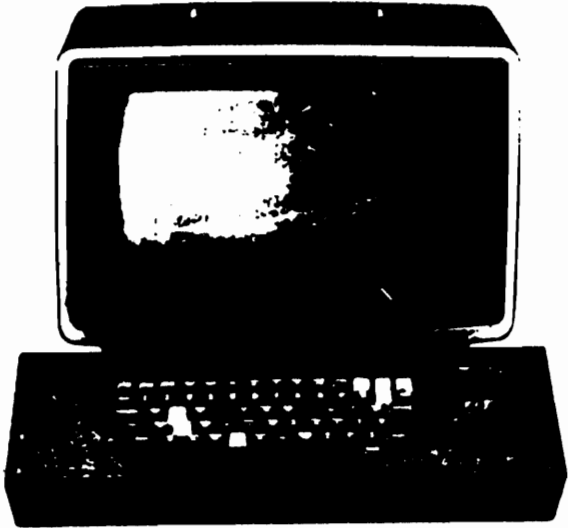# Product Test Report

Compucolor II Model 4 Personal Computer System

Has full graphics and built-in floppy-diskette drive

AMONG THE few small computing systems that provide color graphics is the Compucolor II from Compucolor Corp. (Address: 5965 Peachtree Corners East, Norcross, GA 30071; Tel: 404-449-5861). Several versions of this computer are available, offering a variety of optional RAM, keyboards, single and multiple disk drives, etc. These are basically two-package systems consisting of a 13" (33 cm) diagonal color monitor and disk drive in one and a keyboard/computer system in the other package. The two are interconnected via a single 30" (76.2 cm) long multiconductor flat ribbon cable.

We evaluated the Model 4 version of the Compucolor II, configured with 16K of user-available RAM and a single 5¼" floppy-disk drive. The optional 101-key Model 101 Extended Keyboard was substituted for the Standard 72-key keyboard. In addition to the standard 72 keys, the Extended Keyboard has a separate four-function calculator-type cluster, and a cluster of editing keys. (There is also an optional Deluxe keyboard with 117 keys and offering extended plotting capabilities available at extra cost).

The keyboard/computer package measures 19" (48.3 cm) wide by 7" (178 mm) deep and slopes from 4" (102 mm) high at the rear to 2" (51 mm) at the front. The monitor/disk drive package measures 18" wide by 15" deep by 13" high (457 x 381 x 330 mm). Price of the Model 4 with a Standard Keyboard is $1695, plus $135 when substituting the Model 101 Extended Keyboard.

Technical Details. The computer is based on an 8080A operated with a 2-μs cycle time. It can support up to 65K of memory, and has on-board space for 32K. There is 16K of ROM in which are the operating system and BASIC, and sockets are provided for additional 8K of ROM. The system is designed to use up to 480 I/O ports, 30 of which are implemented in the standard computer. This number includes an RS-232C serial port for printer or modem, with a broad selection of baud rates.

The graphics display features an 8-color selection on a 10" by 7" (254 x 178 mm) usable screen area. The 128 x 128 graphics is refreshed at power-line frequency. Alphanumerics consist of 32 lines of 64 characters/line for small-size capital letters or 16 lines of 64 characters/line with large-size caps. Lowercase letters are not included, but 64 special graphic symbols are.

Conventional 40-track diskettes are used with an average access time of 40 ms for 40 tracks, while average latency is 200 ms. Data transfer rate is 76.8K bits per second, with a diskette storage capacity of 51.2K bits per side (both sides usable).

The basic keyboard is standard ASCII four-level with 192 codes. It uses gold crossbar keyswitches of commercial quality. CPU reset and automatic diskette loading keys are included.

In software, a complete disk operating system as well as disk BASIC are in ROM. The BASIC is similar to most other disk BASICs and has 32 statements and commands, 19 mathematical functions, nine string-manipulation functions, and 12 disk-file commands. Calculations are to five decimal places.

The operating system has 31 CONTROL-plus-key commands, 31 ESCape-plus-key codes, and 12 graphic-plot commands. There is also a full complement of CRT Terminal commands as well as full-function foreground/background color selection along with 15 plot commands. This wide variety of commands gives the user control over every possible function of the computer.

Most of the keys are assigned two functions. Switching from one function to the other is via the CAPS LOCK key. Some keys are used in conjunction with the CONTROL and ESC keys. Those keys that permit color changes are color coded with their respective colors.

A 50-pin bus connector (located on the rear) provides all addresses, data, clocks, etc., to allow the Compucolor to be extended with any upcoming peripherals. Also located on the rear apron is a connecter for RS-232C signals. This latter port can also be used for a printer or modem. Each connector is fully described in the manual.

A large loose-leaf-type "Programming and Reference Manual" is supplied with the system. This manual contains 10

sections that cover full details for using the BASIC language and covers programming examples; print formatting and machine-level interfaces for the disk BASIC. The disk-manipulation system is spelled out in detail, as are all color and graphics techniques and the file control system (FCS).

The Manual concludes with seven appendixes that contain in-depth discussions of the disk BASIC file control system, CRT commands, internal features of the computer, an ASCII value table, and the Compucolor alphanumeric and graphic character set, along with other documentation.

User Report. The Compucolor is a complete computer. Simply unpack the two sections, interconnect them via the flat ribbon cable, plug the line cord into an ac outlet and turn on the power. That's all there is to getting the system up and ready to go in either the operating system or BASIC.

To use a diskette, simply insert the diskette in the drive, close the drive door and press the AUTO key on the keyboard. In just a couple of seconds, the disk menu pops up on the screen.

The graphics display was clean and sharp with bright colors. The overall quality of the graphics was excellent due to good convergence and the fact that the monitor bandwidth is better than that of a conventional color-TV receiver. One of the major advantages of the color monitor is that optically disturbing moire patterns (from nearby TV transmitters or adjacent channels or local or mobile hams and CBers) are not seen on-screen. Also, this approach provides an apparent increase in bandwidth since the monitor is not bandwidth-limited by r-f or sound circuits. The Compucolor "Sampler" program on diskette demonstrates the system's graphics capability.

The keyboard was a dream to operate. It has a positive professional "feel" and operated flawlessly.

Having had experience with other BASICs, we found Compucolor's version easy to use. It is a fast BASIC and is broad enough to easily adapt to programs written in other BASICs, except where unique symbols are used.

After working some of the programming examples given in the Manual, we typed in several game programs incorporating color graphics. This is quite easy to do, as a single keystroke can be used to change colors, flash symbols, invert and do other formerly difficult graphics tricks. These keystrokes can

be written into the program.

We also adapted a couple of simple business programs to the color format, making them much easier to read and interpret. Credits and debits for example, are much easier to follow when they are color-coded.

The bottom line here is that the addition of color to a video display does make working and playing with a computer much more pleasant and exciting.

Compucolor is supporting its system with lots of software (diskettes), including a large variety of color games, text editor, assembler, and several money-management programs.

In our opinion, the Compucolor II is an excellent choice for a computer system to start and stay with for home use. It is very flexible, thanks to its built-in disk drive, and has sufficient on-board memory to handle just about any length programs. This is a lot of computer for the money. —*Leslie Solomon, Technical Director*

Compucolor² Corporation

Compucolor II

Steve North

The Compucolor II is a recent entry into the field of consumer-oriented personal computers. It's an improved, up-to-date version of the original Intercolor 8001 microcomputer. The 8001 was first made under the Intercolor name back in the days when Altairs and IMSAIs were all the rage, but Intercolor decided to concentrate on OEMs and business customers and so it formed Compucolor to make personal computers. The 8001 was far ahead of its time, with BASIC in ROM and high-quality color graphics on a large screen, but it was a bit expensive for the personal computer market (at $3000), its "floppy tape" eight-track tape units had chronic compatibility problems and it wasn't S-100 bus standard when that was an important thing. In the past year or two the market for graphics-oriented microcomputers has exploded and Compucolor has had some time to develop a new model. So it was with special interest that we tested the Compucolor II.

Hardware

The computer comes as two units: a keyboard/CPU (central processing unit) and a video display/minifloppy disk drive. The system is based on the 8080 microprocessor, which seems a little odd since there are newer, more powerful microprocessors than the 8080 which also enable less complicated electronic designs. Not really important if you're going to stick to BASIC, though.

The concept behind the design is very good. There's no tangle of cables running from one component to another, just a ribbon cable. Because there's a built-in color monitor, you don't need to monopolize the family TV set for hours, and the display is better. Regular TV's intentionally blur

and soften images, but computers don't need compromises that normal broadcasting does. The Compu-

color's special video monitor provides much sharper graphics and more brilliant colors.

Compucolor also deserves credit for foregoing audio cassettes in favor of floppy disks. Audio cassettes are plagued with loading problems, slow data transfer rate and can't handle serious data file manipulation. A floppy disk allows you to load programs in a second or two and keep data files on-line for quick access and updates. The tradeoff is that the price of a basic Compucolor II is much higher than that of a cassette-based TRS-80 or Apple because you pay for the disk drive right away. A Compucolor formatted disk has a capacity of 51K, which isn't exactly impressive, though they brag that you can flip the disk over and use the other side. (This does not give you more storage actually on-line because the computer can't access both sides simultaneously, nor do most floppy disk media manufacturers sell single-sided disks for dual-sided applications.) A further minus is that the disks are nonstandard and must be purchased from Compucolor because, ha, ha, you don't get a formatting program with the computer. The

concept of not bothering with cassettes at all and including a disk drive with the computer is still good, though the price difference won't help sell any computers. A second disk and a printer can be plugged into the basic unit.

The keyboard comes in three versions. The least expensive (71 key) model is probably adequate for most users, though the other two keyboards have some nice extras such as a numeric keypad, special color and graphics control keys and a BASIC command key so you can enter BASIC keywords quickly. The keyboard is apparently shared with an Intercolor model as some of the legends on the keys have no apparent significance. For instance, the "P" key doubles as an escape function key for "CPU OPSYS." Funny, there's no resident operating system in the Compucolor and escape-P doesn't do anything. There are some other keys which have purposes not yet fathomed by the reviewer.

Most important, the Compucolor II is capable of some pretty spiffy graphics. It has eight colors (black, blue, red, violet, green, light blue, yellow, and white). Points are plotted on a 128 x 128 grid, while the characters are displayed in a 16 x 64 or 32 x 64 format. (There are two character sizes, one twice as big as the other, but both are all caps, a disappointment on a highly graphics-oriented machine. In place of the lower-case characters there are special graphics characters, such as chess men and portions of geometric shapes.) Further, the characters can be set individually to blink. The graphics and characters can be mixed on the display and each block may be programmed for foreground and background color. This allows you to

Compucolor II, con't...

plot green points on a red background or a letter X in black on a violet background. By comparison, the Apple II has 16 colors in low-resolution mode, but plots only on a coarse 40 x 48 grid, and graphics and characters can't be mixed. In high-resolution mode the Apple has denser graphics than the Compucolor, but only four colors (black, white, green, and violet) and text can't be mixed with graphics, either. The Compucolor isn't the ultimate in personal computer graphics but it's one of the best-performing ones we've tested so far.

System Software

The Compucolor II comes with 8K, 16K, or 32K (maximum) of RAM. The rest of the addressable memory is reserved for system programs, including BASIC, FCS (file control system), CRT Mode, and probably some other handy stuff for graphics and I/O.

The BASIC is Microsoft 8K BASIC, with disk I/O and graphics additions by Compucolor. The BASIC is good, but not as good as Microsoft Extended BASIC (a.k.a. TRS-80 Level-II BASIC). The Compucolor II would be a better machine if it did have Extended BASIC, but possibly there was a problem in fitting all the system software and screen maps into just 32K of memory. (A handy argument to remember next time someone knocks 16-bit personal computers with 24 meg of memory addressing space.)

In BASIC, some graphics can be done simply with PRINT statements, because character strings can contain color information. More complex graphics are controlled through the PLOT statement. PLOT is followed by numeric codes (range 0-255) which are apparently just fed to an internal graphics processor. Thus, you program plot codes to control blinking, character sizes, vector plotting and bar graphs, etc. This is a very flexible approach but it's unwieldy since you have to memorize plot codes or refer to a list, and it doesn't make readable programs. Likewise, all the random disk file I/O is done with just three statements: FILE, GET, and PUT. This works, but making one verb do the work of five isn't people-oriented.

Lurking elsewhere in the 32K is a File Control System—a small DOS for listing directories, purging files, copying files from one drive to another and the like. Fortunately, it is possible to get from BASIC to the FCS and back to BASIC without

damaging your program in memory. The CRT Mode allows the Compucolor II to be a dumb terminal for hookup to another computer system. The color and graphics are still available by transmitting special codes from the main computer.

An AUTO key on the keyboard automatically loads and runs a menu program from disk, very handy for idiot-proof turnkey operation.

Usually you can get from one program or function to another with only one or two keystrokes. The system powers up in BASIC, and you can return there by typing escape-W. The CPU-Reset key enters the CRT Mode and FCS is entered by typing escape-D. The FCS error messages are typical inscrutable computalk (like EDCS, ENVE, and EWSF). It may be unfair to chide Compucolor for something that IBM has gotten away with for years, but shouldn't personal computers be different? (That reminds me of an ugly rumour going around that a very big microcomputer software house is coming out with a disk operating system inspired by IBM's JCL. Just when you thought it was safe to have a computer...)

Documentation

The documentation that comes with the unit is an 18 page booklet, chock full of at least one or two helpful hints. It's best used as a quick reference for commands, statements, and error messages. The real manual (called a Programming Manual) is over 120 pages long and includes helpful information for beginners and experts both. The section on BASIC

"Poor dear! Our new puppy chewed up all of the software for his computer..."

© Creative Computing

starts out with variables and gradually explains character strings, arrays, nested loops, graphics, and files. It also includes details about machine-level programming, but probably not enough to get started without some additional information. But you have to purchase this manual separately from the computer. Perhaps Compucolor had in mind that their computer would be bought by users, not programming types.

Applications

Our Compucolor came with a number of "Sof-Disks," each pre-programmed with several games or applications. In general, the canned programs were well above average in quality. We especially enjoyed Othello (the computer plays a good game), Artillery, Star Trek, Hangman, and Piranha. There are also some useful programs for 1040 forms, computer-assisted instruction and financial planning. The disks cost $20 each. There are over nine disks already, so this is probably the beginning of a good library of software. However, there are very few second-sources of Compucolor application software at this stage.

Overall

In general, you can't help but admire an idea like the Compucolor II, but the overall impression is that they had a lot of outstanding ideas but didn't quite pull them all together. The BASIC could be improved by better statements for control of graphics and disk I/O. Also, sound-making hardware would be a major plus.

The Compucolor II has a lot of different capabilities and functions and programs inside, but they're not presented to the user in an easy-to-understand manner. I'd have to admit that I think disks and ROMs don't mix. The advantage of ROMs is that they're a cheap way to have instant BASIC. As soon as you add disks, the ROMs tape up valuable space that could be used for RAM and interfere with a well-organized disk operating system. As long as you have disks, you might as well put BASIC on the disks and load it like any other program. However, Compucolor perhaps envisions this as a turnkey machine and didn't want to bother with changing disks or putting BASIC on every Sof-Disk.
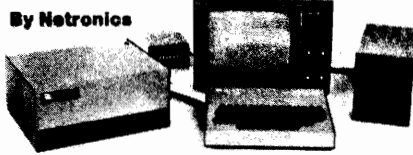
The Compucolor could be a really dynamite personal computer if it was redesigned for twice the disk capacity, with 48K of RAM and 16K of

Explorer/85
Professional Computer

Compucolor II, con't...

ROM or screen maps as needed, to run the CP/M disk operating system. Microsoft BASIC with graphics extensions and other useful system software could be kept on disk. A system like that would easily be worth twice the present price of the Compucolor, though it would be out of the league of inexpensive personal computers.
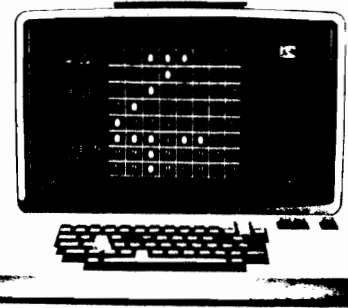
In brief, the Compucolor II is worth your consideration if you're especially interested in high-quality color graphics, and don't need the reassurance of all the TRS-80 owners on your block to know you bought the computer that's right for you. ☐

> Next month we'll have another evaluation of the Compucolor from a person who has owned it for several months and learned to really use its capabilities.

Another view...

We have had several young children learning to program in BASIC on the Compucolor. Our observations indicate that while in most ways a beautiful system, the Compucolor has several idiosyncrasies that may prove to be annoying. For example, there is no SCRatch or NEW command to erase a Basic program in memory. Most programming texts use this extensively to erase an existing line or short program before going on to the next one; with the Compucolor one must hit Control/Shift/CPU Reset and wait about 5 seconds for the machine to restart itself.

Also, the absense of a built-in speaker for music or sound effects is a bit surprising on a system in this price range.

Nevertheless, the kids love the spectacular color graphics and, eventually, have learned to adjust to the above idiosyncrasies.   —DHA

CREATIVE COMPUTING

CIRCLE 54 ON READER SERVICE COUPON

COMPUCOLOR II

A colorful home computer complete with a monitor and disk system

THE MANUFACTURER OF COMPUCOLOR II likes to call his personal computer "The Renaissance Machine." With considerable justification, it would seem, in light of the way the equipment performed during our evaluation tests. Admittedly, we did not tear the equipment apart, piece by piece, to check and count every component inside. But we did give it a thorough operational testing, of the kind you would perform after taking it out of the shipping container. We found much to laud, and nothing serious to criticize, and can unhesitatingly suggest that Compucolor II should be on your list of "possibles" when you go shopping for a hobby/personal computer.

The first positive vibes came through awareness of the general handling convenience of the system. There are just two components to hook together—the video monitor and the keyboard which mate instantly by means of a multi-lead ribbon umbilical. Then just attach the power cord to an AC supply, and away you go! You can immediately enjoy pre-programmed games and other material available on floppy disks, start to learn how to do your own programming, and store your programs on blank discs by using the disk mass storage feature *built into the video monitor*. More about that handy feature later.

Options. First, let's eyeball the price tags in effect at this writing. The system shown here features an "Expanded" keyboard with 101 keys. It costs

more than a system having the simplest keyboard which lacks the 16-key numerical pad on the right, and the 9-key color pad on the left. There's also a deluxe keyboard which adds

A built-in disk system makes this a versatile machine. Disks insert into the monitor case.

$200 to the base price; it offers another 16 "additional function" keys. The following model base prices relate to the simplest keyboard: Model 3, 8K user RAM, $1795.00 Model 4, 16K user RAM, $2095.00 Model 5, 32K user RAM, $2395.00 An additional 16K RAM module, costing $468.00 is available for Models 3 and 4. A second Compucolor II Micro-Floppy disk drive is offered for

Keyboard convenience starts with use of a Standard ASCII unit coded with 192 codes, and utilizing 71 gold crossbar commercial key switches. All versions include a CPU Reset key, an Automatic (AUTO) disk loading key, and two Shift keys. The expanded keyboard shown here has 25 extra keys that do not actually expand programming capability, but do add materially to convenience of use. The 16-key numerical pad is much handier when doing extensive mathematical computation than using the numerical keys on the main bank of keys. Also, the color keys on the left save time and effort two ways—by speeding color selections,

and by providing single-tap convenience when writing such frequently-used instructions as Plot, Poke, Save, Load and List. Without this double-function pad, you must repeatedly spell out the words, letter by letter, using the main keyboard.

Seventeen extra keys found on the deluxe keyboard (not shown) are for the purpose of facilitating graphics programming.

Unique Video Monitor. The keyboard is relatively compact compared to others on the market because the bulk of the computer electronics is housed in the monitor, rather than in the keyboard unit. The completely self-contained monitor utilizes a 13-inch diagonal high-resolution color tube, designed specifically (along with the durable and stylish housing) by General Electric Company.

On the right is a disk compartment with a door that flips open and closed with the touch of a finger. Insertion and extraction of diskettes is fast and easy. The Micro-Floppy is a high-speed, random access commercial disk drive made

COMPUCOLOR II

by Wangco, a top, disk drive company.

On the rear of the video monitor are the power cord connection (the power cord is completely removeable for easier storage), on/off switch, fuse, keyboard plug, a modem plug, and a 50-pin bus for connecting peripheral equipment. Small openings on the back wall of the monitor permit easy access to video controls without need to remove the back; these include horizontal center, focus, and red, green and blue screen controls. The careful thought given to design details is manifest even in the carrying handle which nests tidily in a well at the top of the housing, yet is easy to pop out when needed.

Technical Details. Computer electronics are built around the popular 8080A central processing unit that is characterized by a 2 microsecond cycle time with total memory expandable to 64K bytes. There's 16K bytes of ROM (Read Only Memory), and memory sockets are provided for 8K bytes of additional EPROM/MROM memory. The ROM includes Disk BASIC (the high level language used by the computer), File Control System, and Terminal Software.

Missing in these photos is the outstanding color ability of the Compucolor II. You can, however, see the detail that is possible with the good high-resolution graphics. Note pin-cushion curve mentioned in text.

Screen refresh utilizes 4K bytes of RAM (Random Access Memory), leaving 8K bytes for user workspace unless, of course, you opt for the more powerful 16K or 32K version.

The system is designed for 478 input/output ports, with 30 ports implemented on the standard unit, including one RS-232C Serial Asynchronous Channel for a printer or modem. A 50-pin bus provides all addresses, data, clocks, and whatever else is needed for expansion of the system with peripherals.

The CRT (Cathode Ray Tube) terminal commands: page/roll mode; erase line; erase page; tab; two character sizes (both upper case); cursor XY addressing; blink; cursor home, left, right, up and down; caps lock; CPU reset; foreground and background color selection; 15 plot modes; blind cursor mode; local, full and half duplex modes; write vertical mode; and transmit cursor and page modes.

Programming. BASIC Language is by means of a disk basic 8001 interpreter in ROM memory, which includes 29 statement types, 3 command types, 19 mathematical functions, 9 string functions, and 12 disk file commands.

There are independent Baud Rate generators for choosing one of seven Baud rates from 110 Baud to 9.6K Baud. The data transfer rate is 7680 CPS—extremely fast when compared with the 50 to 100 CPS transfer rates of cassette storage systems used by other popular personal computers.

As with any computer, you need to adjust to variations from other styles of BASIC language. But sometimes those adjustments are to the good. For example, the Compucolor does not have the traditional LET statement, so you must drop it from programs you may pick up from books and magazines. Instead of writing LET A = B+C, for example, you simply write A = B+C.

If you have never before programmed in BASIC, the Compucolor will seem downright *eager* to help you do things right. Make a mistake, even
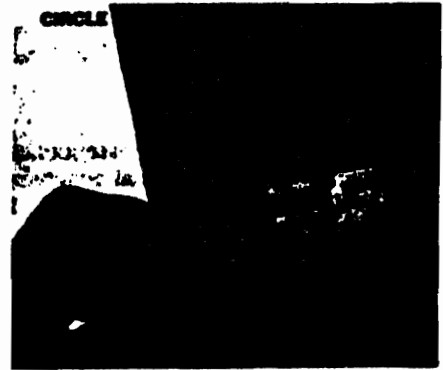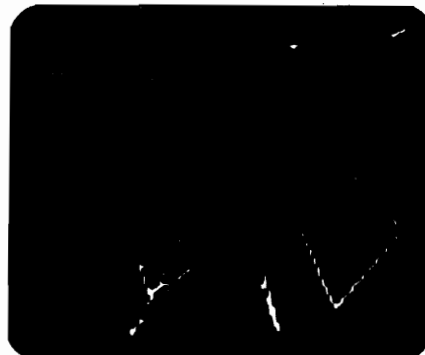
Left key pad has instruction keys and color programming keys to simplify operations.

The upper right keypad has all the editing controls to make programming very simple.

a one-letter spelling error, and the computer uses one of 30 different error codes to tell you what kind of error you made, even in what program line it occurred. An additional 36 error codes describe mistakes made during use of the File Control System when saving programs on floppy disks, or when loading the computer memory from disks.

You may not consider yourself a mathematician, but you will soon appreciate the Compucolor's capability to handle decimal numbers in all kinds of computations. Some other popular computers do only "integer" math and (legally according to computer practices) come up with disturbing answers like 3 divided by 2 is 1. You have to pay extra to fit these computers with decimal capabilities by purchasing special BASIC languages; that's not necessary with the Compucolor II. The advantage is that any number or symbol can be used in any mathematical expression without regard to its type. Numbers used must be in the approximate range from 10^{-88} to 10^{88}. In addition to integers and real numbers, a third format of numbers is recognized and accepted. This is scientific or "E-type" notation wherein a number is expressed as a decimal number times some power of 10. For example, the value $-3.47021E+08$ would be equivalent to $-347,021,000$.

Color Graphics. Plot Codes built into the Compucolor language provide programming shortcuts that make planning of graphs and other complex graphics a picnic rather than a hazardous trek

through a bug-infested programming jungle. Various plot codes enable you to quickly tell the computer what colors you want for backgrounds and for the images on them, when you want to make a graph, whether it is to be a horizontal or vertical bar graph, or perhaps a point-plotted curve, or when you have a "vector" display in mind. For example, you need write only six uncomplicated steps to generate a horizontal bar graph, in color, so that the varying bar lengths form a "sine wave" pattern.

If you tend more toward artistic than mathematical innovation, you'll revel in the opportunities to create original abstract art using the brilliant Compucolor colors. The same PLOT codes are very convenient for generating art forms consisting of kaleidoscopes of constantly changing colors as well as patterns.

CRT Display. The 8-color display provides 32 lines of 64 characters each, for a total of 2048 characters. There are two different character sizes available at the touch of a button. Plotting graphics of 128 by 128 include vector generating software. There are 64 standard ASCII characters plus 64 additional special graphics characters which have a resolution of 384 by 256, or 98,304 points. The usable screen area is 9 inches wide by 6¾ inches high.

The eight colors are brilliant, and even the smaller size characters are very legible. About the only fault I could find is a pin cushion curvature of the two vertical edges of the display, and one soon becomes accustomed to that small distortion. However, if you are finicky about such matters, Compucolor has a solution. In a *Users Group Newsletter* the company says: "It is possible for you to install a horizontal pin cushion kit that you can obtain by writing to the company, but we do recommend that your dealer perform the installation. This kit will largely eliminate the side curvature of the screen display and make the display appear more rectangular."

Mini Disk Drive. The Compucolor's mass storage Mini Disk Drive system uses 5¼-inch square Compucolor II diskettes having 40 tracks, 48 tpi track density, a power-on delay of 1 second, and a transfer rate of 76.8 Kilobits per second. The capacity is formatted at 51.2K bytes per side, and both sides of the diskette are usable.

To load a program from one of the pre-programmed floppy disks just open the door on the monitor, slip in the disk, close the door, and key the

AUTO button on the keyboard. In about four seconds the screen displays a "Menu" listing of programs on that side of the disk. You punch in the number of the program you want, hit RETURN, and within seconds the selection is up and running.

I ran into just a little difficulty saving my own programs on diskettes because I and the writer of the user manual seem to think on different wavelengths. But no matter. A telephone call to the dealer put things straight in short order. It all seemed much more complicated than it really was. While still new at floppy-disking, I can now save a program within about 40 seconds. Fast enough!

Tempting Software. The Sampler diskette that comes with the computer you buy will surely make you want many other Sof-Disks that are sold mainly at $36.00 per disk, although some are priced as low and high as $29.00 and $92.00 Actually, the cost per game, or whatever is on a disk, can be as low as four dollars, depending on the number of selections on a Menu.

Among the more popular games in the Sof-Disk library are Hangman, Othello, Chess, Startrek, Star Wars, various gambling games, car races, horse races and the like.

For more serious-minded computer hobbyists there are: personal finance, bonds, equity, personal income calculations, assembler, text editor, personal data base for creating your own data management system. Blank diskettes on which to save your own programs now cost only $9.95 for two—half the original price. You'll need a good supply of these, especially if you see yourself as a hot-shot programmer, because the manufacturer of Compucolor II will *pay you* up to $1,000 for a really good original program worth putting on a Sof-Disk!

Good Documentation. In the main, Compucolor II documentation ranges from good to excellent. The 145-page *Programming Manual* is packed with useful information. There's some easy introductory material for novices, but also much meatier chewing for more advanced hobbyists.

The even thicker *Maintenance Manual* is one of the best I have seen. My unit worked flawlessly from the moment it was plugged in, so there has been no reason to actually use the manual. However, there's no doubt but that every effort was made to provide a complete troubleshooting reference with everything from memory map to wiring diagrams; there are 22 double-page fold-outs in all.

There's also a handy *Instruction Manual* that conveniently summarizes essential programming commands, port assignments, key memory locations,

character sets, operation of the diskette unit, and identification of most important parts of the keyboard. If you happen to also purchase the Assembler diskette $45.00 you get with it a 68-page *Assembler Operating Manual* as a supplement to the floppy itself.

Incidentally, you'll find all kinds of fascinating programs and ideas in the *ColorCue* newsletter. Many are sent in by Compucolor II users. For example, the March '79 issue reveals a trick, not mentioned anywhere in the basic programming guide that comes with the computer, that enables you to combine the basic 8 colors to achieve 28 additional color tints!

The many excellent features built into the Compucolor II cannot of course be detailed in an article of this length. You will want to personally check out such capabilities as vector graphics, the peripheral interface that enables addition of extra hardware such as serial printers, and perhaps even use of the Compucolor as a data communications terminal. This may not be the universal and ultimate computer for every hobbyists dream, but you'd have to be dreaming pretty hard to find much to fault in this "Renaissance Machine." For more information about the Compucolor II, write to the Compucolor Corp., P.O. Box 569, Norcross, GA 30071 or circle number 54 on the Reader Service Coupon. ∎

HOBBY COMPUTER HANDBOOK

THE COMPUCOLOR II

A User's Report

by Blaise W Liffick
Photos by Ed Crabtree

After using the Compucolor II for several weeks, I've only just begun to learn about all the capabilities of the machine. In the area of vector graphics, I've discovered all kinds of things that aren't described in the documentation, and there are areas I've had to leave virtually unexplored due to lack of time. Each feature of this machine would take several weeks of careful scrutiny in order to review it as thoroughly as I'd like, so I'll present what I've discovered so far.

Hardware

Photo 1 shows the Compucolor II Model 5 with deluxe keyboard as delivered, with all disks and documentation purchased with the system. It uses a TMS 8080A microprocessor and has 32 K bytes of programmable memory. It has vector graphic capabilities in eight colors on a direct video monitor which displays 32 lines of 64 characters of text, or a resolution of 128 by 128 in

graphics mode. The character set includes the standard 64 character ASCII set plus 64 additional special graphics characters.

The most convenient feature is the single 5 inch floppy disk drive mounted in the right side of the display cabinet. Each formatted disk will hold 51.2 K bytes of data.

The unit I tested came with the deluxe keyboard (see photo 2). It has 117 keys, including 16 graphics function keys (labeled F0 through F15 at the top of the keyboard). It also has a numeric keypad at the right. The selection of colors is done via the keypad on the left.

The company literature describes the unit's input and output (I/O) ports, which include an RS-232C serial channel suitable for a printer or modem, and a 50 pin bus to be used for additional peripherals in the future.

Photo 3 shows the internals of the Compucolor II. Inside a standard television case is the power supply (bottom left of photo), main processor and memory board (bottom), video board (right), and floppy disk drive (upper left).

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Photo 2: The deluxe keyboard, $200 option with the Compucolor II. Its extra keys allow sophisticated interactive vector graphics and easy color selection.

Photo 1: The Compucolor II Model 5 with deluxe keyboard.

Photo 3: An inside view of the Compucolor II. The power supply for the entire unit is at the lower left of the photo.

The Compucolor II is quite portable, since its dimensions are those of a small color television, and the keyboard can be disconnected easily. I don't know the exact weight of the unit, but it appears to be approximately 45 pounds. The price of the unit as tested is $2200.

Software

Compucolor Corp has as complete a line of software as I've seen from any company. That goes for both system software and application programs. And it's obvious that their programmers enjoy using the powerful color commands available to them. Every program they provide seems to use color quite effectively.

BASIC is the native language of the Compucolor II. The dialect it speaks is summarized in table 1. It includes 30 keywords for program, editing, and command statements, 18 mathematical functions, 9 string functions, and 30 two-letter error messages. As nearly as I can determine, this is Compucolor's own version of BASIC, but it is essentially the same as the most well-known Microsoft versions. BASIC is contained in the machine's 16 K bytes of read only memory.

A disk operating system is provided in the form of a *file control system*, which is also in read only memory, and is accessed from BASIC by pressing the [(ESC)] and [D] keys, in that order. *(Note: in this article an item enclosed in brackets is one keystroke. For example, [CONTROL] indicates the control key.)* Table 2 summarizes the file handling commands. Once in the file control system, [(ESC)] [E] reenters BASIC without disturbing any programs. The file control system can also be entered under program control, making it possible to access data files, the disk directory, etc, from a program.

Photo 4 shows the character set of the Compucolor II in large size. A smaller character size (one half the size of the larger set) is also available. A line will hold 32 large or 64 small characters.

Also available are an 8080 assembler, text editor, and application programs including chess, Star Trek, Othello, and a math tutor.
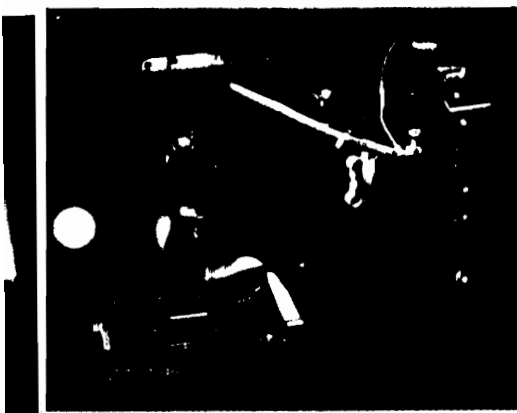
STATEMENTS:

Input and Output	Control	Definition	Execution Control		
READ	RUN	DIM	GOTO		
DATA	CONT	REM	IF	THEN	
RESTORE	LIST	DEF FN	FOR	TO	STEP
PRINT		CLEAR	NEXT		
INPUT			GOSUB		
GET			RETURN		
PUT			ON	GOTO	
OUT			ON	GOSUB	
INP			CALL		
			END		

OPERATORS:

Arithmetic	Comparison	Logical
=	=	AND
+	< >	OR
−	> =	NOT
★	< =	
/	>	
∧	<	

BUILT-IN FUNCTIONS:

Arithmetic	Transcendental	String	Miscellaneous
ABS	SIN	LEFT$	FRE
INT	COS	RIGHT$	POS
RND	TAN	MID$	
SGN	ATN	CHR$	
SQR	LOG	ASC	
	EXP	LEN	
		VAL	
		STR$	

OTHER FEATURES:

File Operations	Miscellaneous
SAVE	PEEK
LOAD	POKE
FILE "N"	PLOT
FILE "R"	WAIT
FILE "A"	
FILE "C"	
FILE "D"	
FILE "T"	
FILE "E"	

Table 1: A summary of Compucolor's BASIC commands. This version of BASIC is similar to that used by other manfacturers which was written by Microsoft. The notable differences are the CLEAR command, which is used to set up space for arrays and strings, the numerous FILE commands, the LIST command, which will either list an entire program or the program beginning at a specified line number to the end, and the PLOT command, used for the graphic mode.

Graphics

Without vector graphics, the Compucolor II might be just another computer. But the graphic capabilities make this machine quite versatile, and the brilliant colors can create exciting displays.

The graphic mode can be entered via either the BASIC PLOT command or through keyboard control. This allows the user to design graphics either automatically via BASIC or interactively in the graphic (CRT) mode, depending on the situation. To make this capability even nicer, an entire graphic display can be saved on disk using just a few BASIC commands. So you don't have to recreate a conplete display from scratch; rather, just load it in from the disk.

Photo 5 shows the range of the plotting capabilities of this machine. The display is 128 by 128 graphics blocks. Notice on the cross lines the resolution of the blocks used in this mode: somewhat coarser than is possible using the Apple II high resolution graphics, but much finer than, for instance, the TRS-80 graphic mode.

Color can be added to the display easily. Photo 6 shows an example of

```
COPY ... TO
DELETE
DEVICE
DIRECTORY
DUPLICATE ... TO
EXIT "FCS"
INITIALIZE
LOAD
READ
RENAME ... TO
RUN
SAVE
WRITE
```

Table 2: The file control system (FCS) commands. The file control system is entered by hitting [(ESC)][D] while in BASIC, and [(ESC)][E] to reenter BASIC.

the range of possibilities of the Compucolor II, with listing 1a showing how this box was designed under BASIC control, and listing 1b showing how the same display would be made interactively under the graphic mode.

The deluxe keyboard makes designing interactive displays much easier through the use of the vector graphics keys F0 through F15 (see photo 2). This keyboard is a $200 option, but if you plan on using the Compucolor II to design colorful displays, it would be well worth the investment.

Impressions

I ran into several difficulties while learning about the Compucolor II, its operating system, and its deluxe keyboard. Some of my problems arose from an incomplete understanding of the system, but others can only be attributed to areas overlooked by Compucolor.

The seemingly universal problem with company documentation has not been spared Compucolor. Although they go to greater lengths than many manufacturers in providing both hardware and software documentation, the most notable lack of information is ironically in the area of vector graphics, the strong point of the Compucolor II. While the descriptions of the BASIC commands and the interfaces of the machine were detailed abundantly, Compucolor provides only sketchy documentaion of the graphic functions. Also curious is the fact that the documentation provided for the vector graphics assumes graphic trol under BASIC, not graphic (CRT) mode. Thus, the steps shown in listing 1b took me many hours to discover. A table of the possible graphic characters, their ASCII values, and the location of each value as it is displayed on the screen is definitely needed. There should also be a table showing where each graphic character is located on the keyboard. The documentation leaves this as an exercise for the reader.
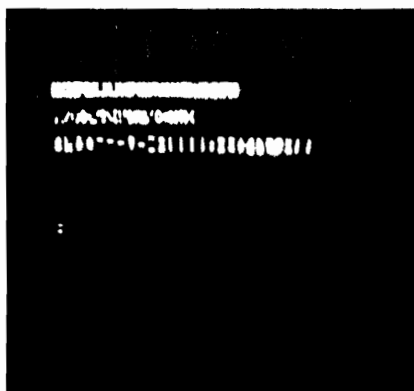
Photo 4: The character set of the Compucolor II. The characters were printed in large size. Note that there is a space between all graphic characters for clarity.
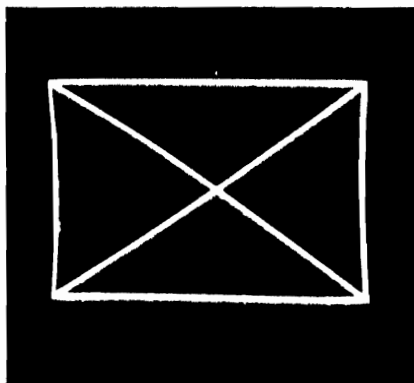
Photo 5: A demonstration of the range of the video display, 128 by 128 blocks. The resolution of the blocks is obvious from the cross line. Also note the slight aberration of the vertical sides of the square.
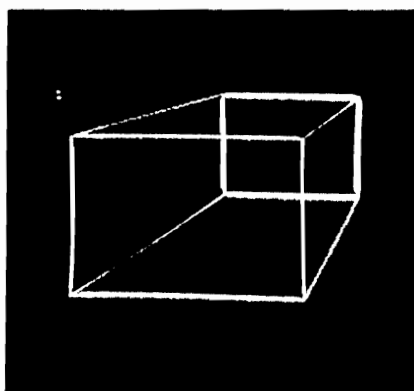
Photo 6: A demonstration of the added dimension that color and vector graphics give to a microcomputer. Listings 1a and 1b show the steps taken to produce this display.

In the area of software, I was also occasionally frustrated. In the application programs, the programmers could have been more careful to prevent the user from "bombing" the execution. Inputs inadequately screened and no keyboard lockout while the program was calculating were the two most common problems here.

In the area of systems programs, I ran into one major glitch. When the steps shown in listing 2 are followed, the system goes off into limbo and the only way to get it back is to reset. The problem becomes obvious when you become more familiar with the system, though. Listing 2 shows a BASIC program being loaded under the file control system. BASIC is subsequently reentered via the [(ESC)] [E] sequence. Now, the program just loaded, in this case MENU, can be listed, and you might even be allowed to execute it, but try to modify it and boom...limbo. What is wrong here is that the BASIC has its own load command for BASIC programs. Evidently the file control system should not be entered to load a BASIC program. I don't know if you are supposed to be able to load a BASIC program under the file control system, but apparently you can't. Again, this situation should have been caught by the programmer(s) who wrote the file control system.

From a hardware standpoint I found little I didn't like. The video display is clean and sharp; the machine is well laid out. However, the display does have a tendency to wave. This may be interference from the power supply. Whatever the cause, it is annoying, although eventually I learned to ignore it.

The only other problem I encountered with the video display was in Compucolor's choice of colors. I am slightly color blind and I had a particularly difficult time differentiating green from yellow and cyan (light blue) from white. But this appears to be not entirely due to my color deficiency, since others I know

```
 5    REM DRAW BOX THE COLOR OF THE PRESENT FOREGROUND COLOR
10    PLOT 2,64,64,242,64,122
20    PLOT 242,122,122,122,64,64,64,255
30    PLOT 29,20: REM CHANGE COLOR TO BLUE
35    REM DRAW BLUE BOX
40    PLOT 2,97,97,242,97,4,4,4,97,97,97,255
50    PLOT 29,17: REM CHANGE COLOR TO RED
55    REM DRAW RED CONNECTING LINES
60    PLOT 2,4,97,242,64,122,253,4,4,242,64,64
70    PLOT 253,97,97,242,122,122,253,97,4,242,122,64,255
80    END
```

```
(the CAPS LOCK key is in the off position)
[CPU RESET]                         (enter CRT mode)
[CONTROL][B]                        (select interactive graphics mode)
[@][@]                              (plot the green box)
[F2]
[@][Z]
[Z][Z]
[Z][@]
[@][@]
[F15]                               (get out of vector graphics mode)
[CONTROL][FG ON/FLG ON]             (select new color)
[CONTROL][T]                        (for blue color)
[CONTROL][B]                        (reenter graphics mode)
[A][A]                              (plot blue box)
[F2]
[A][DELETE LINE]
[DELETE LINE][DELETE LINE]
[DELETE LINE][A]
[A][A]
[F15]                               (get out of graphics mode)
[CONTROL][FG ON/FLG ON]             (select new color)
[CONTROL][Q]                        (for red color)
[CONTROL][B]                        (reenter graphics mode)
[DELETE LINE][A]                    (plot connecting lines)
[F2]
[@][Z]
[F13]
[DELETE LINE][DELETE LINE]
[F2]
[@][@]
[F13]
[A][A]
[F2]
[Z][Z]
[F13]
[A][DELETE LINE]
[F2]
[Z][@]
[F15]                               (done)
```

Listing 1: The listings shown here will display a 3 color box, as shown in photo 6. Listing 1a is a BASIC program which draws the display, and listing 1b is the keystroke sequence (with the [CAPS LOCK] key off) used in the interactive CRT mode which accomplishes the same thing as the BASIC program. In listing 1b, an item enclosed in brackets, [item], is one keystroke, and the [CONTROL] key is pressed simultaneously with the next key listed.

```
[(ESC)][D]                          (enter FCS)
>FCS: LOAD MENU                     (load a BASIC program)
>FCS: [(ESC)][E]                    (reenter BASIC)
10   REM CHANGING A LINE IN MENU CRASHES THE SYSTEM
```

Listing 2: The steps followed which totally "crash" the system. The point here is that the file control system should not be used to load a BASIC program, since BASIC has its own LOAD command.

who are not color blind also had difficulty telling these colors apart. I first noticed this problem while playing Compucolor's Star Trek game. On the long range scan of the galaxy, the number of stars in a quadrant shows up as yellow. If there is a star base in that quadrant, the number of stars is green instead. The first few dozen times I played the game I was soundly beaten because I couldn't find the star bases. A change to line 45 of the program to make the number of stars in a quadrant show up as blue and the star bases show as yellow fixed this problem quite easily, however.

I don't want to give the impression that I have only negative feelings about the Compucolor II. On the contrary, I found some incredible nuggets of unknown features by playing around with the keyboard. For instance, the [COMMAND] key can be used to print out a complete BASIC keyword. The sequence [COMMAND] [T], for example, prints the keyword LOAD, and [COMMAND] [TAB] prints RUN. Very handy, making it unnecessary to type out all those keywords when entering a program by hand. Unfortunately, this feature appears to be undocumented, so it's trial and error for a while until you get the hang of it. But this illustrates some of the unique planning that went into this machine.

Conclusions

As I said earlier, to discover and describe all the features of this machine would take months, so this is where I'll stop. The Compucolor II is an extremely versatile machine and deserves ranking with the big three off-the-shelf computers (Apple II, TRS-80 and PET). Don't overlook this machine when you get ready to buy. ■

A complete line of available software and documentation is available from the Compucolor Corp, POB 569, Norcross GA 30071.