SOFTWARE TOOLS

No matter how small the computer, even the most dedicated programmer will rapidly become bored with binary notation. Some hobbyists use a Teletype as there are several older models on the market at reasonable prices. Even with a Teletype, though, you need some software to convert those keystrokes into something meaningful in memory. If you can't afford a Teletype, you can almost always use an encoded keyboard. These are frequently on the surplus market for less than $25.00.

A terminal is important, but it is only one tool in the computer hobbyist's kit. Once you've written a program and gotten it into storage, you ought to use the cassette interface (HIT) described in September's column. With this tool, you have to "button in" the program bit-by-bit only once. After it is in storage, you can write it out to be taped and read in the next time you want it. Of course, if your only storage medium is RAM, you'll lose the memory contents when you turn the computer off. So, it's a good idea to copy the latest version of a program out to tape as a backup.

Also, if your only storage medium is RAM, you'll have to reenter the tape reading routine laboriously through the switches (or the terminal) each time the computer power is turned on. That is a good reason for having a small program, called a bootstrap loader, kept in read-only memory. This program makes it possible to read data from the tape and then execute that data. Such a read-in program is usually somewhat larger and more powerful, so it reads in several records (perhaps using the bootstrap program as a subroutine), which make up an even larger and more sophisticated program. The effect, then, is to use one group of records to read the next

By Jerry Ogden
group in, thus "pulling" the program in by its own bootstraps.

Using a Monitor. The ability to preserve a program for later recall is important, but it doesn't solve two major nuisances: (1) you still have to key in the program bit-by-bit the first time; and (2) every time you make an error in the program, you have to key in the changes, some of which may be traumatic and complex. One of the best ways to solve this kind of inconvenience is to provide a small monitor. A monitor is just another computer program, but one that is designed to make computer use more convenient. This program reads characters from a terminal (or a separate keyboard), with these characters specifying the bit patterns to put into memory.

The simplest monitor has three basic commands: Load, Dump and Go. A command is a single letter typed at a time when the monitor is not otherwise engaged in some activity. Typical commands are single letters like "L" for Load, "D" for Dump and "G" for Go. When you type in "L" you are directing the monitor program to accept keyboard input and load it into memory; "D" means you want to display contents of memory on your terminal or display device; "G" is your means of transferring control out of the monitor into the program you have previously loaded.

Most programmers now use the hexadecimal number system for communicating with the machine, although there are "pockets" of users of octal. Hex and octal are, of course, just shorthand notations for binary code. Hex digits allow us to specify four bits with one symbol, octal allows three. The hexadecimal digits are 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, and F. (The letters A through F stand for decimal equivalent values 10 through 15, respectively.) The monitor, for utmost simplicity, uses only hexadecimal digits for the specification of addresses and data byte values.

Each of the command letters (L, D or G) is followed by an address that specifies where to start. For the Load command, that address is where the first byte of data from the keyboard will be stored; for Dump, it is the address from which data will begin being displayed; for Go, it is the address that is to be placed into the CPU's program counter. Whenever the Go command's address has been supplied, control is transferred to that location. Whenever the Dump command's address has been given, data displaying will begin. However, after the Load command's address, the monitor will expect more bytes (one after another) to be loaded into successive locations in memory.

A small monitor for the 8080 microprocessor that you can use as a model is shown opposite. Each command is stopped by resetting the CPU, thus returning control to the top of the monitor. Notice some error correction conventions that have been instituted to save you some time: numbers are assumed to consist of any number of hex digits but if the monitor wants an address, only the least-significant four digits are used. Likewise, for a data byte, only the least-significant two hex digits are preserved. This means that if you've made an error, just keep typing. Hex digits end with any character that is not a hex digit; most people find that the space character is the most convenient.

News Items. The extremely popular 8080, originally from Intel, is now being supplied by other semiconductor makers as well. The TI TMS8080 is identical to the original 8080, which Intel no longer makes. Intel's newer device, the 8080A, is functionally identical but has better current drive capacity. Intel has another part, the 8080A-1, that'll go faster so that AMD's 9080 (which is supposed to run 50% faster than the original Intel part) will have a competitor. So, if you are using the 8080, be sure to check the diagrams to see that your part matches the requirements.

The news, however, is that the MOS Technology 6501 is destined to become a popular CPU among hobbyists, if only because of its dramatically low price ($20 at press time). The device is modelled after Motorola's 6800, although with some major differences. All of the Motorola support parts like memory I/O chips can be used with the 6501, so you can get on board quickly. The Motorola software, however, cannot be executed on the 6501 without revision. The 6501 is capable of operation at twice the Motorola part's speed; some parts may operate three times as fast. The introduction of this part is likely to start the real price war that has been brewing in the microprocessor business. Even with the new support chip for the 8008 that Intel has announced, it seems unlikely that it can compete with the 6501 for hobbyist use.

QUICK....
what number is this?

○ ○ ○ ○ ○ ○

If you have to read your microcomputer like this—bit by bit, from rows of lights—the computer's making you do its work. And if you have to use rows of toggle switches to program it, you might wonder why they call the computer a labor-saving device!

Contrast the layout of a typical pocket calculator. A key for each number and function; six easy-to-read digits. Why not design microcomputers like that?

Here they are! The modular micros from Martin Research. The keyboard programs the computer, and the bright, fully-decoded digits display data and memory addresses. A Monitor program in a PROM makes program entry easy. And, even the smallest system comes with enough RAM memory to get started!

Both the MIKE 2 system, with the popular 8008 processor, and the 8008-based MIKE J rely on the same universal bus structure. This means that accessories—like our 450 ns 4K RAM—are compatible with these and other 8-bit CPUs. And, systems start at under $300! For details, write for your...

FREE CATALOG!

MIKE 2 MANUAL...
This looseleaf book includes full information on the MIKE 2 system, with schematics. $19

Price for orders received by November 15, 1975...
Includes a certificate worth $10 towards a modular micro system, good 90 days. (Offer valid, USA only.) After 11/15: $25.

Martin Research / 3336 Commercial Ave.
Northbrook, IL 60062 / (312) 498-5060

INFORMATION