programmer to force a garbage collection; it is a good idea to do this at frequent intervals — but the user should be given a 'please wait' message as the computer will appear to be doing nothing while garbage collection is being dealt with.

The way that a programming language handles input and output will influence the design of the interface between computer and user. The superior string-handling facilities of BASIC will lead to more sophisticated use of strings in the humancomputer dialogue than is allowed by languages like PASCAL. BASICS that have built-in commands for cursor addressing will encourage better screen layouts than those that do not. The same holds true for BASICS with graphics commands. BASIC is well supplied with input/output commands -INPUT and PRINT are fine for simple programs. But for real control of input (the kind needed to produce a form containing protected input fields, for example) try experimenting with GET\$, INKEY\$, INPUT\$() and similar commands. PRINT USING is an extremely versatile command for formatting output; it is invaluable for aligning decimal points and for justifying columns of text.

Hain Micronel Menu KEY FUNCTION CON OF OFF Micronet Terminal Cove Frame

Micronet 800 'Log-on'

View Frame Print Frame Downloader Mailbox Message 6 Operating System 7 GOTO Main Menu

USER PSYCHOLOGY

TAB

The user is the most unpredictable element in any man-machine system. Like any other component, though, the user has certain performance characteristics that must be understood before the interface is designed.

People share with computers the basic characteristic of being 'information processors'. However, human beings have inherent limitations on the amount of new information they can hold in 'working memory' — it has been reckoned that for most types of information around seven different items may be held in the brain at one time. The size of these items depends on how meaningful or well structured they are. If the information to be remembered consists of random characters, each item will consist of no more than a single character. But if the characters are not random but form common surnames, each item remembered could be an entire name. Increasing the structure of the information in this way increases the user's ability to remember and make use of it.

There are several ways of helping people to structure information when using computers. One method is to relate data to familiar, wellunderstood structures — this is the way that the Lisa-style 'desk-top' metaphor works. Similarly, a financial spreadsheet package may be organised to look like a book with pages, indexes, etc. Another method is to train the user to understand unfamiliar structures. By repeatedly showing examples, and explaining topics in depth, the program itself may be used to teach the user how the information should be structured. The



drawback with training of this type is that it is expensive in both time and effort. Detailed instructions, 'help' screens and 'signposts' may provide a type of on-line training, but these can be difficult to use efficiently.

Finally, presenting information in recognisable patterns can help the user to understand the program. This can be done by using colour or layout to lead the eye to the desired information. To understand what this means, consider colourcoding as it is used in Prestel and similar videotext programs. On a typical page, the heading and 'footer' will be set in blocks of the same colour; there will be a single background colour, and text will be displayed in two other colours, with alternate paragraphs in each colour. Key words may be highlighted by using yet another colour. The purpose of this is to allow the user to select only the information required and to ignore whole sections of the page if these sections contain information of no immediate value. Colourcoding can be confusing if it is over-used, however, and tests have shown that people may waste time reading and re-reading paragraphs to try to understand the significance of an entirely arbitrary colour change! A good rule of thumb is: never use more than four colours at once.

Three Degrees

These photographs of microcomputer operating systems illustrate three varving degrees of user-friendliness. In the first photograph, a new user is attempting to communicate with the CP/M operating system. CP/M has no built-in 'help' features, so requires a thorough knowledge of commands before it can be used properly. Our second example is a menu-driven system - the 'Log-on' menu for Micronet 800 on the BBC Micro, Options are clearly numbered, and the user makes his selection by entering the appropriate number from the menu. The screen does not offer a great deal of information, so the user must understand the options before he can make use of them. Our final photograph shows the Apple Macintosh operating system, which provides visual clues and graphic displays, as well as simple, easily understood menus