as an operating system that has been loaded into memory from an external memory device. Its functions include file-handling commands considerably more advanced than those encountered on other ROM-only computers such as the Spectrum.

The operating system used by a computer, then, can be seen as a program with the function of sitting between the user and the rest of the computer system, including its CPU, systems software (such as programming languages) and applications software.

## PORTABILITY

The ability to use software on more than one computer system is known as *portability*. There are, broadly, two aspects to this. The first is the fact that different processors require different instruction sets in order to perform equivalent operations. Thus, machine code instructions to, say, add together the contents of two memory locations would have one form if written for the 6502 (used in the Apple) and an entirely different form if the same operation were required on a Z80 computer such as the Spectrum. The problem of converting high-level code into suitable machine code is, however, the responsibility of the interpreter or compiler used. Different interpreters and compilers have to be written for each different CPU.

There is, however, a separate problem affecting software portability. Even when the same CPU is used, as in the Apple and the BBC, there are other complications. Different address locations are used for the video memory, different codes are needed to move the cursor about the screen, different input and output facilities are provided, and so on.

To overcome this problem, generic disk operating systems were developed that would allow all software written for, say, one disk-based Z80 computer to run on any other disk-based Z80 computer having the same operating system. The best known of these disk operating systems is CP/M (Control Program/Microcomputers).

Disk operating systems such as CP/M are essentially a development from the more machine-specific monitors and operating systems, but they represent a major advance in terms of software portability. Any program written to run under a generic operating system such as CP/M or MS-DOS will run on any computer with that operating system, provided the software does not try to make use of any special features (such as sound effects) specific to one machine. The operating system software itself is supplied in standard form by its developers to the computer manufacturer. All the hardware manufacturer has to do is to rewrite a small machine-dependent portion of the program.

Disk operating systems vary considerably in their complexity and capabilities, but the simpler ones such as CP/M and MS-DOS comprise

essentially three parts: the command processor, the basic disk operating system (BDOS) and the basic input/output system (BIOS). Of these parts, the only one relevant to portability is the BIOS. The BIOS is a separate part of the program that contains all the routines needed to handle the peripherals, including the screen and the keyboard, and it has to be specially configured for each new computer design. Any program that runs under the control of this operating system will interface with the computer through the BIOS. The BIOS, then, will handle such things as getting characters fom the keyboard, outputting characters to the screen or printer, addressing the disks, and so on.

The BDOS consists of the parts of the operating system that are not device-specific (i.e. generalised routines for handling the screen, printer, disk drives etc.). These parts of the program do not need to change between implementations. The BDOS and BIOS together correspond roughly to the monitor or operating system found in ROM-based computers.

The command processor is the part of the program that handles operating system commands typed in from the keyboard. Typical commands include those that load files from disk into main memory, list the file names present on the disk and erase or rename files on the disk.

Because the operating system is something that does its work in the background it is often overlooked, yet it is an essential part of any computer system. This makes it well worth the effort of understanding it.



IAN McKINNELL

**Key To Success**
The Osborne 1 owes much of its success to being a CP/M-based computer. It comes with some of the most popular CP/M programs, including WordStar, SuperCalc and MBASIC