

The Apple IIc Personal Computer

A portable IIe compatible that runs ProDOS

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In an industry that sees dozens and dozens of personal computers introduced each year, and despite the fact that the venerable Apple II is rooted in seven-year-old technology, it's remarkable that Apple Computer has succeeded in keeping its II product line alive and even thriving. Now, in the face of stiff competition from both foreign and U.S. manufacturers and in the wake of its own introduction of two significantly more powerful desktop computers (Lisa and Macintosh), Apple Computer has introduced the fourth version of the Apple II product line, the Apple IIc (see photo 1).

Evolving Apple II Technology

While the IIc will remain highly compatible with the Apple II product line from a software perspective, it is clearly not just "old wine in new bottles."

The IIc is what Apple Computer refers to as a "focused product." It is designed to fit into a market niche that places it in head-to-head competition with the IBM PCjr at the high end of the home market for personal computers. However, a great deal of flexibility is evident in both the IIc software and hardware architecture and peripherals. As such, you can expect to see the IIc appearing in a variety of other markets, including business and educational applications.

The IIc represents an evolution of Apple II hardware and software tech-

nology in a number of areas. First, it is truly portable. The system unit weighs just 7½ pounds and occupies a space of approximately 11½ by 12 by 2¼ inches. Its carrying handle folds into the backplane. A built-in half-height 5¼-inch disk-drive unit is accessed from the right-hand side of the case. The IIc and its optional 9-inch monochrome monitor are shown in photo 2.

Later this year, Apple intends to enhance the portability of the IIc when it introduces a full-screen, high-resolution flat-panel display (see photo 3). I'll discuss the flat-panel display later. Although a battery pack will not be available upon introduction, the IIc runs on virtually any 12-volt (V) power supply. The AC-to-DC converter has been isolated from the system, and, because the IIc has no slots, the power-supply capacity has been reduced from 45 to 35 watts. A small briefcase-size carrying case is available to hold the computer, flat-panel display, and other peripherals.

The IIc is based on the 65C02, a new CMOS (complementary metal-oxide semiconductor) implementation of the 6502 microprocessor. The 65C02 is an extension of the 6502's instruction set (with 27 new instructions) and offers faster graphics and arithmetic operations. The 65C02 runs virtually all existing Apple II software; however, software written to take advantage of the new instruction set will not be compatible with

the IIe and II Plus. The new microprocessor has a clock speed of 1.023 MHz and will perform up to 500,000 eight-bit operations per second, performance figures that match the 6502's.

The IIc extends the use of custom-designed ICs (integrated circuits) beyond what was used in the original IIe design. In addition to the input/output unit (IOU) and memory-management unit (MMU), the IIc contains a custom timing-generator (TMG) chip that generates several time and control signals, a general logic unit (GLU) that provides miscellaneous logic control required by the system, and the disk-controller unit, which is referred to as the IWM (Integrated Woz Machine). The IWM is also used as a disk controller on the Macintosh. It is a one-chip LSI (large-scale integration) of the disk controller originally designed by Steve Wozniak for the Apple II.

The increased use of custom LSI ICs has permitted Apple to further lower the chip count of the IIc (see photo 4). In addition to its sixteen 64K-bit RAM (random-access read/write memory) chips (the computer comes with a standard 128K bytes of RAM), the IIc has only 21 chips. This is particularly striking when you consider that this is three chips fewer than the number of non-RAM ICs in the IIe, despite the fact that many functions performed by additional cards (disk controller, two serial interfaces, 80-column video circuitry)

are now integrated into the IIC design.

Finally, the design of the IIC is based on a closed-hardware architecture giving the user no direct access to the system bus. However, in return for taking away the II's expandability, Apple included many of the features that have in the past required slots.

A quick look at the back of the IIC reveals connectors for two RS-232C serial ports, two video ports, an external disk-drive port, and a combination mouse/joystick port (see photo 5). Thus, in the slotless version of the IIC, users will have access to the functions that traditionally have taken as many as five of the computer's seven slots. While the Macintosh's relatively closed hardware architecture has created some controversy, the decision to restrict hardware expansion appears to be more clear-cut in the case of the IIC.

Portability and ease of use have clearly been gained at the expense of expandability. Apple has decided to market the IIC to a novice computer user who, it is argued, will have no desire to get inside the hardware, but instead will be interested in a computer that can be set up and run as simply as a stereo system. Toward that end Apple has separated the documentation into a setup guide and reference manual.

The software evolution of the IIC is more subtle, yet it may prove to have far-reaching consequences. The IIC will come with Apple's recently released ProDOS operating system, which offers a significant increase in performance over DOS 3.3. ProDOS includes Unix-like hierarchical file structures that are compatible with the Apple III SOS operating system.

Although the Apple IIC ROM (read-only memory) will appear very similar to the IIe ROM to programmers, it actually was redone almost completely. The ROM went through a dramatic "code crunch" according to Peter Quinn, manager of the IIC design team. Additionally, several bugs in the IIe ROM were removed and other features added, including improved interrupt-handling capability, a built-in windowing function, and a series of 32 graphics characters

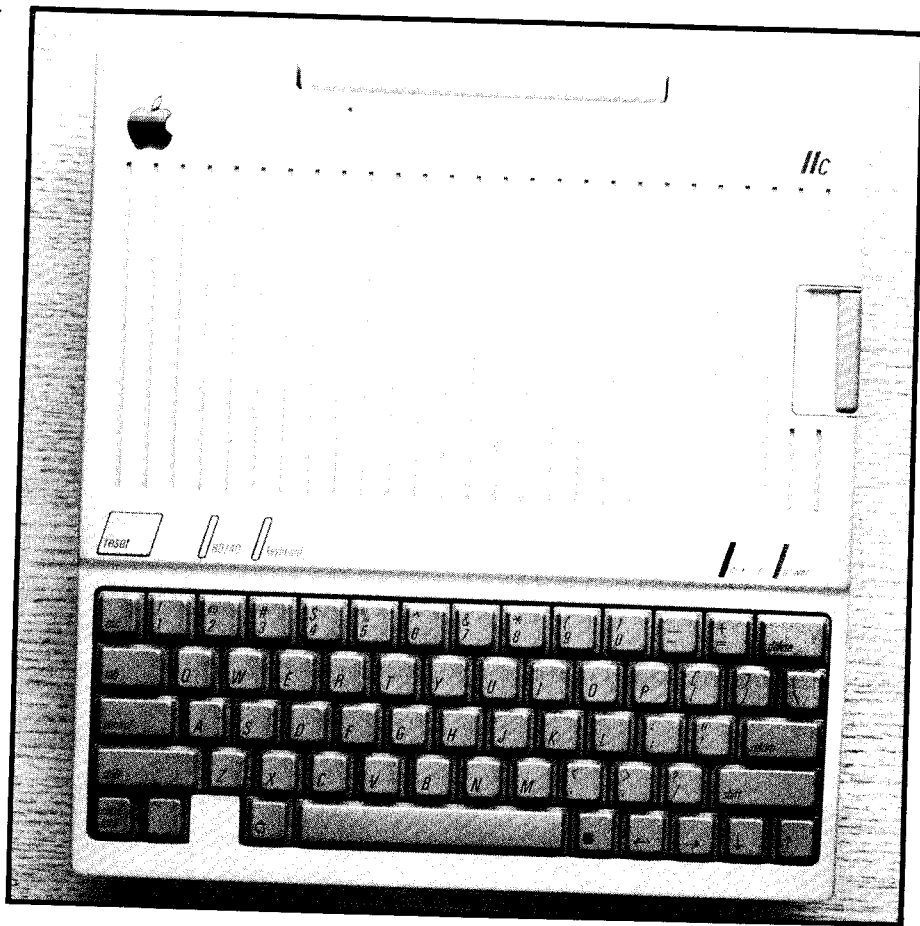


Photo 1: A top view of the Apple IIc. It has a lower profile (2½ inches) and weighs less (7½ pounds) than the Apple IIe computer. The keyboard is the same in size and functional layout but is designed around a low-cost key switch that provides tactile and auditory feedback. The Reset key has been moved from one side of the keyboard to the other, and switches for 40/80-column mode and Dvorak and QWERTY keyboard arrangements have been added.

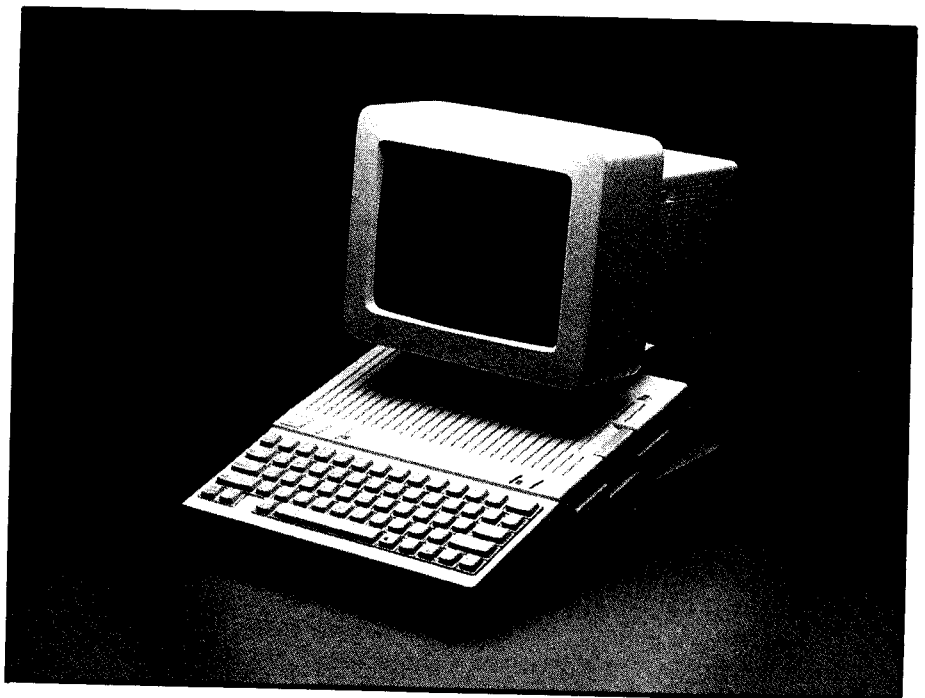


Photo 2: An optional 9-inch monochrome monitor is available for the IIc. When separated from the monitor, the system can be carried in a briefcase-size carrying case that includes room for the flat-panel display.

At a Glance

Name

The Apple IIc Computer

Manufacturer

Apple Computer Inc.
20525 Mariani Ave.
Cupertino, CA 95014
(408) 996-1010

Dimensions

Width: 11½ inches; depth: 12 inches; height: 2¼ inches

Weight

7½ lbs.

Power Requirements

9 to 20 volts DC, 35 watts

Processor

1-MHz 65C02 8-bit CMOS microprocessor

Memory

128K bytes of RAM; 16K bytes of monitor in ROM (includes self-test, Applesoft BASIC, 80-column routines, Mousetext icons, and interrupt-handling routines)

Keyboard

63 keys capable of generating the 128 ASCII characters; features auto-repeat and two-key rollover

Mass Storage

Built-in Alps half-height 5¼-inch disk drive that is fully compatible with the Apple Disk II: single-sided, 35-track, 16-sector disks

Video Display

Optional 9-inch monochrome monitor; flat-panel LCD will be introduced before the end of the year. RGB adapter to be offered at an unspecified future date. Video-display modes: 40-column text; 80-column text; low-resolution color graphics (40 horizontal by 48 vertical, 16 color); high-resolution color graphics (280 horizontal by 192 vertical, 6 color); double-high-resolution color graphics (560 horizontal by 192 vertical, 16 color). Text capacity: 24 lines by 80 columns. Character set: 96 ASCII (uppercase and lowercase). Display formats: Normal, Inverse, Flashing, Mousetext

Other Features

RF modulator; external AC-to-DC power converter; two RS-232C serial ports; video expansion port; external disk port

Hardware Options

Second disk drive; mouse; joystick; flat-panel LCD, carrying case

Operating System

ProDOS: single-user, single-task operating system; includes hierarchical directory structures, predefined and user-definable file types, file sizes up to 16 megabytes; compatible with DOS 3.3

Available Software

Includes almost all existing Apple II software. Specially designed packages from Apple: Appleworks integrated database management, word processing, and spreadsheet analysis; Access II communications program; Apple Logo II (requires 128K bytes of RAM); Apple Education Classics

Prices

Basic system unit: under \$1300; other prices to be announced

has decided to go after the same market that IBM is trying to reach with the PCjr and has priced the IIc accordingly. Still, given equivalent features with the IIe, the IIc represents some price savings. But the trade-off for that price saving is the IIc's lack of an expansion slot. The amount of the price saving may determine the IIc's ultimate importance.

A Computer for the Home

Apple has styled the IIc to reach a group of potential buyers that heretofore have been afraid or uninterested in personal computers. The IIc is, according to senior product designer Rob Gemmell Jr., "the cuddliest computer we have ever designed."

This is reflected in the IIc's case, which has a significantly lower profile than that of the IIe. Apple also has chosen a lighter, white color called "Apple Fog" for the case. The new color scheme is part of a general redesign effort that will affect all new Apple products. Originally code-named Snow White, the project led to a worldwide search for a design consultant. Ultimately, Apple settled on German designer Hartmut Esslinger, the designer of the Sony Walkman portable stereo. Esslinger set down the aesthetic design guidelines for the IIc and has since been retained by Apple to consult on future products.

The back panel of the case also reflects Apple's attempt to simplify system installation. Connectors are labeled with icons that represent modem, printer, and other ports. Frequently used interface cables make use of easy-to-fasten connectors. For example, Apple has chosen to use standard DIN 5-pin connectors to fasten the serial cables to the IIc.

Other external design features include a new door design for the internal disk drive (see photo 6), a miniphono headphone jack and volume-control knob that are recessed on the left side of the computer, and two switches set just behind the keyboard that control 40/80-column display and selection of a Sholes or Dvorak keyboard layout. The Dvorak option was available on the IIe, but it had to be accessed with

found in the character-generator ROM. These characters, called Mousetext by Apple, are a series of icons designed to offer programmers access to a user interface that appears similar to that found on the Lisa and the Macintosh. They can be called

directly and thus moved around on the screen faster than bit-mapped characters.

At the time of this writing, Apple was planning to price the IIc at "less than \$1300." While this price is higher than some expected, Apple clearly

jumpers and printed-circuit board trace cuts. The technical reference manual points out that you can change the key caps yourself, but it warns that if you break the switch stems you will void your warranty.

The IIC keyboard itself is functionally a duplicate of the IIE keyboard; it has 63 keys capable of generating the 128 ASCII (American National Standard Code for Information Interchange) characters. The actual mechanical design of the keyboard, however, is significantly different from keyboards on other Apple products. The IIC keyboard is laid out in a flatter fashion, in part because the IIC is designed to be used tilted up at a slight angle while resting on the handle, which folds down to serve as a stand. Although the keyboard is physically the same size as that of the IIE, the keys themselves are based on a new low-cost key switch that Apple has developed. The switch is not "full travel" (i.e., the keys don't depress deeply), but instead offers what Apple claims is improved tactile and auditory response.

It seems that no new version of the Apple II would be complete without altering the placement of the Reset key. This time it is placed just above and to the rear of the keyboard on top of the system case. As with the IIE, there are two levels of Reset. Holding down the Control key and the Reset key will cause a warm-start procedure with some programs. This leaves the resident program intact. Simultaneously holding down the open-apple key (to the left of the space bar) with the Control and Reset keys forces a cold start, which has the same effect as turning the power off and back on again.

Display Options

Although the video output of the IIC is similar to that of the IIE, Apple has attempted to generalize the output options of the IIC as much as possible. The back panel offers two connectors: a standard RCA pin-plug jack for a video monitor and a 15-pin D-type connector for video expansion. The latter interface is designed to support a number of display options, including RGB (red-green-

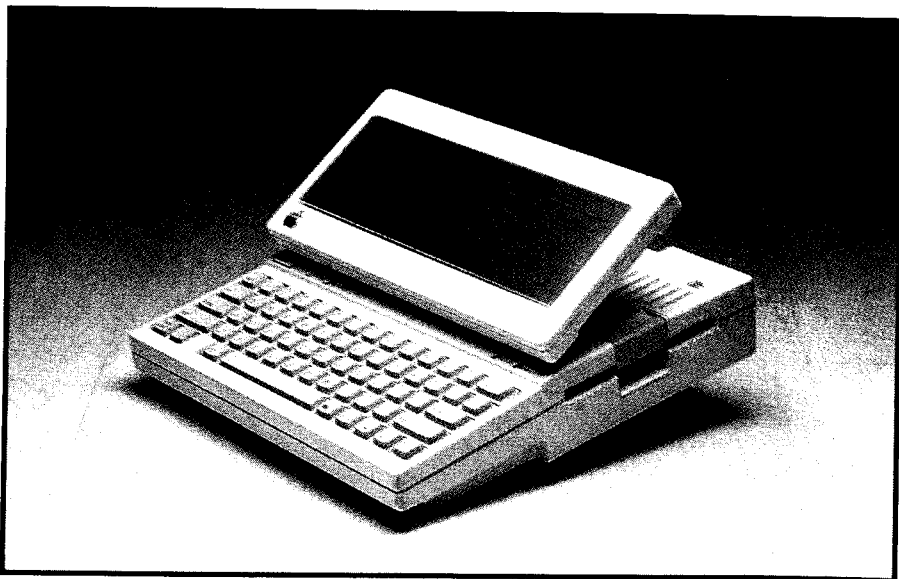


Photo 3: Apple has announced that a full-screen (560- by 192-pixel) flat-panel LCD will be available for the IIC before the end of 1984. The flat-panel display will support all the IIC's text and graphics modes and draw its power from the video expansion port.

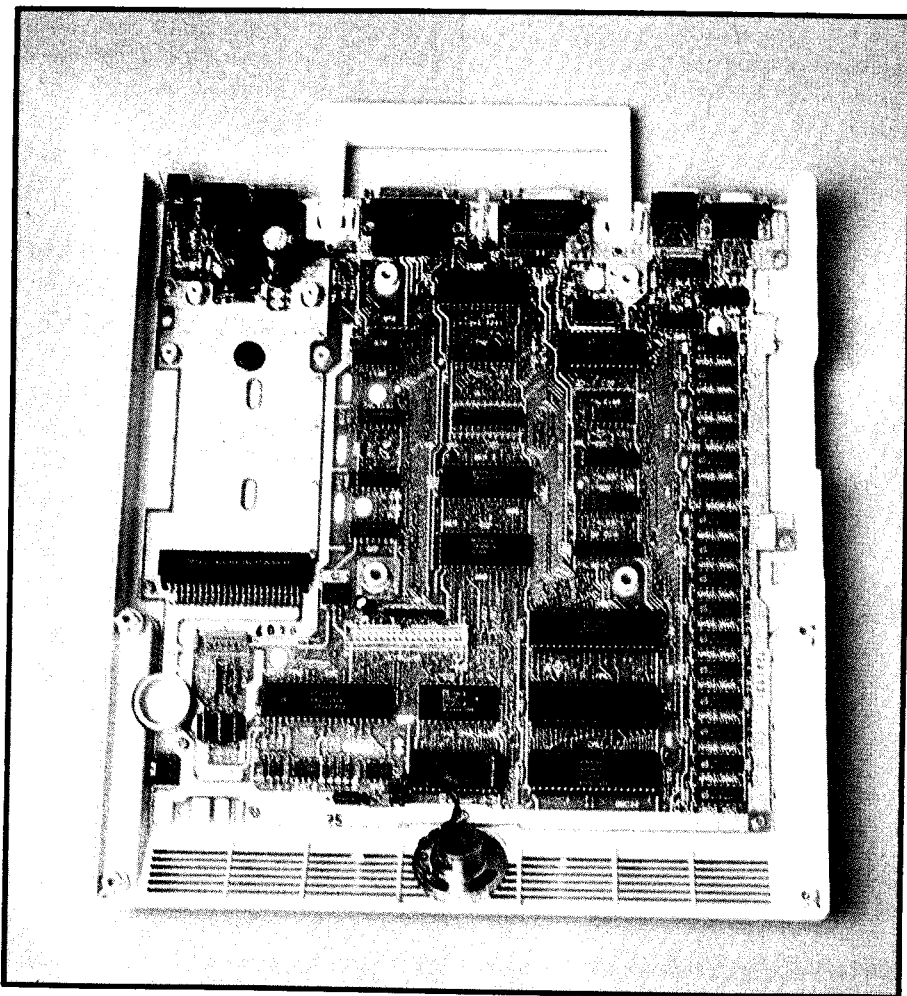


Photo 4: The main circuit board of the Apple IIC. The IC count is now down to 21 (excluding RAM), including two serial ports, video circuitry, and a disk controller. By comparison, the IBM PCjr has more than 90 ICs.

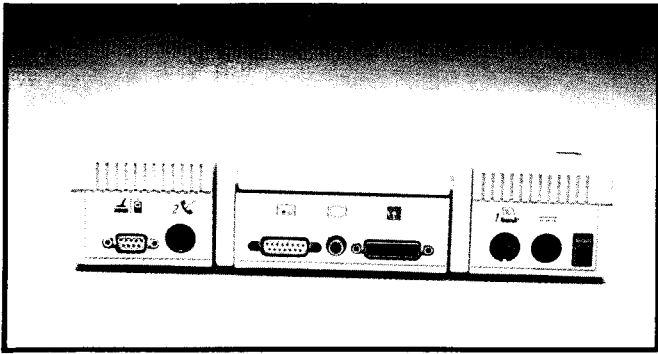


Photo 5: The rear panel of the IIc. The panel consists of seven connectors and a main power switch. From left to right: a 9-pin D-type miniature connector for hand controls or a mouse; a 5-pin DIN (Deutsche Industrie Norm) connector for serial I/O (input/output) (port 2, normally for a modem); a 15-pin D-type connector for video expansion; an RCA pin-plug jack for a video monitor; a 19-pin D-type connector for linking a second disk drive; another 5-pin DIN connector for serial I/O (port 1, normally for a printer or plotter); a special 7-pin DIN connector for 9-15-volt DC power input; and the main power switch.

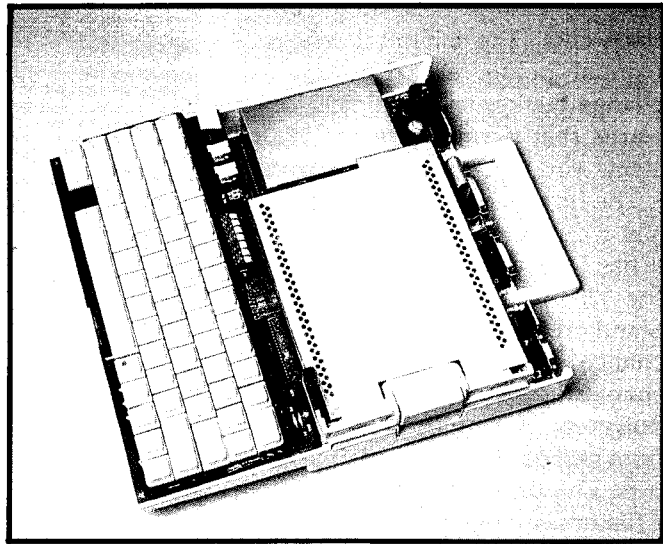


Photo 6: View of the IIc's internal 5¼-inch disk drive. The drive was initially designed to face backward but in the final design faces the side of the case. The drive is heavily shielded and ventilated.

blue) displays, the forthcoming flat-panel display, and a variety of European display standards. All 15 pins are used and signals include a video-text signal from the GLU, a 1-V sound signal to permit television speaker sound, a power source, a composite NTSC (National Television System Committee) video signal from the VID (video interface device) hybrid IC, a color-reference signal, and others. The intent is to let designers easily access all the hooks for both serial and composite data.

The basic system unit comes with a standard RF modulator designed to connect to the video expansion port, and an optional 9-inch monitor is available. An RGB adapter still is necessary, and Apple plans to have one available in the future.

Like the IIe, the IIc can produce both 40- and 80-column text displays. However, if you use an ordinary color or black-and-white television set, 80-column text will be too blurry to read. For a clear 80-column display, you must use a high-resolution video monitor with a bandwidth of 14 MHz or greater.

In addition to text-display modes, the IIc also has three graphics modes: low-resolution (40 horizontal by 48 vertical), 16 color; high-resolution (280 horizontal by 192 vertical), 6 color; and double-high-resolution

(560 horizontal by 192 vertical), 16 color.

The double-high-resolution mode is achieved by bit-mapping the lower-order 7 bits of the bytes in the two high-resolution graphics pages. These bytes in the two graphics pages are interleaved to provide 560 dots per line.

When the flat-panel LCD (liquid-crystal display) is available later this year, it will support all three graphics modes.

Compatibility

As it did during the transition from the II Plus to the IIe, Apple has made a significant effort to ensure software compatibility. Although it has switched to a half-height drive, Apple has continued to employ the 5¼-inch disk size for the II product line. The IIe also will continue to use 140K-byte single-sided drives.

In recent months, Apple has undertaken a major program of testing Apple II software on the IIc and informing software publishers if changes are needed to make their software compatible. Currently, Apple believes that the IIc is 90 to 95 percent compatible with the Apple II.

Compatibility problems, where they arise, may come from the ROM, the 65C02 microprocessor, unorthodox protection schemes, or illegal

memory addresses. For example, programs that enter the monitor ROM at unpublished locations will not work. A more intriguing but apparently rare problem emerges from the fact that some programmers have discovered and used undocumented instructions for the 6502 microprocessor. These instructions no longer exist in the 65C02.

Software

Apple has made the decision to endorse selected third-party software that has been specially designed for the IIc. Of the 21 products that Apple is introducing with the IIc, 17 are published by independent software publishers. The programs fall into the broad categories of education, entertainment, and productivity and come from such publishers as Microsoft, Software Publishing, The Learning Company, and Brøderbund Software. Apple itself is offering Appleworks, an integrated database-management, word-processing, and spreadsheet program; Apple Logo (see photo 7), redesigned to take advantage of the 128K bytes of RAM available in the IIc; Apple Education Classics; and the Apple Access II communication program.

Apple's endorsement is not an exclusive one. More than 100 other companies also are developing their

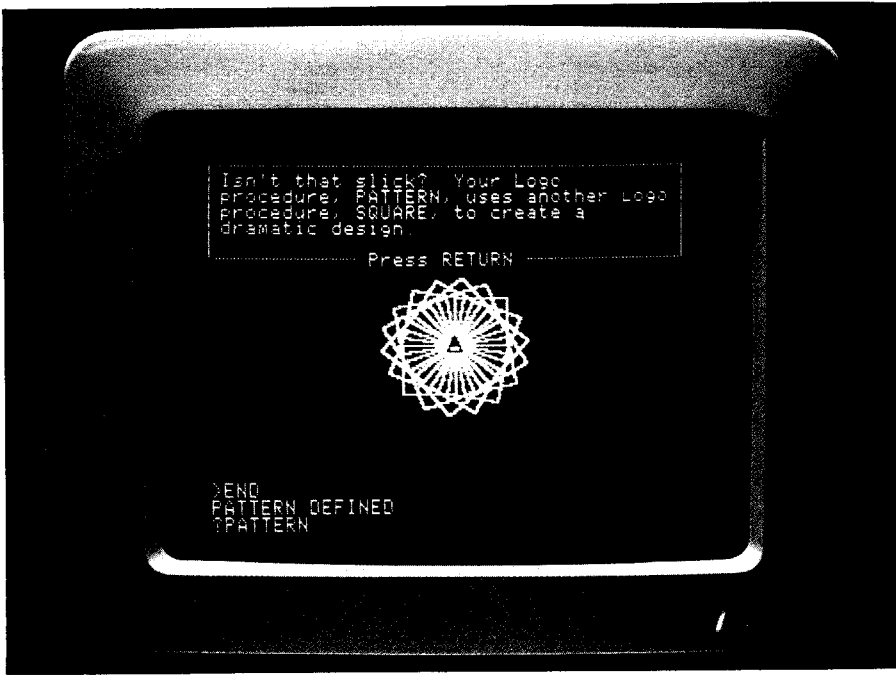


Photo 7: Part of the Apple Logo tutorial. Apple has limited the amount of printed documentation and increased the interactive on-line tutorials available with the IIc. The basic system comes with four disks of tutorials designed to offer 10 to 12 hours of instruction.

software for the IIc. A software developers toolkit and a technical reference manual will be available to software publishers.

Peripherals

Several peripherals designed to work with the IIc represent significant technological advances.

Apple has gone to the Japanese manufacturer Sharp for a full-screen flat-panel display that Apple hopes to have ready for introduction later this year. Several Japanese LCD manufacturers now are on the verge of introducing 80-character by 24-line flat-panel displays. Significantly, most of them will have an aspect ratio of 640 by 200 (width to height), corresponding to the IBM monochrome display. However, Apple has persuaded Sharp to manufacture a display for the IIc with an aspect ratio of 560 by 192. Apple currently has several working prototypes of the display. Recently, BYTE was shown a demonstration of one of these prototypes. The display differs from a CRT (cathode-ray tube) in appearance because of the square shape of individual pixels. (Individual pixels on an Apple monitor are twice as high as they are wide.) This makes

characters on the display appear somewhat flattened; however, characters in 80-column display mode appeared quite crisp, and the display also produced remarkable high-resolution graphics.

The Scribe printer, which is being announced simultaneously with the IIc, is an impressive plain-paper thermal-transfer printer with color capabilities. Although the final price of the Scribe has not been set, it is likely to be in the \$300 range. Apple is taking some pains to separate the Scribe thermal-printing technology from other thermal-printing techniques that require specially sensitized or coated papers. By contrast, the Scribe will print on virtually any paper surface, ranging from Xerox copier paper to continuous form-feed paper. The Scribe also will print on projection transparencies.

Although the Scribe is being announced with the IIc, it is designed as a printer to function with the entire Apple product line, including the Macintosh and the Lisa. BYTE was shown printing samples of graphics screen dumps from the Macintosh that appeared to exceed the ImageWriter in quality. The Scribe has two resolution modes and can operate at

either 80 cps (characters per second) in draft mode or 50 cps in letter mode.

Scribe technology is based on a proprietary print head that consists of 24 resistance elements that are arrayed in a vertical column. While printing, the head is pressed against a ribbon that consists of a polyester backing and a carbon-filled paraffin ink. The resistance elements are pulsed briefly, heating them and melting the ink to deposit it on paper.

The design of the print head permits a resistance element to rise to a temperature above 300°F and then drop to below 95°F (below the melting point of the wax in the ribbon) within the space of several hundred microseconds. The dot resolution of the Scribe can range as high as 160 horizontal by 144 vertical dots per inch in letter mode.

Color printing can be achieved by inserting a color ribbon that has different colors laid out in serial bands; the Scribe skips intermediate colors when printing in a particular color.

While the Scribe is a low-cost printer to purchase, the cost of printing will be high. Ribbon cost for an 80,000-character black ribbon will be in the neighborhood of \$5, and color ribbons may cost as much as \$8. Apple claims that the Scribe will be most compatible with "low duty cycle" applications such as those associated with students, homes, or executive workstations.

Questions and Comments

Now that we've seen what the Apple IIc has going for it, what does it lack? First, there are the obvious shortcomings, such as its inability to run CP/M software. This is not an insubstantial omission, since Z80 cards are one of the most common additions to the Apple II beyond 80-column cards, serial cards, and disk controllers.

Second, Apple has chosen not to include a built-in modem. It seems reasonable to expect that a modem should be an integral part of any computer that is designed to be readily transportable. Apple's response is that it decided to leave the modem out for reasons of time, cost,

and space. However, since lap-size computers selling for as little as \$700 now include integral 300-bps modems, this may be the IIc's most significant design flaw.

Less obvious, perhaps, are problems associated with the decision to maintain media compatibility between the IIc and earlier versions of the Apple II. Certainly Apple is the only company that can get away with introducing a personal computer with just one 140K-byte single-sided drive.

Even in its half-height form, it seems that the 5¼-inch disk standard is not an ideal one for a truly portable computer. The drive adds considerably to the weight and size of the computer and, in fact, the Apple design team admitted that the internal drive created major headaches in terms of cooling the IIc. (The critical element in the cooling equation is the jacket of the 5¼-inch disk.)

The obvious alternative would have been to switch to the Sony 3½-inch disk drive used by the Macintosh. That drive is lighter and more compact and has more than twice the storage capacity in its single-sided version. The problem of transferring software from one medium to another doesn't seem insurmountable, particularly because Apple seems intent on marketing the IIc to first-time computer users.

Also less clear is the question of open- versus closed-hardware architecture. It seems obvious that, in the case of the IIc, expandability had to be sacrificed to achieve a genuinely portable computer. Peter Quinn, the director of engineering for the IIc, insists that, while Apple's two most recently released products have been slotless, the company has not backed away from its commitment to the principle of open architectures: "I think that within this division we're still very sold on open architecture, open slots, and I think any of our new products will ultimately reflect this, once we evolve into a new architecture," he says. ■

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