Photo 1: *The BMC if800 computer. Shown here is the basic machine consisting of a keyboard/processor module, two floppy-disk drives, a color video monitor, and a unique built-in printer. Notice the 10 "super-function" keys along the bottom of the display screen. These are fully programmable function keys that can be used for menu selection or other forms of interaction in programs.*
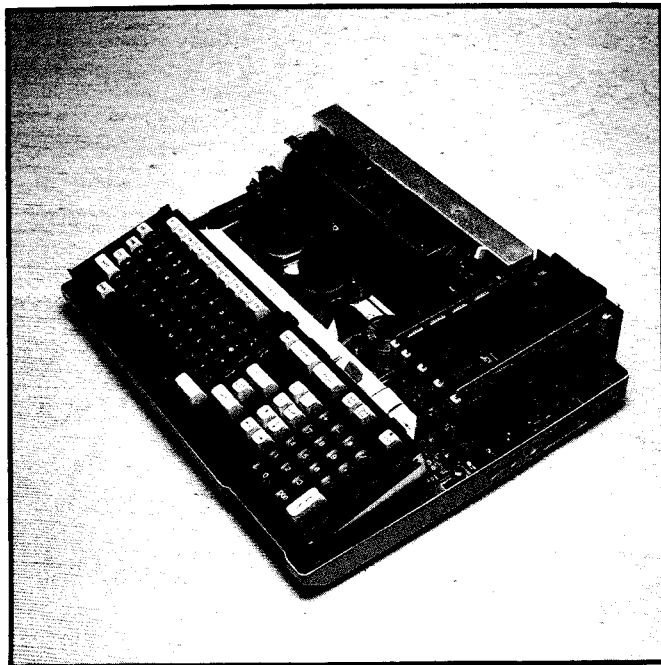

Photo 2: *Inside the keyboard unit of the if800. The built-in printer mechanism is clearly visible. The printer can operate as either friction-feed or tractor-feed, and produces a high-quality dot-matrix output.*

Photographs accompanying this article, except photo 6, were taken by Paul Avis, photographer, and Pauline Elkin, stylist.

BMC if800

The prize for the most computer in the smallest package goes to the if800 Model 20 computer, manufactured by the Oki Electric Company of Japan. But since it is marketed in this country by BMC Computer Corporation (which has its office in Carson, California—the abbreviation stands for Business Machines Corporation), we refer to it as a BMC product to avoid confusion. Although it is billed as a personal computer, it will receive much consideration as a small-business computer because it has high-resolution color graphics, support for Digital Research's CP/M operating system, a built-in printer and floppy-disk drives, and a very high-level BASIC language all as standard equipment.

Hardware Overview

The basic if800, shown in photo 1, consists of two pieces, one mounted above the other. One module contains the processor circuitry, the keyboard, and the printer; the other module contains the video-display screen and two 5¼-inch floppy-disk drives. The two modules are connected by two cables, one for the monitor and one for the disk drives. The combined system is sufficiently compact to fit well on even the most crowded table.

Keyboard

The 98-key keyboard is very solid and has a nice typing feel. In addition to tactile feedback, you receive audio feedback with every key depression in the form of a faint click from the speaker under the keyboard. If a key is held down for more than a second, it automatically repeats the typing of its character, along with audio feedback.

The 98 keys are separated into several groups: a typewriter-keyboard section, 10 program-assignable function keys, 8 editing keys, a numeric keypad, and several special keys. The special keys include keys for setting tabs, a CAN (cancel) key (which erases the line currently being typed), and three keys for controlling the printer. The typewriter section also has a GRAPH key (for accessing a set of special graphics characters, such as card symbols and line-drawing characters) and a COMD

key that allows single-keystroke access to various BASIC keywords.

When the PRINT key is depressed, everything that appears on the display screen is printed by the built-in printer. A small LED (light-emitting diode) on the keytop indicates whether the computer is in print mode. For example, to get a program listing, merely hit the PRINT key, type LIST, and hit RETURN, and you have instant hard copy. A separate HARD COPY key can be used to dump the current screen image (text and/or graphics) to the printer.

It also has a KANA key, which the manual says allows access to Japanese katakana characters. However, in the American unit, the key has been disabled with a metal spacer. (See the text box "Japanese Character Sets.")

Built-in Printer

The if800's self-contained printer is conveniently placed behind the keyboard so that the paper comes out in the same direction as it does in an ordinary typewriter. The dot-matrix printer uses a wire-impact mechanism and a regular typewriter ribbon, and has both friction- and tractor-feed mechanisms. Its printing speed is 80 cps (characters per second), and the print quality is excellent (almost good enough to conceal the dot-matrix printing method). The only shortcoming we noticed is that in dumping a screen image (as opposed to regular character-by-character text printing) the scan lines are spread quite far apart in the printed image, making text or detailed graphics difficult to read. We hope this is only a software limitation.

What's Inside?

Photo 2 gives an inside view of the keyboard/processor module, where various components of the computer are visible. The cover lifts off easily for access to the insides. The keyboard sits on top of the main printed-circuit board, which contains the microprocessor (a Z80A running at 4 megahertz [MHz]), memory, and support circuitry, as well as a small speaker for audio output. The keyboard assembly is all metal, providing a degree of electromagnetic shielding for the main circuit board.

Also inside the case is a real-time-clock chip that can be read by software. We were surprised at one feature of the time-of-day clock: the first time we plugged in the if800 and ran

Japanese Character Sets

Japanese, unlike most languages, has four separate writing systems, and it is not unusual to see all of them on one page.

Kanji characters are pictographs taken from Chinese. One character represents one word or concept. Kanji characters are used to represent roots of nouns or verbs.

The hiragana and katakana systems are syllabaries in which one character represents one consonant-vowel pair. Hiragana characters, full of graceful but tiny curlicues, are considered easier to read and are used in most text to indicate inflectional endings and to spell out words that are uniquely Japanese. Katakana characters represent exactly the same syllables as the hiragana but are more angular. They are used for children's books, official documents, and transliterating foreign words, especially foreign technical terms.

The Roman alphabet is used for such things as computer commands, in large part due to the ubiquity of Western computer-language systems.

Most of the Japanese personal computers reviewed here offer a Roman-alphabet keyboard with some sort of locking shift key that allows the same keys to be used for katakana as well. Generally, a few very common kanji characters are thrown in as graphics keys (the pictographs for "date" and 'time," for example), but the hiragana characters require resolution beyond the capability of most noninterlaced video displays.

If you think about it, the Japanese character sets might explain much of the feverish technological development in certain segments of the Japanese electronics industry—like the work on very dense read-only memories. The Japanese require great amounts of memory just in character generators to form the complex kanji characters.
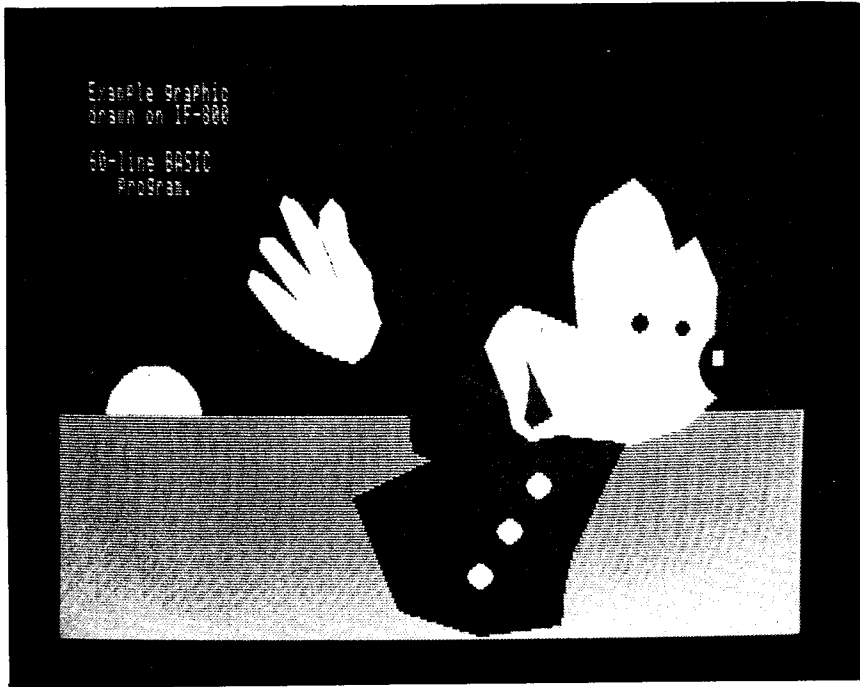
Photo 3: *A sample display from the if800, illustrating some of the graphics primitive operators. Most of the picture was produced using LINE commands to draw polygonal outlines followed by PAINT commands to fill the polygons.*
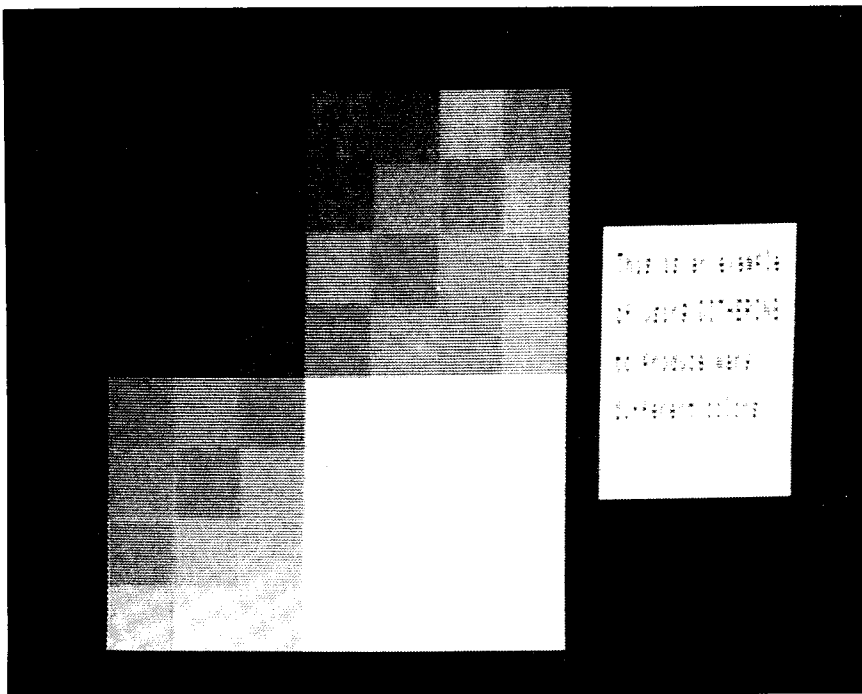

Photo 4: *An example of "dithering" on the if800. Even though only eight colors are available, by juxtaposing dots of different colors in different combinations, many different, apparently solid, colors can be displayed. This technique can also be used on the Fujitsu and Bubcom computers.*

one of the demonstration programs, the system showed the correct time! A little hunting inside the unit revealed a nickel-cadmium battery that keeps the clock chip going when the computer is unplugged or turned off.

Connecting to the World

Near the rear of the keyboard/processor module are five slots for peripheral-device-controller circuit cards. Two of these slots are occupied by controller cards for the color video display and the two floppy-disk drives. Many other optional interfaces are available, including a controller for 8-inch floppy-disk drives, a Centronics-compatible parallel printer port, an IEEE-488 interface (an Institute of Electrical and Electronics Engineers standard connection scheme), A/D (analog-to-digital) and D/A (digital-to-analog) converters, and additional RS-232C serial I/O (input/output) ports.

The keyboard/processor module has other switches and connection points. Built into its right side are a DB-25S connector for RS-232C serial communication and DIN (Deutsche Industrie Norm) connectors for a light pen, a black-and-white composite-video monitor, and an audio-cassette recorder. On the left side are two push-button switches that reset the system. The first button, labeled IPL (Initial Program Loader), is a "hard" reset that restarts the system in its power-up state, whereas the second button, NMI (Non-Maskable Interrupt), is a "soft" reset that returns you to the BASIC or CP/M command level (if possible). The NMI button is useful for aborting execution of a program in an infinite loop or some other "hung" state (when Control-C may not work).

Display Module

The top module of the if800 houses the standard color video monitor, which provides a high-resolution (640 dots horizontally by 200 dots vertically) eight-color display. Characters can be displayed in two sizes and in various screen formats (80 or 40 characters by 20 or 25 rows).

A unique feature of the if800 is the group of 10 "super-function" keys that are located on the video-monitor module, just below the display screen. These 10 keys duplicate the functions of the 10 function keys on the keyboard. Thus, they can be used under program control to produce any desired response. Their location makes it easy for an inexperienced user to select an item from a menu simply by pressing the function key just below the item shown on the screen. This would be especially useful in combination with a light pen because a program could be written that never required you to type on the main keyboard. You would just have to use the super-function keys.

Just to the right of the display screen are the two 5¼-inch two-sided double-density floppy-disk drives. Each floppy disk can store 280k (280,000) bytes.

Overview of Software

The two major software packages that came with our if800 computer were Oki BASIC, a Microsoft product, and a version of the CP/M operating system. In addition, several demonstration programs that run under each were provided.

Oki BASIC is a very high-level implementation of the BASIC language that fully exploits the hardware of the if800. For example, many of the special functions on the keyboard (such as TAB, DEL [delete], CAN, and the function keys) are supported, as well as the COMD key, which allows single-keystroke typing of commonly used BASIC commands. Most of the peripheral devices can be directly controlled from BASIC, including both disk drives, the printer, the onboard speaker, the light pen, the clock and calendar, and RS-232C ports.

Each peripheral device is supported by a whole array of BASIC keywords. An example of a device-control keyword is ON COM GOSUB, which allows a program to be interrupted by data arriving at the RS-232C port. A subroutine call is performed when a signal is detected

on the port. This in effect allows for interrupt processing—usually reserved for assembly-language programmers—entirely within BASIC.

Displaying Graphics

Because the if800 contains a high-resolution color display, you might expect good graphics support from BASIC. We were not disappointed; many high-level keywords are available for manipulating the graphics screen. Primitive operators for drawing are available for creating images, including CIRCLE, LINE (which includes the capability of drawing rectangles), and POINT. In addition, a graphics macroinstruction facility called GML (Graphics Macro Lan-

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Each computer represents a design team's attempt to assemble a set of features that will appeal to a variety of users.

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guage) is built into Oki BASIC. This is used by defining a BASIC character string consisting of GML commands, which appear mostly as a single letter followed by a single numeral. Typical GML commands are:

Un—Move cursor up n pixels (there are corresponding commands for other directions)
Cn—Set color to n
Sn—Set scale factor to n
Xstring—Execute a previously defined GML string

To execute a GML command, the statement DRAW *string* or *string-variable* is issued. One GML string can call another GML string, thus providing a nested-macro facility. Consequently, small detailed objects (such as game pieces or special symbols) can be compactly described and drawn with a single command.

Another facility for describing detailed graphics images is the DEF CHR$ statement in BASIC, which redefines any of the characters in the character set. Note, however, that characters can be only two colors (foreground and background), whereas GML commands can draw images with multiple colors.

Another interesting BASIC keyword is PAINT. A PAINT statement fills in the area starting at specified Cartesian coordinates and bounded by a specified border color with a specified fill color. The area boundary can be any complex shape bounded by any color (which need not be the same as the drawing color). If the boundary is very large and complex, an OUT OF MEMORY error may result, since a recursive algorithm utilizing a stack is used to process a PAINT command. This command, combined with the geometric commands, can be used to easily create graphics displays using filled polygons. A sample picture drawn by one of the authors is shown in photo 3. This was drawn entirely by a small BASIC program (containing a lot of DATA statements!).

The high horizontal resolution (640 dots across) allows use of a standard trick in computer graphics that can effectively provide many more than eight colors. This technique is called *dithering* and depends on the following effect: if we draw a horizontal line consisting of alternating blue and red pixels, our eyes will area-average the pixels and perceive the line as a solid line of a color somewhere between blue and red. By using different combinations and mixtures of the eight available colors, a whole array of different, apparently solid, colors can be displayed. Photo 4 shows a display created using this technique. Unfortunately, the BASIC PAINT keyword does not support filling with dither patterns, but someone will eventually write such a routine for the if800. Even more impressive graphics will then be possible.

The eight-color display can be thought of as three overlaid planes of red, green, and blue pixels. It is possi-

ble in software to choose whether one or several of these planes are to be displayed at any time. This could be used, for example, to allow superimposing a grid over an image in an architectural application program. The grid could be instantly displayed or removed at the touch of a key.

Musical Possibilities

A set of commands is also available for making single-voice musical melodies through the onboard speaker. Another sublanguage called MML (Music Macro Language) is used. A BASIC string is defined containing MML commands, which include commands for specifying pitches, octaves, timbres, and rests. To play the melody, the statement PLAY *string* is executed.

Minor Gripes

We noted only a few minor problems with the if800. When programming in BASIC, the keyboard produces uppercase letters in the normal mode. To get lowercase letters, the SHIFT key must be used. There is no shift-lock or lowercase-lock key, and there does not seem to be any way to reverse this behavior to the behavior most people expect (no shift = lowercase, shift = uppercase). This is fine for most programming, but if you have to type a lot of text (for example, in entering program instructions into the source file), it becomes annoying. The lowercase characters that have descenders are somewhat inelegant, as well; this is because of the small character matrix (8 by 8 dots).

Other Observations

In addition to Oki BASIC, we tested a 64K-byte version of CP/M. Since CP/M is widely known, we shall mention only a few unique features of the BMC version. First, a library of graphics routines that can be called from Microsoft's MBASIC is available. This allows utilizing most of the Oki BASIC graphics primitives (LINE, CIRCLE, PAINT, etc., but not GML commands) from MBASIC. In fact, the CP/M graphics library seems to execute these commands slightly faster than Oki BASIC.

A version of Wordstar, the popular word processor from Micropro International, was also supplied. Overall it works quite well, with most of the special features (such as boldface, underlining, and text justification) supported by the if800's built-in printer. Features not supported include multiple text sizes and proportional spacing, since the if800 printer cannot perform these functions. Also of interest is the fact that Micropro is said to be working on a color version for the if800, which will utilize the color capability of the video display.