." No big deal, of course. But an adult/business-directed machine would have the 80 columns set as the default.

The PCjr's graphics and color quality are stunning. Unlike with other PC models, text and graphics are built-in features. There's a choice of seven screen modes, too, which are three more than PCs have. Furthermore, Junior's complex sound generator lends itself to better musical results than does the simple one-tone system of other PCs. In addition to graphics and color functions that are "extras" with other PC models, a built-in serial port and both NTSC and RGB color ports come with the smaller computer, as well as light pen and joystick ports, among others.

As good as the color is on the PCjr, I would still rather use a monochrome video monitor, which you can with the Junior, if its main application will be for word processing. But, then, I would say the same thing for any computer.

A video monitor (or small TV set) can be set comfortably atop the PCjr's main body, as shown in a

photograph in the article. For non-IBM monitors, however, you should check out the monitor in this location to be sure it doesn't produce interference that effects the computer's operation. Sometimes, extra shielding is required here.

Many prospective buyers will find the *PCjr*'s open architecture inviting, since a growing number of third-party manufacturers are producing additional hardware because of it. A second, outboard disk drive, for example, is available (IBM doesn't offer one . . . yet) for users who wish to use the Junior for disk-intensive programs or to eliminate the tedium of the many floppy-disk exchanges that are necessary with a single drive. So if you're a heavy computer user, and intend to buy a *PCjr*, plan on a second double-sided, double-density floppy disk drive.

Two ROM cartridge slots are maintained in the *PCjr*. Probably originally intended mostly for game cartridges, it's likely that more and more business-oriented programs will be supplied in ROM-cartridge form. One of the most popular integrated-program pieces, Lotus 1-2-3, should be available by the time you read this, for example. Incidentally, it's important to note that inserting or removing a ROM cartridge automatically resets the computer. So if you do this when data is in memory, you'll blow away your work. Therefore, it's imperative to *save* your data before using a cartridge.

You'll find plenty of software available for use with the *PCjr*, though many of the more sophisticated, popular ones are not yet on board. The *PCjr* uses IBM's DOS 2.10, a more complex disk operating system than its popular DOS 1.10, which does not include graphics. The 2.10 version is shared by all of IBM's micros, so it's all in the family. To get *PCjr* BASIC, however, requires using a separate ROM cartridge, while the other PC models take it straight from the DOS disk. Since there are some differences in BIOS calls be-

tween the Junior and other PCs, not all software designed for the latter will work well with Junior. Enough will, though, to provide a tolerable degree of compatibility for people who already own IBM PC software. Check out what can and what cannot be used with the *PCjr* at your local authorized IBM dealer.

For a 128K-RAM *PCjr*, keep in mind that 16K is immediately needed for video, while 24K is needed for the disk operating system, leaving the user with only 88K of application RAM. Therefore, you'll likely need another 128K minimum of memory plugged into the Junior's side for some of the better business software.

The *PCjr*, which has been called a scaled-down PC, is quite compact, measuring 13.9" x 11.4" x 3.8" for its main body. Weight is only 8¼ lbs, though this is accomplished by having a separate 2.8 lb stepdown transformer for wall plug-in. It provides 17 volts to the Junior, but is limited in power for extensive external circuits. There's no problem getting inside the Junior. The top pops off easily by twisting a coin in the appropriate slots in the enclosure.

There's always a few little things about any computer that could irk a person, of course. The list is short for the *PCjr*. Among them are the following: Why does IBM insist on using nonstandard connectors? Couldn't Big Blue have included a parallel port, which is what most printers are set up to use without having to buy a serial interface board?

Where does the *PCjr* sit among competing brands now that IBM has corrected what everyone acknowledges to have been a mistaken design thrust with its earlier Junior? Wrong question for the limited space given here; it would take a book to provide this answer, which would require customizing the response finally to an individual's needs.

But not to avoid this natural query altogether, let's quickly contrast the *PCjr* with the Apple IIc, examined here last month:  Both are compact

(Junior's footprint is about 20 square inches more than the IIc's).  Both use bulky external transformers, the IIc's being bulkier and heavier.  Both come with 128K RAM. The Junior's memory, though, can be greatly expanded.  Junior's floppy disk holds more than twice as much data as the IIc's.  Both have a reduced number of keypads compared to "standard" desktop computers.  Both handle monochrome, composite video, and RGB video displays.  Neither comes with a parallel port that would expand one's printer choices inexpensively.

Junior further provides a Look-No-Wires-Mom infrared keyboard and two ROM-cartridge slots.  The IIc throws in a Dvorak-keyboard toggle switch, a second disk-drive controller for use with an outboard disk drive, an audio volume control, a headphone jack, and a TV-set modulator.  Neither is completely compatible with software written for their other micro models, though Apple likely has an edge here in sheer software available, especially for games.  The Apple IIc, using a CMOS microprocessor 6502 version, can be used for battery-powered portable applications with an optional LCD video display that's promised soon.

The Junior with a color monitor has about the same suggested retail price as the Apple IIc with a monochrome video monitor.  The *PCjr*'s keypads are somewhat superior to that of the IIc's.  There will be more hardware add-ons for the *PCjr* than for the Apple IIc since the latter does not employ an open architecture.

In sum, the *PCjr* is now a neat personal computer at the high price end of low-end computers (or is it the low end of higher-priced, disk-based computers?). In comparing the *PCjr* to just one personal computer in its price range, you can see that there are many plusses and minuses, and that much depends on your intended applications and whether or not you own or have friends who own one of the brands contrasted here.