MS-DOS Comes to the Apple

ON BALANCE
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Using the @LOOKUP Function

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Eight Top-Rated Programs for Health Education

IIgs OSCILLOSCOPE
Includes Free Program Listing

IIgs MEMORY UPDATE
How Direct Memory Access Affects IIgs RAM Cards

Exclusive Preview!
PC Transporter board turns your Apple II into a high-speed IBM clone.
SEPTEMBER 1987/VOLUME 5/ISSUE 9

COVER STORIES

30 PC TRANSPORTER
BY JOHN MARKOFF
PC Transporter does the seemingly impossible—it lets the Apple II Plus, Ile, and IIgs run IBM software. Here's our preview of this technological achievement.

51 MOVING OVER TO MS-DOS
BY CHARLES RUBIN
Running IBM software involves dealing with the MS-DOS operating system. If you're mostly familiar with ProDOS or DOS 3.3, here's a primer on operating systems in general—and MS-DOS in particular.

56 AT YOUR COMMAND
BY GARY B. LITTLE
A chart showing the most common commands in ProDOS, DOS 3.3, MS-DOS, and CP/M.

QUICK TAKES

79 DELUXEPaint
BY ROBERTA SCHWARTZ AND MICHAEL CALLERY
A quick look at DeluxePaint, a program Schwartz and Callery say is reason enough to buy a IIgs.

85 SLOT-BUSTER
BY KEN LANDIS
Forget about phantom slots with Slot-Buster, a board that lets you add many functions to your Apple II.

93 ON BALANCE
BY MARY JANSIEWICZ
An easy-to-use personal-finance program from Broderbund Software.

APPLEWORKS REPORT

97 THE @LOOKUP FUNCTION AND OTHER APPLEWORKS TIPS
A guide to the @LOOKUP function in the spreadsheet module, suggestions for using AppleWorks effectively, answers to AppleWorks questions from our readers, and another approach to creating multicolumn text.

EDUCATION

113 SPEAKING OF GRAPHICS
BY ROBERTA SCHWARTZ AND MICHAEL CALLERY
This month, Schwartz and Callery offer a forum in which Activision responds to commonly asked questions about Paintworks Plus.

114 GRAPHICS GALLERY
A face, a fish, a whale, and a wail

RECREATION

117 GAMEPORT
BY BOB LINDSTROM
Ladies and gentlemen, meet the next president of the United States! Also this month, "GamePort" columnist Bob Lindstrom goes bargain hunting.
Think of an alliance between the Star Wars antagonists Darth Vader and Obe Wan Kanobi. 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 code-named Little Blue) is a combination
of hardware and software—including a set of utility programs—that adapts an Apple II Plus, Ile, 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+.)

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 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.

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, IIcs, 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 Uni-Disk 3.5 drives can’t be connected to PC Transporter. The IBM drives may be in either 5¼- or 3.5-inch format.

Finally, a third, custom, “glue” chip concentrates all the miscellaneous circuitry that normally re-

quires 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-
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PC Transporter

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

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 IIcs, 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 IIcs's RGB monitor.

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-

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

DOS operating systems have very different internal structures. To surmount these obstacles, The Engineering Department had to design an extremely flexible disk controller.

As a result, you can simultaneously connect up to four floppy drives directly to PC Transporter: up to two PC-compatible 5¼- or 3½-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-
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 ear-

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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.