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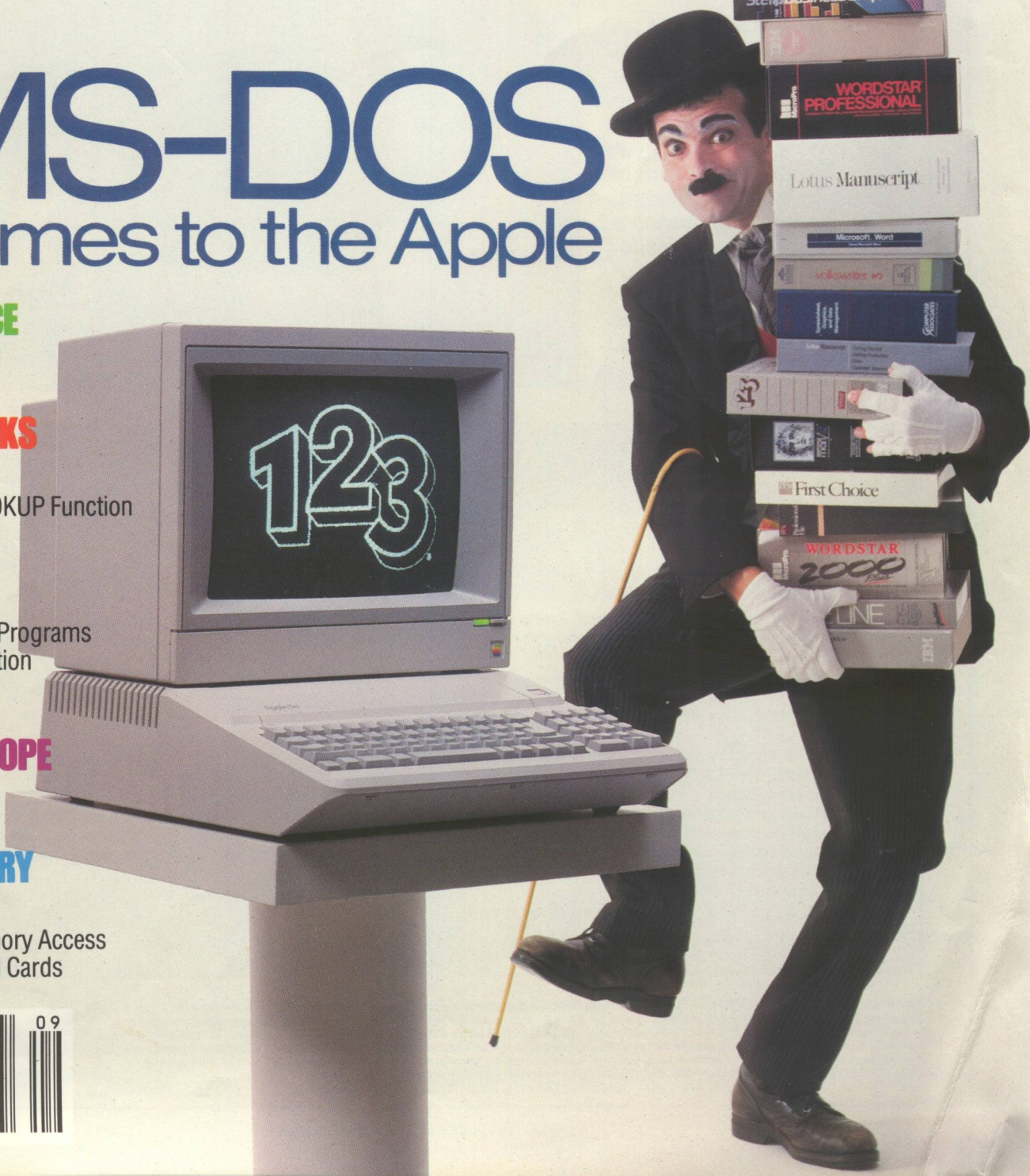

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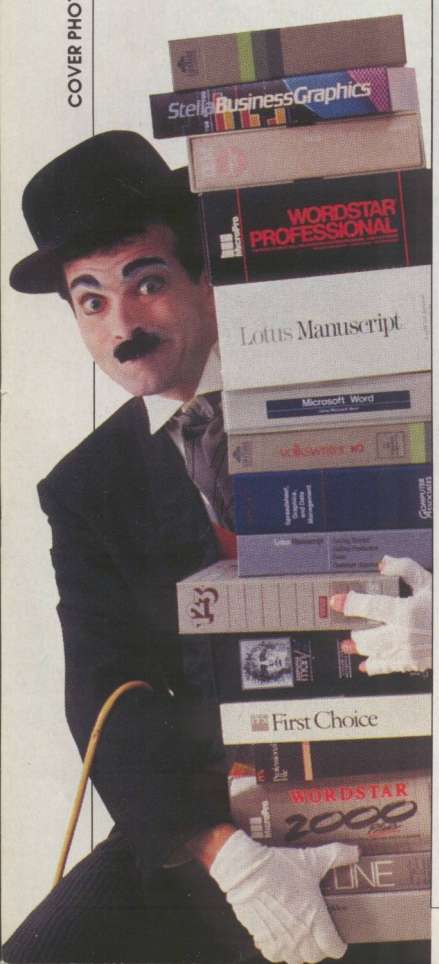

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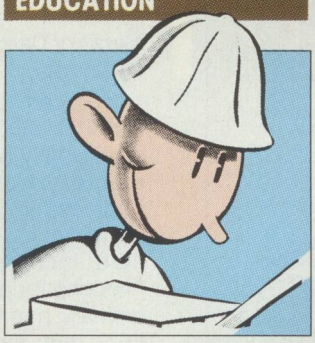

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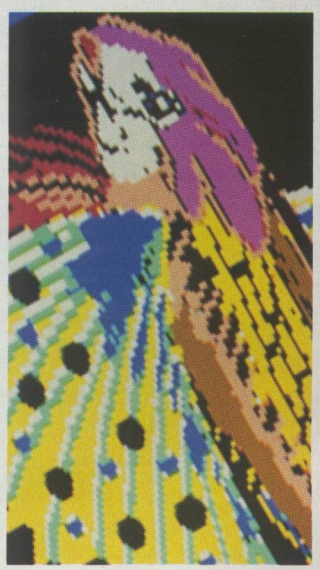

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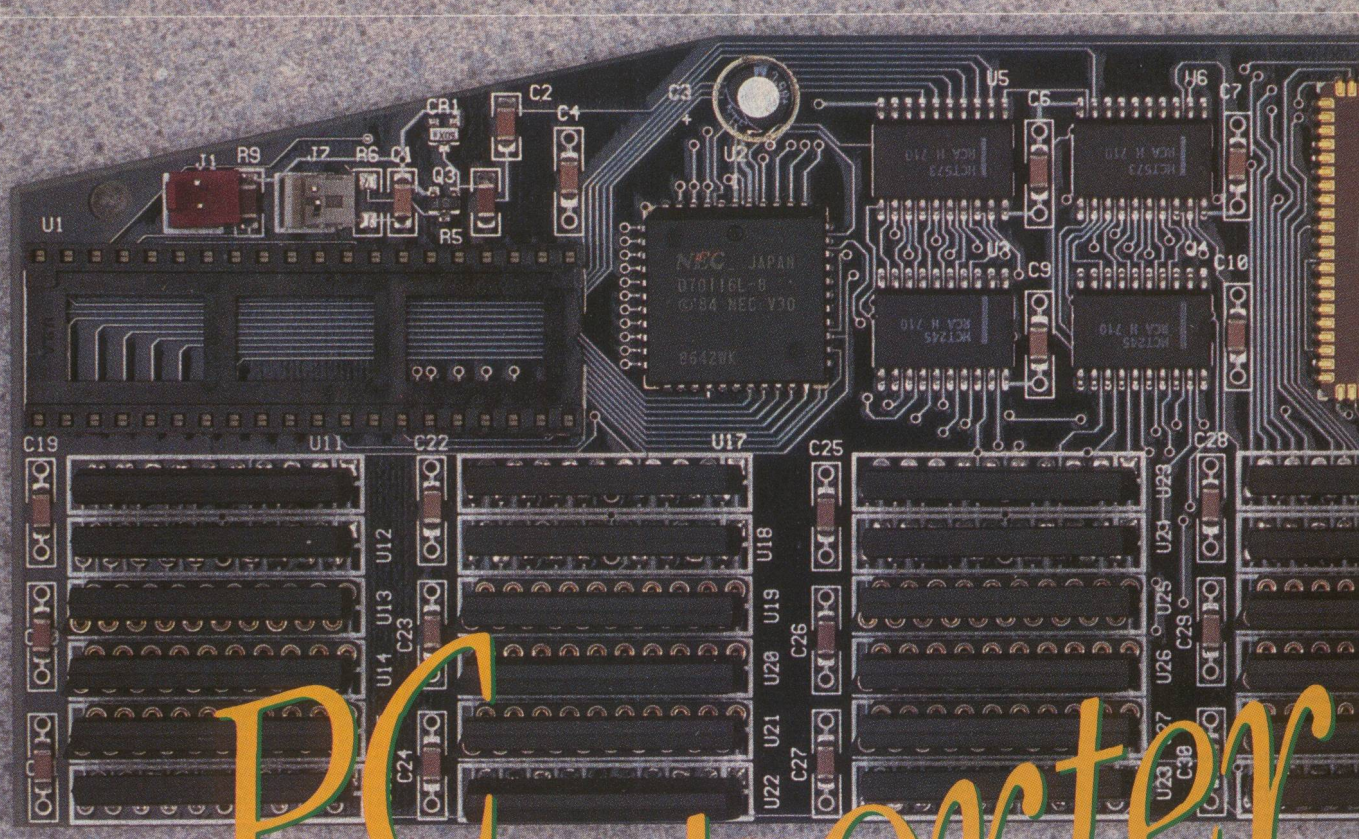

PC Transporter

COVER STORY BY JOHN MARKOFF

An IBM-compatible coprocessor card that gives Apple II users the best of two worlds

Think of an alliance between the *Star Wars* antagonists Darth Vader and Obe Wan Kanobe. Admittedly an unlikely team, it has certain obvious advantages.

Apple Computer, Inc., and International Business Machines Corporation are the two great opposites of the personal-computer world, but a merger of the two also makes a great deal of sense. After all, the Apple II family of computers is the clear leader in educational software, whereas IBM dominates business markets.

Why not, then, have the best of both worlds? IBM compatibility can give Apple II owners access to the wealth of business software in the MS-DOS world.

Enter PC Transporter, an IBM-compatible coprocessor card from Applied Engineering. Designed by The Engineering Department, a Campbell, California, development group composed of key former Apple Computer engineers, PC Transporter (which was codenamed Little Blue) is a combination

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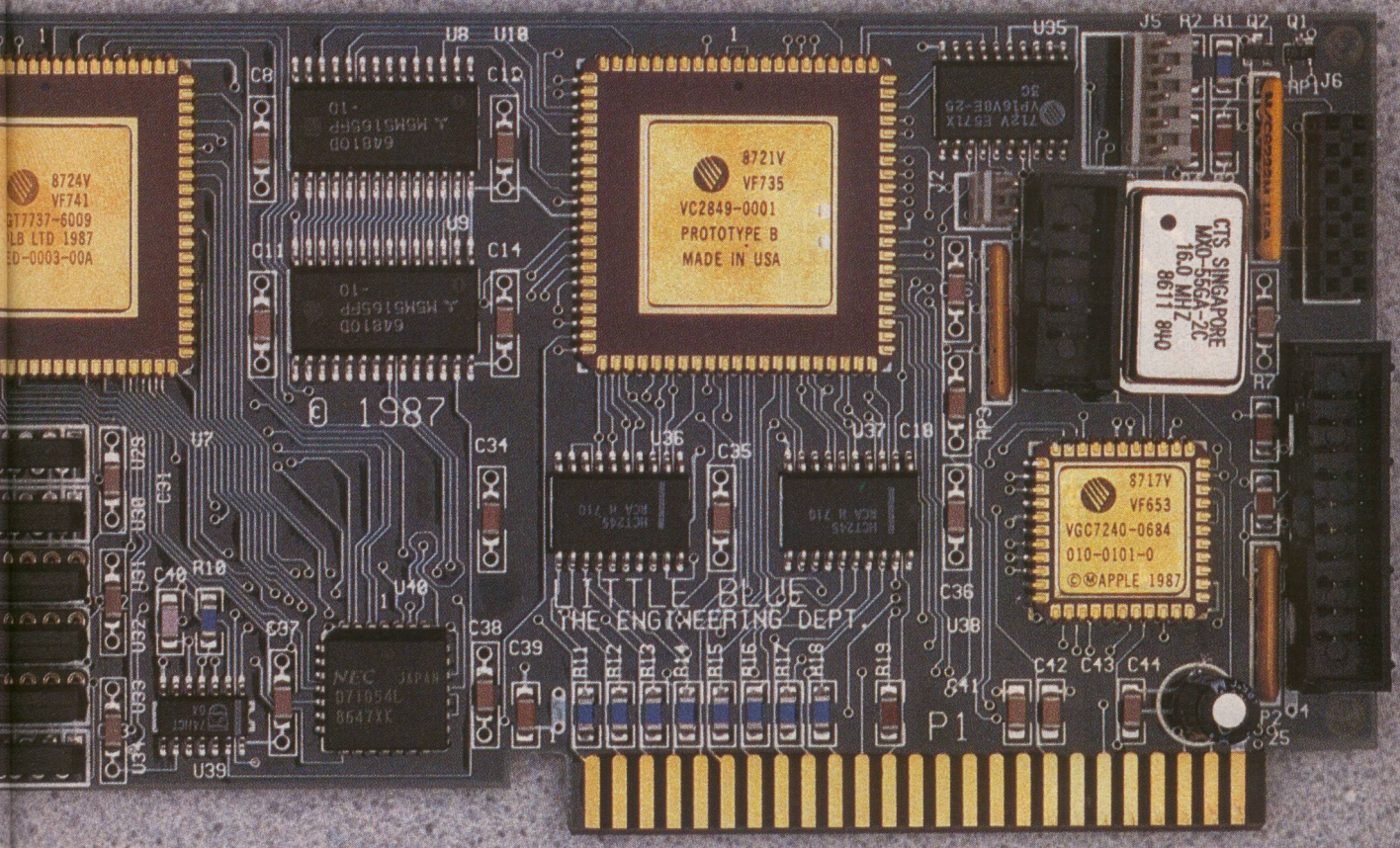


of hardware and software—including a set of utility programs—that adapts an Apple II Plus, IIe, or IIGS to the IBM PC and PC/XT world.

Plug PC Transporter into your Apple, and you have an inexpensive IBM-compatible computer that runs the major MS-DOS packages, as well as a large RAMdisk that increases the power of your Apple and a simple means of transferring program data between the IBM MS-DOS and Apple II ProDOS worlds.

Even better, an Apple II with PC Transporter runs faster than a standard IBM PC, in fact almost as fast as an IBM PC/AT. The Engineering Department has chosen a low-power-consuming, true 16-bit, CMOS, 7.2-MHz NEC V30, a chip that has more than twice the speed of the standard Intel 8088 microprocessor of the IBM PC.

I saw PC Transporter running the Norton Utilities benchmark program 3.5 times faster than a run-of-the-mill IBM PC with a 4.77-MHz Intel 8088 microprocessor. The faster processor speed, along with PC Transporter's 16-bit data bus (vs. the 8088's 8-bit bus), makes this speed possible. (Other benchmarks also show the speediness of PC Transporter. Watch for a complete performance review in an upcoming issue of *A+*.)

An Apple II with PC Transporter runs faster than a standard IBM PC.

Besides speed, the PC Transporter has a range of other features:

The PC Transporter circuit board includes a socket for an Intel 8087 math coprocessor. The 8087 dramatically speeds operations such as recalculating spreadsheets.

Fully configured, the PC Transporter card offers a total of 768K of RAM that you can reconfigure as a RAMdisk when using PC Transporter while running Apple II software. This setup lets the AppleWorks 2.0 desktop, for instance, show 750K of work space.

With PC Transporter, you can easily translate documents between ProDOS and MS-DOS by using an MS-DOS conversion utility from The Engineering Department. It is even possible to use an Apple 3.5-inch disk drive, connected directly to the PC Transporter disk-drive port, to read from and write to specially formatted disks, which can then be directly transferred to the new breed of IBM-compatible portable computers, including the Toshiba T1100, Zenith 181, and NEC Multispeed. PC Transporter is also designed to be compatible with the 3.5-inch disk drives in IBM's new PS/2 series of computers.

Best of all, perhaps, PC Transporter allows you to retain your existing Apple II peripherals. You can use most Apple II monitors (both color and monochrome), printers, and hard-disk drives, rather than having to buy PC-compatible peripherals. To add MS-DOS compatibility, all you need is the PC Transporter package and a single floppy-disk drive that can read PC-formatted diskettes.

(You will also need an IBM-style keyboard if you have an Apple II Plus.)

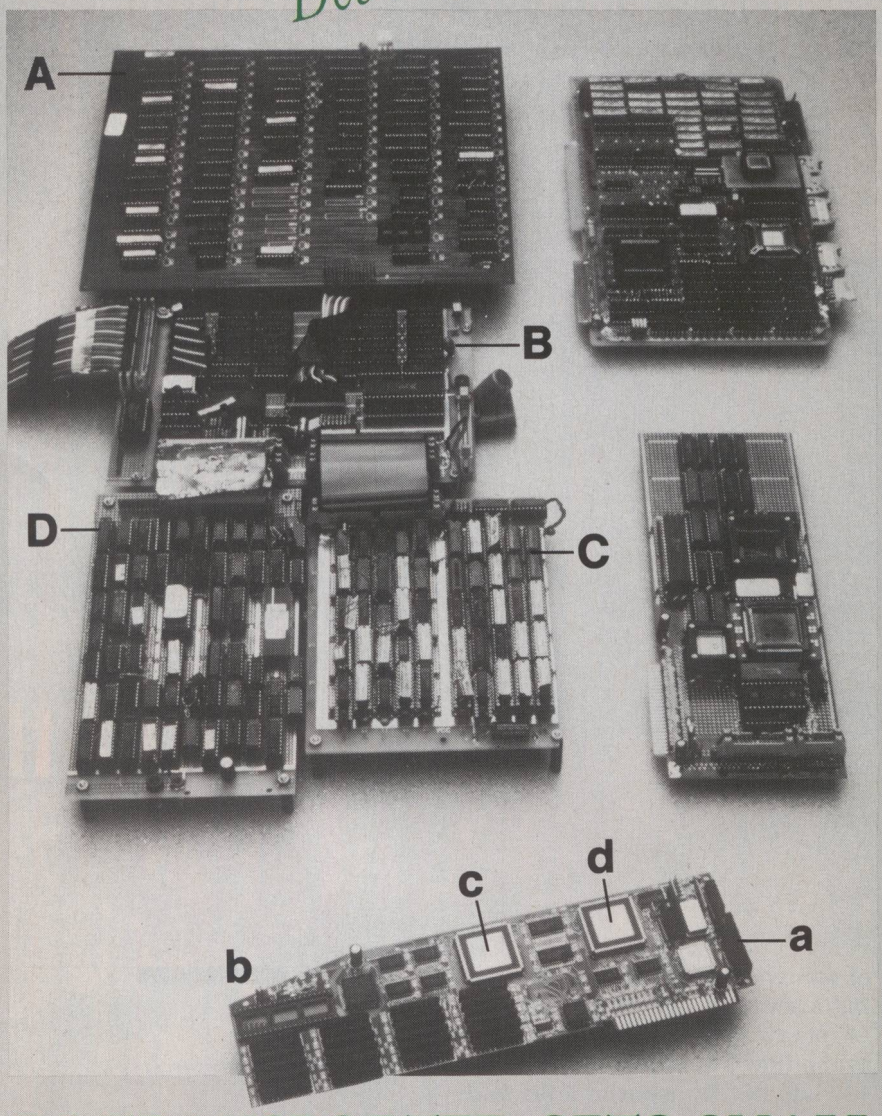
Bringing together two computers as radically different as the Apple II and the IBM PC is a first-class engineering challenge. Although cloning the IBM PC is now common—hundreds of IBM-compatible models are on the market—obtaining the same functionality inside an Apple II requires a more sophisticated approach.

It also requires the expertise of engineers intimately acquainted with both Apple II and IBM hardware and software. The Engineering Department has drawn together the talents of a group of

PC Transporter lets you retain your existing Apple II peripherals.

veteran Apple engineers: Cliff Huston was one of Apple's earliest employees—he helped Steve Wozniak design the disk controller for the Apple II; his brother Dick joined Apple as its first full-time programmer and 25th employee and wrote the ProDOS operating system; Wendell Sander, chief Apple III designer, also designed the Integrated Woz Machine (IWM) chip; Bob Lashley designed modems and local-area networks at Apple; and Peter Quinn was the engineering project manager for the Apple IIe and IIc. It's an impressive group.

Silicon Valley is the best place in the world to undertake a project as complex as creating PC Transporter. Not only is it possible to find engineers who understand the fundamentals of PC design, but the most advanced semiconductor-design houses are here as well. The members of the Engineering Department team have taken circuitry that originally required dozens of separate off-the-shelf chips and squeezed it down so that it now fits comfortably on a single plug-in board (see "PC Transporter Gets Small," this page). The hardware they couldn't fit on the board they have imitated



PC TRANSPORTER GETS SMALL

Like any other circuit board, PC Transporter started out large and got small. The photograph above shows PC Transporter in several stages of development, starting at the upper left and moving clockwise to the bottommost board—the finished product. On the left are four subboards (*A–D*) that were built in the late summer of '86 and linked together to form this early prototype. (The original prototype, not shown here, was built a year earlier to test the product concept.)

A is an early version of the disk controller, which has since been scaled down to the pint-size controller chip (*a*) on the finished board. *B* is the motherboard that contains the RAM, CPU, and math coprocessor, as well as the logic that buffers between the IBM and Apple worlds; it corresponds to *b* on the completed PC Transporter. *C* is the ancestor of the "glue" chip (*c*) that combines the miscellaneous circuitry from the two systems. And *D* is what eventually became the custom video chip (*d*).

In the upper right-hand corner is the first "wire-wrap" version of PC Transporter, meaning the first incarnation of the product in which all the various components reside on the same board. The Engineering Department came up with this board in early 1987.

Midway down the right-hand side is the next iteration of PC Transporter, which came into the world in the spring of this year. If you look closely, you'll notice that it has drastically fewer chips than does its immediate predecessor.

—Lisa Raleigh

in software that runs simultaneously on the Apple II's 6502 microprocessor.

To mimic the IBM PC, The Engineering Department has chosen to shrink most of that computer's functions onto three custom chips. First, a video chip allows PC Transporter to send IBM Color Graphics Adapter (CGA) graphics to either an Apple II monochrome or an analog RGB monitor, or directly to an IBM-compatible digital RGB monitor. (The IBM monochrome monitor doesn't work with PC Transporter.)

Second, a powerful, custom, single-chip disk controller includes the functions of the Apple IWM chip (used in the Apple IIe, IIGS, and Macintosh) plus the ability to read from and write to IBM-compatible drives. The disk-controller chip allows you to connect several types of disk drives to PC Transporter. It is perhaps the most flexible personal-computer disk controller ever designed. You can daisy-chain up to four drives off PC Transporter—as many as two IBM drives and two IIGS-style 3.5-inch drives (officially called Apple 3.5 Drives). The older Apple UniDisk 3.5 drives can't be connected to PC Transporter. The IBM drives may be in either 5¼- or 3.5-inch format.

You can daisy-chain up to four drives off PC Transporter.

Finally, a third, custom, "glue" chip concentrates all the miscellaneous circuitry that normally requires several dozen chips on an IBM PC motherboard. All the custom chips are attached to the PC Transporter board via a technique called surface-mount technology. The advantage to surface-mount is that it creates very reliable products, but the downside is that if the products fail, they are quite costly to repair.

As impressive as PC Transporter's custom very-large-scale integrated-circuit (VLSI) hardware is, the secret of the coprocessor board is the role the Apple II 6502 microprocessor plays in emulating all the hardware ports that normally provide I/O for an IBM PC. While running MS-DOS software, the 6502 operates in the background under the ProDOS operating system.

Every time the PC Transporter coprocessor asks for data from one of its own ports, the 6502 supplies it. The Apple emulates the functions of standard IBM chips and devices such as the 8237A DMA controller, 8259A interrupt controller, 8255A PPI (keyboard, speaker, and switches), game control (through the Apple's game port), parallel interfaces (printers), asynchronous communications (modems), and a hard disk (as a ProDOS volume or file that appears as an MS-DOS volume to PC Transporter). Perhaps most impressive is PC Transporter's emulation of the NEC 765 disk controller; without this emulation, PC Transporter would have a tough time running copy-protected IBM software. A master control program running on the Apple II translates between PC Transporter and various Apple peripherals.

You as a user see only a maximum of 640K out of PC Transporter's total 768K of RAM, because PC Transporter uses the rest of memory for programs that help emulate a PC, as well as for the menu-driven software that helps you configure the system. For example, the Basic Input/Output System (BIOS) takes up 10K of memory, and an extension for the PC/XT fills another 10K. In a PC, the BIOS (a set of low-level software programs that mediate between application programs and the computer hard-

ADDRESSING THE DISK-DRIVE DILEMMA

When you buy PC Transporter, you must also acquire an IBM-style disk drive in order to run IBM software or to load IBM programs and transfer them to an Apple 3.5 drive. To make life easier for its PC Transporter customers, then, Applied Engineering is also selling IBM-compatible drives. These are not just off-the-shelf IBM-type disk drives; they are specially modified to work in an Apple/IBM setup.

The Applied Engineering drives come in a box that's the same size as that of the older Apple Disk II. You can get one or two half-height drives in a single box. The drives come with their own power supply, which relieves the Apple II power supply from the extra load, and also have a little circuit board built in that protects your Apple in case you shut it off but forget to turn the power off on the drives.

The most critical feature, though, is the arrangement of the cable connectors. A standard IBM-style drive comes with a 34-pin connector with which you're supposed to hook up the drive to the computer. Unfortunately, that's not the right pin configuration to connect with PC Transporter, which was designed to let you connect either IBM-style or Apple GS-style drives to it. Thus, PC Transporter favors the Apple pin configuration and has a DB-19 (19-pin) connector for disk drives—and so does the disk-drive set from Applied Engineering.

The back of the drive box also has a DB-19 connector for daisy-chaining Apple 3.5 drives. The drives' internal circuitry has daisy-chain logic built in so that it knows how to handle up to four disk drives.

Of course, you can wire your own cables and connectors for hooking an IBM-type drive to PC Transporter, but you run the risk of blowing the disk-controller chip on the PC Transporter board if you get the wiring wrong. The price for all this equipment is not especially cheap: $239 for a one-drive box and $349 for two. If the functionality of PC Transporter appeals to you, though, the price is probably worth the headaches you'll avoid.

—Lisa Raleigh

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ware) permanently resides in read-only memory (ROM). BIOS resides in RAM to save cost and enhance flexibility. Since you load it from disk, rather than burning it into ROM, the task of updating BIOS in the future is simplified.

Starting PC Transporter

To start PC Transporter, you must first load the ProDOS operating system and then run the PC Transporter program on the Apple from the same disk. The PC Transporter program initiates a sequence that begins with a simple series of menus for configuration (see below). Once you set up PC Transporter to match your system software, the special driver programs load into Apple II memory, and then the BIOS from the disk loads into PC Transporter's own RAM memory.

You configure PC Transporter by using a program that you can also access any time PC Transporter is running by holding down the Shift key and pressing Caps Lock twice. It is a ProDOS application running on the Apple II that lets you select items such as printers and printer interfaces, video displays, and communications equipment; set PC Transporter's ports to match standard ports on a PC; adjust settings similar to those set by switches in a PC; set memory configurations; and configure disk-drive arrangements. This "control panel" consists of menus that allow you to load specific drivers, which are ProDOS control programs that govern the devices attached to PC Transporter. Once you set up your configuration, you can save it to your boot disk, which PC Transporter subsequently reads every time you start it. There is also an auto-configure option.

The most challenging aspect of using PC Transporter may be the actual task of installing it in your Apple. Part of the task is straightforward. You can put the PC Transporter card into any of your Apple II's expansion slots (the higher-numbered the better), except the auxiliary slot on the IIe, the memory-expansion slot on the IIGS, or slot 0 on the II Plus. After you've installed the card, the more arduous task is connecting it to its life-support system through a series of cables and connectors. Separate cable kits are available for the Apple IIe and IIGS. (At press time, Applied Engineering said it would probably bundle these cables with the PC Transporter card as well as provide them separately.) You need an additional cable to connect a II Plus to an IBM-compatible keyboard.

For the IIe, the connections include a speaker connector and an optional keyboard connector that lets you add an IBM keyboard. If you don't opt for the latter, you must connect your IIe keyboard cable to the PC Transporter card. In addition, there's a composite video jumper that you need if you are using an Apple monochrome composite monitor, plus a 19-pin disk-drive port and an optional analog RGB connector port. The II Plus setup is similar, except that you must add an IBM-style keyboard to use PC Transporter because the II Plus keyboard doesn't have enough possible key combinations to simulate an IBM keyboard. With the IIGS, you don't need to worry about the keyboard, speaker, and video-jumper connections, but you must use a video converter that translates PC Transporter's digital video signal into analog for the IIGS's RGB monitor.

The engineering feat of PC Transporter's designers is impressive.

The Monitor

PC Transporter works with one out of three graphics-hardware devices that IBM PC-compatible computers use. Currently the most popular Personal Computer graphics standards are the monochrome text-only mode (Monochrome Display Adapter), high-resolution color (Enhanced Graphics Adapter), and low-resolution color (Color Graphics Adapter).

Although EGA is considered the optimal mode in the IBM world, PC Transporter uses CGA because it is a lowest common denomina-

tor. Still, it provides adequate resolution with a good monitor. If you have a standard Apple II composite monitor such as the Apple Monitor III or Monitor II, programs running on PC Transporter will appear in the Color Graphics Adapter mode. In this case, a simple gray scale is mapped onto the color output, meaning that you get a monochrome image.

You can also use PC Transporter with a PC-compatible digital RGB monitor. If you have an Apple RGB monitor, you can also use it, but you need a special converter to let PC Transporter work with an analog RGB monitor. If you have two video displays connected when you're using PC Transporter, you can switch back and forth between monitors.

Disk Drives

PC Transporter's design elegance is evident in the single-chip form of the disk controller, which normally takes up an entire expansion card in most PC-compatible computers. The engineering feat of PC Transporter's designers is particularly impressive because PC-compatible disk drives and Apple disk drives use two entirely different recording methods to store information on diskettes.

PC-compatibles employ a method called Modified Frequency Modulation (MFM), whereas Apple-compatible drives use a different technique called Group Code Recording (GCR). Another complication is that the ProDOS and MS-DOS operating systems have very different internal structures. To surmount these obstacles, The Engineering Department had to design an extremely flexible disk controller.

PC Transporter makes a great deal of sense for practical reasons.

As a result, you can simultaneously connect up to four floppy drives directly to PC Transporter: up to two PC-compatible 5¼- or 3.5-inch drives and up to two Apple "Unified" disk drives (meaning the "universal" drives that can work with both the IIGS and the Macintosh). Additionally, you can use a PC-compatible drive as a ProDOS volume when running in the Apple II mode and similarly use a 143K Apple 5¼-inch drive as an MS-DOS volume.

You can also transfer MS-DOS files from ProDOS in order to move data between the Apple II and PC worlds. A special MS-DOS utility program permits you to transfer MS-DOS files on disk drives connected to PC Transporter to and from ProDOS files. File formats are a limiting factor, but ASCII (text) files are easy to transmit from one environment to another.

PC Transporter permits you to access an Apple-compatible hard-disk drive as a PC-formatted hard-

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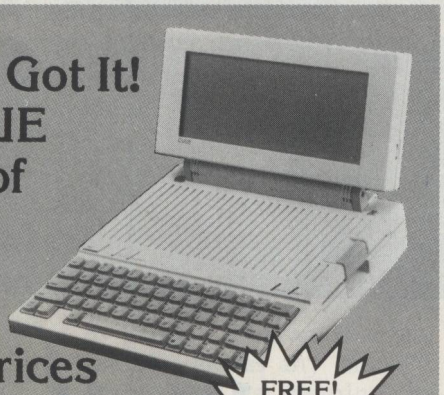

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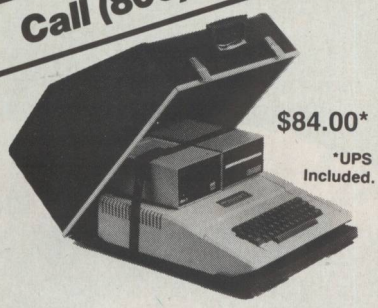

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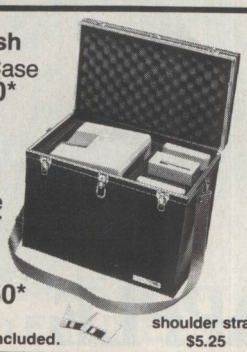

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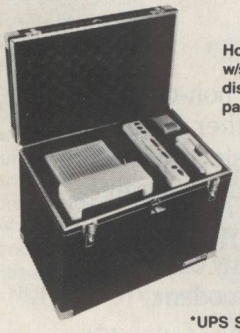

Holds: *IIc*, monitor w/stand, external disc drive, power pack, mouse.

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PC Transporter

disk drive for use by PC-compatible programs. To do so, you first need to prepare the Apple disk by using a selection from the setup menu, which allows you to set aside space on the hard-disk drive, actually creating a special ProDOS file on the disk. To PC Transporter, the file looks like a hard-disk MS-DOS volume on which you can then format and store data. Disk performance is not comparable to the performance of the fastest hard-disk drives available for PC-compatible computers, but using this setup is significantly faster and more convenient than using floppy drives.

The Keyboard

If you have an Apple IIe or a IIGS, you can use the Apple keyboard and emulate a standard IBM PC keyboard through keystroke combinations. If you have an Apple II Plus, you will need an attached IBM PC-compatible keyboard. The PC Transporter card has a special port that can connect to a separate IBM-type keyboard. The problem, of course, lies in the fact that the Apple has fewer keys than the IBM PC. Consequently, PC Transporter interprets Apple key combinations as IBM keystrokes (such as the equivalent of function keys) by requiring you to press certain key combinations that are as easy to use as possible. The PC Transporter card has a jumper connection to the Apple II keyboard-controller chip. The jumper provides separate status for keys, such as the Control key, that are not reported as separate keys through the usual Apple software interface.

Having It Both Ways

PC Transporter is a new alternative for those who have been tempted by the IBM software "standard" but who feel their heart still remains with Apple. It also makes a great deal of sense for practical reasons. It's faster than a PC, it costs less than most clones, and it provides the convenience of easily moving data between the Apple II and IBM formats. Also, consider that buying another computer would take up more than twice the desk space.

When I saw PC Transporter earlier this year, it was still in prototype form, so I could not tell if it would be 100% compatible with the PC world. Its developers aim to make PC Transporter capable of running 99% of all programs written for the IBM PC class of computers, however. Watch for *A+*'s upcoming performance-and-compatibility review to see how well it measures up. ✚

John Markoff has been an editor for both Byte *and* InfoWorld. *He is now a technology reporter for* The San Francisco Examiner.

INTERNATIONALLY AVAILABLE

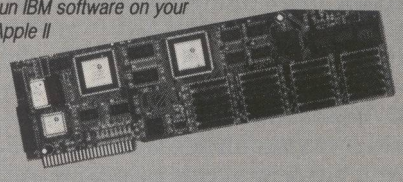
Applied Engineering won't be selling PC Transporter internationally, so if you're interested in the product but you're not in the U.S., you'll need to contact Vortex Corp., 10061 Bubb Road, Cupertino, CA 95014 USA; FAX number (408) 733-9776. Incidentally, Vortex won't be using the name PC Transporter. Instead, it will call the product II Blue.

—Lisa Raleigh

VITAL STATISTICS

PC TRANSPORTER

A plug-in card that lets you run IBM software on your Apple II



CPU: *Apple II Plus, IIe, or IIGS*
RAM: *64K*
DISK DRIVES: *At least one Apple-compatible disk drive (Disk II, 5¼-inch drive, or Apple-compatible 3.5-inch drive running off a disk controller separately from PC Transporter) and at least one PC-compatible disk drive (5¼-inch double-sided/double-density or 3.5-inch drive, to connect to PC Transporter)*
OPERATING SYSTEM: *ProDOS; IBM PC-DOS or Microsoft MS-DOS Version 2.0 or greater (must be purchased separately); PC-compatible keyboard (for Apple II Plus)*
COPY-PROTECTION: *No*
MOUSE: *Works with AppleMouse*
LIST PRICE: *$499 (At press time, Applied Engineering said this price would probably include cable kits, which would also be sold separately for the IIe and IIGS for $40–$50.)*

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