Computer Clones
Automatic Video Game/TV Antenna Switching
How To Print Computer Graphics
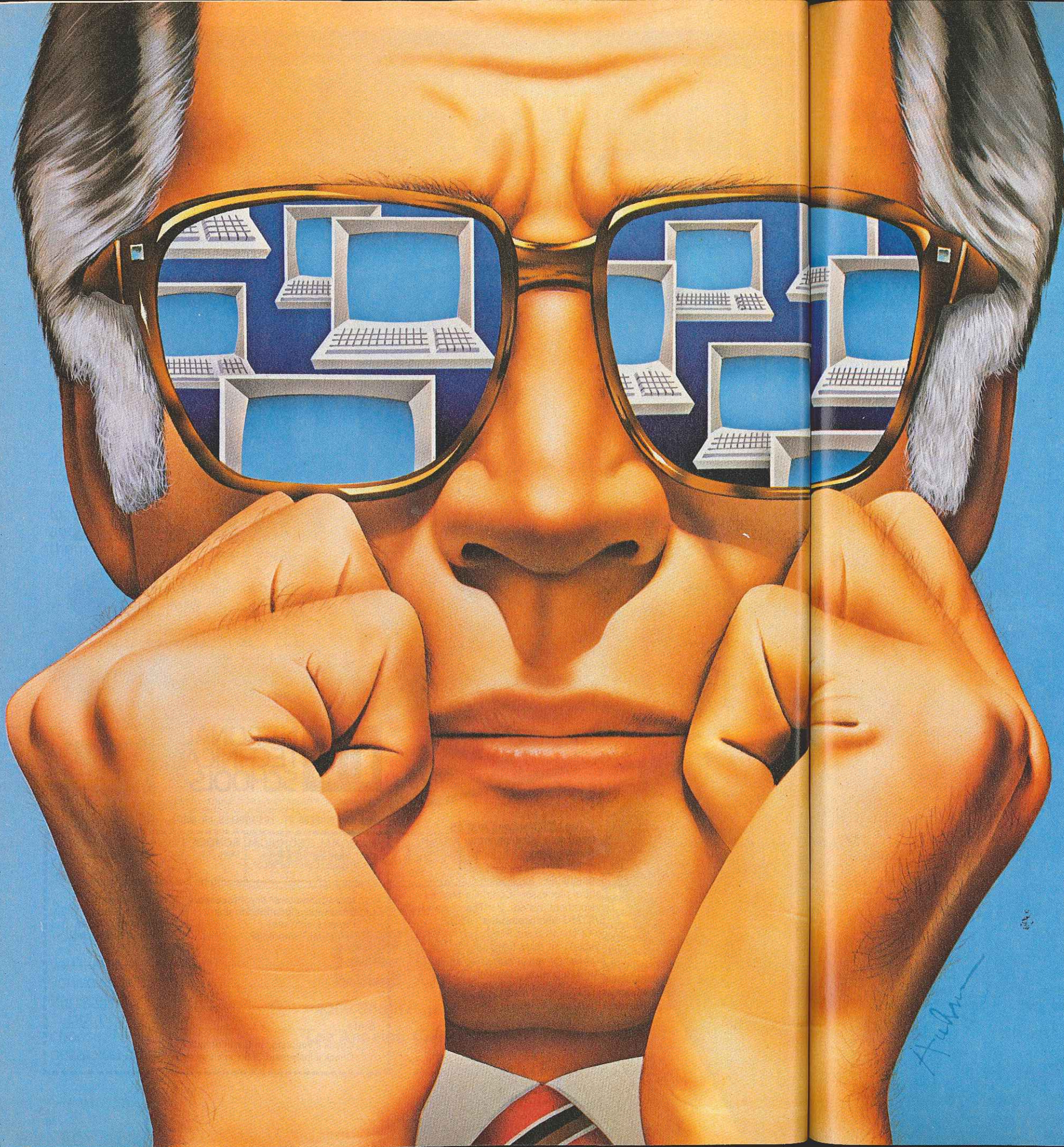
Polish Your Apple with a Luminance Board

Tested in This Issue:
SL-5 Linear-Tracking Turntable
McIntosh MA-6200 Integrated Stereo Amplifier
Teknika 19" Color TV Monitor

COMPUTER CLONES

Comparing computer variations with their originals—TRS-80 Apple II, and IBM-PC

By Stan Veit

Technical Editor

IMITATION is the sincerest form of flattery, the saying goes. But don't expect makers of personal computers that dominate the field to look kindly on computer "clones" of their products. These functional copies run the same software as the originals and, in most cases, interface easily with the same peripherals. Are the copycat machines cheap imitations? Are they better than the originals? To answer these and other questions, here are the results of our detailed examination of many such models.

TRS-80 Clones

Tandy's TRS-80 Model I was a pioneer product that quickly spread the personal computer gospel across the nation through its easy sales availability in many thousands of Radio Shack stores. The machine's great popularity spurred an enormous number of small entrepreneurs to develop and sell software programs for use with the Mod I. And hardware makers took advantage of some of the Mod I's design shortcomings by making available select improvements such as adding lower-case letters, making cassette-tape loading easier, etc. Better or less costly peripherals for the Mod I were also developed by independents.

As time progressed, Radio Shack began to catch up with improvements and enhancements for the Mod I, until it was finally displaced by the company's Model III, which might be considered an upgraded, all-in-one Model I.

Meanwhile, other brands that use the same software material sprang up to emulate Radio Shack's original products. Here are what two leading types are all about.

The PMC-80 Computer. The PMC-80 is a TRS-80 Mod I clone that is made in Hong Kong and imported into the United States by Personal Microcomputers of Mountain View, CA. It is a Z80-based computer that is functionally identical to the TRS-80 Mod I but has no physical resemblance to the Radio Shack computer. The console unit has simulated wood sides and a front panel on which are mounted the keyboard and a built-in cassette recorder. It includes either 16K or 4K of RAM memory. There is also a PMC-81 model that includes a numerical keypad in place of the built-in cassette recorder. Since both machines are otherwise identical, we shall only discuss the PMC-80.

Although there is a video interface supplied with the computer, no video display comes with the machine. The user can employ either a monochrome video monitor or a built-in r-f modulator and a TV set. This dual output concept is also carried over to the cassette mass storage facility. There is a DIN connector on the rear panel to connect the standard Radio Shack TRS-80 cassette cable. This is used to connect an additional recorder or, in the case of the PMC-81, the prime recorder.

The PMC-80 allows for a choice of two video formats. There is a 64-character display and an enlarged 32-character display for use with TV sets. The selection of video formats is done with the VIDEO CUT button on the rear panel. When the computer is turned on, the 64-char-

acter display is in force. When the VIDEO CUT button is pressed, the 32-character format is selected. In this mode, the PAGE button on the front will select either of two possible pages of video display.

The keyboard includes the following special function keys:

PAGE—Displays either the left half or the right half of the video display when in 32-character format.

F_1—Controls the cassette recorder and isolates it from the computer during fast-forward and rewind operations.

BREAK—Stops program execution and returns control to the active command mode.

NEWLINE—Enters line of program or data.

BACKSPACE—Cancels the character previously typed.

The cassette recorder mounted on the front panel is equipped with a three-digit counter and a VU meter for setting the audio level during record or playback. The latter greatly improves data loading accuracy. The optional secondary data recorder is used to read data files into the machine and record them on another file after processing. The quality of the built-in recorder

surprised and pleased us. We loaded commercial tapes from several software publishers and tapes we had made on another recorder. Using the VU meter as a guide, we were able to load the programs and data without a single bad load! Using the secondary cassette recorder (one we used with a TRS-80 Mod I) we had some trouble setting the level; but once set, the loads were very reliable.

Both memory expansion and I/O are accomplished by connecting the computer to the company's EXP-100 Expander, the same method used with the old Mod I's interface adapter. The Expander has provisions for adding additional RAM memory, external disk memory, and I/O devices. Sixteen sockets have been provided to permit the installation of 4116 dynamic RAM chips to expand the internal memory from 16K to 48K, the maximum the system can use. This is identical to the TRS-80 Mod I.

The memory map of the PMC-80 uses memory area from $0000 to $2FFF (0 to 12,287) for ROM-based programs such as the system monitor and Microsoft BASIC. The area from $37FFF to $3800 (14,335 to 14,336) is used for the keyboard. The video display area occupies the memory locations from $3C00 to $3FFF (15,360 to 16,383), while 16K of RAM in the

computer unit is located from 3FFF to 7FFF.

The PMC Expander interface can handle from one to four single-sided drives. It can also be wired to handle double-sided drives; but in that case, one double-sided drive takes the place of two single-sided drives. The disk drives offered by PMC are made in Japan by TEC. They are 40-track units capable of 102K of formatted data in single-density or 184K of formatted data in double-density. The PMC company does not sell a doubler for double-density, but either the one made by Percom or the one made by LNW can be used. The interface does have a built-in data separator, which corrects a major deficiency in the Radio Shack TRS-80 Mod I. We found the TEC drives to be quiet and reliable.

The parallel interface in the expander is Centronics compatible and works with all of the popular printers with this type of interface. We used it with Epson printers and with the TP-1 from Smith Corona. If an RS-232C interface is needed, it is supplied as a $95 option. The PMC bidirectional serial interface is a board that plugs into the Expander main board and features the ability to set the baud rate in software. Another interesting option available with the Expander is the S-100 board interface. This provides slots for two S-100 cards. Personal Micro Computers Inc. supplies manuals printed by the manufacturer in Hong Kong. They are adequate for setting up the system and for operation, but offer no technical details for maintenance.

We liked using the PMC-80 Computer. It loaded software from both disk and cassette without errors and repeats. A person who is used to the original would feel completely at home with this machine, and one just starting with comput-

The Hyperion is a 20-lb portable with 7" screen and two 5¼" disk drives which run PCDOS.

ers should have no trouble setting up and using this system. There's no doubt that the PMC-80 is significantly better than the TRS-80 Mod I was. However, since the I is no longer available, one has to pit the PMC-80 against the TRS-80 Model III.

Total price of the units required to equal the capabilities of the TRS-80 Mod III comes to a little over $2000. This is just $225 less than the price of a TRS-80 Mod III at the local Radio Shack store. While the PMC-80 may sell for a lower price at its dealers, it seems to us that it lacks one important feature: the support that one gets from Radio Shack. The manuals, availability of repair service, and software support are worth a lot of bucks to many people.

The LNW80 Computer. Whereas the PMC-80 is a clone of the TRS-80, the LNW80 can be considered as the answer to the wish list of the owner of a TRS-80 Mod I or III. This machine was designed to supply all of the nice things that are

On this page are the Apple II computer and its clone, the Franklin Ace 1000. On the facing page are the Radio Shack TRS-80 and two clones: Personal Microcomputer's PMC-80 and the LNW80, made by LNW Research Corp.

lacking in both TRS-80's. In fact it can compete on some counts with the TRS-80 Mod II. It is a machine that can be many things to different people. For the new user, it can be a cassette-based beginning computer complete with built-in Microsoft BASIC and with the capacity to grow with the experience of the user. For the advanced TRS-80 users, it is a computer that will give color graphics, and the possibility of using 8" disk drives without giving up the operating system and software they are used to.

Physically, the LNW80 is a neat metal-cased machine with a full keyboard (upper/lower case) in-

cluding a 12-key numeric keypad. All the connectors and switches are located on the rear panel and they include both parallel and RS-232C serial connectors, video outputs for monochrome, NTSC color and RGB color. The floppy-disk system has both single- and double-density controllers and provisions for either 5¼" or 8" drives. It is designed to run any of the popular disk operating systems that have been written for the TRS-80 computers. Furthermore, it will also run either Mod I or Mod III software. The cassette storage system will operate at either 500 or 1000 baud, and can use the same cassette

recorder and cable supplied with the Radio Shack computers.

Internally, the LNW80 uses a Z80 microprocessor with a 4-MHz clock. Interestingly there is a switch on the rear panel to reduce clock speed so that the computer can run the TRSDOS operating system from Radio Shack which is designed to run with a 1.77-MHz clock. The LNW80 is equipped with 48K of user RAM memory and a 12K ROM containing the Microsoft BASIC interperter and 1K for the video screen. In the graphics mode the BASIC is switched out and 16K is used for graphics.

The LNW80 has three versions of the BASIC language available and they can be used for different conditions. First, there is Microsoft Level II BASIC, which is in the 12K ROM. This is identical to the Level 2 used in Radio Shack TRS-80 computers. The second BASIC is a DOSPLUS 3.4 Tiny BASIC, which is on the DOSPLUS diskette. It provides an extension to the Level 2 BASIC and adds disk file handling, advanced keyboard I/O, instring search commands, and user-defined BASIC commands. DOSPLUS Extended Disk BASIC is also on diskette and it adds other features to the DOSPLUS BASIC.

LNWBASIC is supplied on a separate single-density diskette and it provides 40 additional commands to the other BASIC versions. It is the language that controls the high-resolution graphics and color, machine-language calls, sound commands, print spooler, RS232 communications from BASIC, and do/until constructs. It is LNWBASIC that gives this computer much of its power! Although DOSPLUS is supplied with an LNW disk system, the computer is capable of running NEWDOS, NEWDOS80 or LDOS, as well as TRSDOS.

Video display of the LNW80 may be either an RGB color monitor, an NTSC color monitor, or a high-quality monochrome monitor. An r-f modulator and a TV receiver can also be used with reduced screen width. The computer has the capability of displaying 80 characters by either 16 or 24 lines; 40 characters by either 16 or 24 lines; 64 characters by 24 lines; or 32 characters by 24 lines. The exact video display format depends upon the selection of software. The 80- and 40-character displays are only

available to users of disk operating systems when the applicable driver programs are run. In addition, these drivers have limitations—they cannot be used in word-processing applications unless the software has been specially configured for that purpose.

The LNW80 is equipped to display both upper- and lower-case characters without modification once the proper driver programs are executed. This does not apply to the use of any of the standard disk operating systems or word-processing software systems that have their own internal drivers for the upper/lower case functions.

The LNW80 Computer has the capacity to use up to four disk drives. These may be either $5^1/_4$" or 8" drives, a combination of both, or even hard disk drives. Dual-headed drives (two read/write heads) may also be used; but in this case, only three disk drives can be connected. The diskettes may be formatted for either single- or double-density. This gives users who have accumulated a great deal of single-density software the ability to expand from the original TRS-80 Mod I or Mod III. The possibility of using existing software and at the same time expanding disk capacity is one of the most attractive features of the LNW80. It can also operate with any of the popular disk operating systems such as TRSDOS, DOSPLUS, NEWDOS, MULITDOS, LDOS, and VTOS.

The LNW80 is not a cheap computer. It is thoughtfully designed and well made in the United States. The base computer unit, which includes 48K user RAM, the disk controller, upper/lower-case keyboard, complete data and video I/O, cassette interface, and all the graphics and color features, costs $1695. To use the computer, you must add a video monitor and a disk system, plus the DOS and LNWBASIC software. An average black-and-white system will cost over $3000 while a color monitor will add from $250 to $750 to this price. A new model that will add CP/M capability (additional memory and CP/M software) will cost $2495 for the base unit. Although there are a few dealers, at this time, the machine is sold through mail order directly by LNW Research Corporation, Tustin, CA 92680.

The LNW80 does not appear to be a machine for the first-time computer user. Features such as color and graphics are not easy to use since they require the use of specialized software to initialize and run them. However, for the software developer, graphics artist, and advanced computer hobbyist, this machine offers all the things they always wanted in a TRS-80 type of computer. We do not think the business user will find a machine with as little support as the LNW80 very practical, though. With the proper back-up from a systems house, however, this should prove to be a powerful tool that's rugged, versatile and expandable.

Apple Clones

The Apple computer was also an early entry in the personal computer stakes. Its product distribution was largely through independent retail stores. Today, the Apple II is one of the most popular and useful small computers built. It employs a 6502 microprocessor in contrast to Radio Shack's Z80 CPU, and contains a lot of complex programs in ROM that make color, graphics, and audio easy for a user to learn and apply. Until recently, though, functional copies of the Apple II were not produced. Now at least two compatible brands have appeared, as well as blatant replicas being manufactured and promoted in the Orient. Let us examine the two types promoted in the U.S., the Franklin Ace Computer and the Basis Computer.

Franklin Ace 1000. The Franklin Computer Company's Model Ace 1000 is not only a functional copy of the Apple II+, but it has also been designed to look like the Apple II+. It has almost all the features of the the Apple II+ except color and a cassette interface. Moreover, it includes some features that the Apple lacks unless it is modified (like printing upper- and lower-case characters) and 64K of RAM.

To a large section of the computing public, the addition of color is "frosting on the cake." Certainly graphics and games look much better in color than in monochrome but color isn't needed for accounting applications, spreadsheet applications, or word processing; neither do file management programs or data bases. Nevertheless, a Franklin spokesman advises that all of its users who want color will have that option soon. The audio cassette was omitted because it was not considered to be an effective mass storage system for anything more complicated than games. It lacks a file structure and takes too long to load business programs.

Since Apple terminated many distributorships and mail-order retailers, there has been a ready market for the Franklin Ace Computer. The first model was the Ace 100, which was built into a standard case. Apple Computer sought an injunction to stop its sale, but that threat seems to have been eliminated by the courts. The company's new Ace 1000 features a sturdy new plastic case.

Like the Apple II+, the Ace 1000's case has a snap-off lid. Removing the lid, you will see the switching power supply on the left. It has plenty of power for all the extra boards you may plug into the computer. There is a fan built into the front of the power supply to prevent overheating.

The Ace main circuit board is somewhat larger than the Apple and it contains 64K of user RAM rather than 48K. Both units have eight slots for plug-in cards and a joystick/paddle connector for game controls.

The Ace 1000 keyboard has excellent quality and feel. It has typewriter styling and includes an illuminated Alpha shift/lock and a keypad with both numeric and special Visicalc markings. On the left side of the keyboard are four keys marked ESC, BREAK, PAUSE, and CTRL. Locating the BREAK adjacent to the ESC key might cause problems with some software; however, the location of the CTRL key is an unfamiliar positioning that takes

some time to get used to if you have some prior computer experience. There are five keys that must be typed differently on the Ace-1000 as compared to the Apple II, including some common symbols like brackets. Due to these differences and the upper/lower-case type, some Apple II programs must be re-configured to run on the Franklin computers. Thus, the user will have to check carefully before buying Apple II software for the Ace 1000. This type of minor difference can assume major proportions when software with a lot of color commands is run.

The RESET key on the Franklin Ace has been placed in a position where it is easy to get at, but impossible to hit accidentally, the latter being an annoying occurance on the Apple. Franklin installed it on the underside of the keyboard, on the left-hand side.

The DOS supplied with a Franklin disk system is completely compatible with Apple DOS 3.3; it even has the utility to run the older 13-sector Apple diskettes. It contains both floating point BASIC (FPBASIC) and integer BASIC (INTBASIC). The copy of FPBASIC on the disk is only on the disk for diagnostic purposes since the identical BASIC is always stored in the machine. The INTBASIC is automatically loaded into the computer at power-on. Once it is read in, it usually stays in memory until the power goes off. Franklin has collected a group of utility routines into a program called FUD (Franklin Utility for Diskettes). When FUD is run, it gives the user a Main Menu from which utilities can be selected to copy, delete, lock, unlock, or verify files, and to format diskettes and make a master diskette. FUD is a very handy concept because it gives single-key entry to several interrelated programs.

We liked using the Franklin Ace. It is a well-designed computer. Of course it is much easier to "reverse-engineer" a machine to correct the faults of a model than it is to conceive a completely new design. The suggested price of the Franklin 1000 is $1530 and the disk with controller is $579. However, the actual selling price in stores is much less. The price of the Apple II with comparable equipment is about $250 higher.

Basis-108. The Basis-108 is an Apple II+ compatible computer since it runs Apple II software and has six slots for the use of Apple II boards. It cannot really be called an Apple copy, though, since its configuration is not based upon the Apple II design and because Apple II software is only a portion of its software library. Its features and utility go beyond what the Apple II can offer.

Basis was originally Apple Computer's distributor in West Germany and it worked with Apple on design of a Euro-Apple that was never built. Apple took over the distributorship in Europe as they had in the United States, and Basis proceeded to produce the Basis-108 in Germany. It is sold and supported in the U.S. by Basis Inc. of Scotts Valley, CA.

The Basis-108 looks somewhat like the IBM-PC, with a rectangular computer unit having disk drives in the front. The video monitor sits on top of the computer unit and the attractive low-profile keyboard is a detached unit connected to the computer unit by a five-foot, coiled cord.

The Basis-108 is equipped with both 6502 and Z80 microprocessors, with up to 128K of RAM memory on a large main circuit board. The memory is split into two banks of 64K each and bank switched as required during processing. The system has a monitor program occupying 2K of ROM and 5 additional sockets for additional ROM or EPROMs for a total of 10K of ROM memory. There is provision for internal mounting of two disk drives. Either Apple drives or other compatible drives can be used. All the system power, video and I/O connectors are located on the rear panel. These consist of power input, two switched-power utility sockets, one DB25 connector for keyboard I/O, two DB25 connectors for system I/O, three video connectors for composite video, one DB9 connector for RGB video, and one DIN connector for cassette I/O. The rear panel also has three additional slots for extra DB25 connectors.

The low profile, detached keyboard is among the nicest of this genre we have seen. The keyboard consists of 100 keys that are divided into four groups according to function. There is the standard ANSI typewriter keyboard group, a numerical keypad, a cursor control block, and programmable function keys. The keyboard is decoded by a ROM on the main circuit board, and the keyboard configuration can be changed by changing the ROM.

The Basis-108 is compatible with Apple II+ software and runs CP/M.

The Basis-108 has a wide range of video dispays. There are two text modes and three color graphic display modes. The text display can be either 40 columns by 24 lines or 80 columns by 24 lines. The graphics display can be 40 horizontal by 48 vertical with 15 colors; 80 horizontal by 48 vertical with 15 colors; or 280 horizontal by 192 vertical with 6 colors. It is also possible to have high-resolution graphics and up to four lines of text. The video display can be either black-and-white composite video, composite color video, or RGB color video. There is also a built-in loudspeaker for sounds and music programs.

The Apple DOS is supplied with the disk system; either the standard Apple DOS 3.3 can be used or one supplied by Basis that is menu driven but otherwise identical to Apple 3.3. The CP/M disk is supplied by BASIS with a BIOS designed for the BASIS-108. Microsoft BASIC is built into the system.

The Basis-108 represents an alternate upward path from the Apple II. Some dealers report that there are customers who are trad-

Columbia Data Products' 8088 Multi-Personal Computer, an IBM clone.

ing their Apple II computers for the Basis-108. Several users have said that this is what the Apple II's successor should have been.

The Basis 64K unit with no drives, but with a cable set and game paddles, sells for $2050, not a bad price if you add up all the equivalent options being supplied. The 128K Basis costs $2350. A 64K Apple computer with one drive and 35 tracks costs $2625, with two drives, $3100. A 128K Basis-108 with two drives "lists" for $3400. These prices do not include the video display, which will add from $150 to $995, depending on selection. These are suggested prices from Basis Inc. Selling prices in the stores will vary a great deal, of course. In any event, the Basis-108 is a good-quality product, has exceptional versatility, and, expectedly, does not come cheap. Having a 6502 CPU with Apple compatibility down to the card slots plus a Z80 CPU with CP/M certainly offers a world of computing opportunities in a single system.

IBM-PC Clones

The IBM Personal Computer has now been on the market for one year and has become one of the best-selling machines in the industry. IBM has limited the number and location of computer stores and dealers selling its machine thus far. It is likely that the IBM PC compatible market will become a large part of the microcomputer business, with many companies building boards to plug into the IBM-PC and writing software to run on these machines. Some companies are also building functional clones of the IBM-PC Computer. It is difficult to define just what an IBM-PC clone is because this computer does not come with bundled software. IBM offers a choice of operating systems, all of them being written by other companies. The most popular DOS has been PCDOS, also known as MDOS or SB86 DOS. Running second and third are Digital Research CPM/86 and the UCSD-P System. Phase One Oasis 16 is also being offered for the PC.

We cannot define every computer with an 8088 CPU that runs the same software as the IBM-PC as a clone, anymore than all the different machines that run CP/M are clones. We will therefore define an IBM-PC clone as a computer that uses either an 8088 or an 8086 CPU, runs the same software, and uses the same plug-in circuit boards as the IBM PC. There are several of these either in production or about to go into production.

The Hyperion Computer. From Dynalogic Info-tech of Ottawa, Canada, this is a 20-lb portable computer with a 7″ amber screen, two 5¼″ disk drives, a detached keyboard compatible with the IBM PC keyboard, and 256K of RAM. The Hyperion is one of the outstanding designs in portable computers as well as a very powerful computer.

The CPU is the 8088 16-bit processor and there is provision for the 8087 floating-point processor. The 256K user RAM is equipped with parity checking and there is also a 20K video RAM and an 8K ROM containing diagnostics and the monitor program. The display has 25 lines of 80 characters with five pages of display data. The character set has 256 characters, includ-

ing Greek, foreign language special characters, and mathematical symbols. The graphics display format is 640 dots wide by 250 (or 200) dots high, fully addressable array; or 320 dots wide by 250 (or 200) dots high, with 4-level grey scale. The I/O includes the RS-232C standard with an asynchronous 75-to-19.2K baud rate or synchronous 100K with bisync and bit-oriented protocols. The parallel port is compatible with IBM/Epson or Centronics printers.

The Hyperion system also includes a built-in 300-baud modem with auto answer capabilities. The CRT and the disk drives automatically shut down when not in use to conserve energy and prolong life. Other features include a time and date clock with battery back-up, a programmable sound system, and an optional expansion chassis with a 10M-byte Winchester cartridge drive and four IBM-compatible I/O slots. The keyboard fits into an opening at the bottom of the computer and the whole thing fits into a vinyl traveling case.

The software for the Hyperion includes MS DOS, Microsoft Advanced Disk BASIC, Microsoft Multiplan electronic spreadsheet, an Executive text editor and electronic mail system, a telephone management system, and optional languages including Pascal, CO-BOL, FORTRAN, and a BASIC compiler.

The Hyperion contains everything one could possibly want in a small computer, with the added advantage of being portable. The only drawback is the price; the Hyperion costs $5000. This is not high if all the features provided are considered; but since the equipped IBM-PC costs about $1000 less, it will appeal only to those who need IBM compatibility in a portable machine.

The Eagle Computer. The BC1600 series of computers made by Eagle uses the Intel 8086 16-bit microprocessor and is compatible with the IBM PC. The single-user Model 1610, offers 128K of user RAM and an 8088 CPU running at 8 MHz. It has two built-in disk drives with a total of 1.6M bytes, formatted. The Eagle is built into an integrated cabinet which contains the central processing unit, 12″ video monitor, full keyboard with 95 keys including 14 with user-designated functions, and the disk system. All I/O connectors are on the rear panel and they include both RS-232C serial and Centronics compatible parallel ports. The Eagle BC1600 series also has provisions for adding up to seven IBM-compatible plug-in boards. Color graphics is available as an option. The single-user BC1610 runs MS-DOS or CPM-86 as an operating system. Oasis-16, Xenix and IRMX-86 operating systems are also available as options.

The Model 1630 offers 512K bytes of user RAM with integral floppy and hard disks for a total storage capacity of 10M bytes. The Model 1630 also contains asynchronous serial ports to support up to eight local or remote terminals. The Eagle Model BC1630 is the only IBM-PC compatible unit we have seen that is equipped for multi-user operation.

The single-user Model 1610 will sell for around $5000 complete except for software, while the multi-user Model 1630 will sell for about $9000. At the time of writing this article, the final prices had not yet been set.

We did not have a chance to test the Eagle BC1600 series since only the prototypes had been completed in time for the Comdex show in Atlantic City. We did have a chance to operate the Model 1610 at Comdex. In all, we found it to be as promoted. The Model 1630 as a multi-user IBM-PC clone will appeal to businesses with distributed workstation requirements.

The Columbia 8088 Multi-Personal Computer. Columbia Data Products has introduced a computer that seems to be a clone of the IBM-PC in appearance as well as function. The Model 1600-1 is an 8088-based computer with 128K of RAM, two RS-232C serial ports, a Centronics-compatible parallel port, and dual floppy disks with 640K bytes of storage. The computer has a detached keyboard and slots for up to eight IBM-PC-compatible plug-in boards. The Model 1600-1 has a suggested price of $2995, a low price considering the features offered. The Winchester technology hard disk models, 1600-2 and 1600-3 are equipped with a 320K floppy disk and either a 5M- or 10M-byte hard disk. These units feature a cache-buffer hard-disk controller with an independent 64K processor system that provides enhanced disk access performance in both single- and multi-user configurations. The 1600-2 has a suggested price of $4995 and the 1600-3 has a suggested price of $5495. These computers were displayed at the Comdex Show, but were not available for test at the time this article was written. They appear to take the concept of the IBM-PC one step beyond the single-user computer.

Conclusions

There seems to come a time in the development of every branch of the electronic industry when a leader is established and all the other manufacturers devote their efforts to copying the leader. After that the public has a choice between tweedledee and tweedledum. This seems to be happening in the personal computer industry, especially in the portion of it that is concerned with making desktop units.

Until now the computer industry has been marked with spurts of great innovation as manufacturers rushed to build machines using the newest microprocessors. With the availability of such advanced microprocessors as the Motorola 68000, the National 16000, and the Z8000, it would indeed be a shame if computer manufacturers simply restricted their output to copies of popular machines. There is some reason to build TRS-80 or Apple II clones if they contain advanced features not found in the originals and also make use of the vast stock of available software. However, we see no reason to build IBM-clone after IBM-clone during a time when volume deliveries of IBM-PC's are just underway and there is no great store of software. ◇