ABC of Computing

A J ASBURY

INPUT, OUTPUT, AND THE USER

The user

At one end of a wide range of users of computers is the non-expert, the secretary typing information into the general practice computer possibly using a commercial data entry program. When any problem occurs she will have too little knowledge of computing to enable her to disentangle a programming fault and so the system must be easy to use, designed to reduce errors, and have built in safeguards to prevent loss of information. To help the non-expert user the computer may be programmed with "user friendly" features—for example, it will prompt the user throughout the operation: if a date is requested the computer will tell the user in which order to type the day, month, and year.

At the other end of the range is the expert user, the programmer who knows clearly how the computer works. If a problem occurs he will be able to cope because the computer's diagnostic messages will be meaningful and he will know what to do. The professional programmer does not usually require user friendly features: it is often his job to design them for other people. The systems analyst is a computer expert who works with the programmer but concentrates on analysing how an activity is undertaken and how a computer can be introduced to help. In between are people with varying degrees of knowledge about computers, including doctors who have taught themselves to write their own systems.

One recipe for disaster is for an enthusiastic medical computer user to design programs for the non-expert user without bothering to incorporate sufficient safeguards and adequate user friendly features; the frightened non-expert user can be left with an apparently inoperative computer displaying obscure diagnostic messages.

Input

Last week the computer hardware (the parts you can touch) was described in terms of a four component system: two of these components are the input and output units.

A computer can receive information from many sources, and the term input unit designates a route by which information is passed in a predetermined manner to the computer rather than a specific piece of equipment. The important feature of this route is that it converts the data into computer readable form. For example, the user may type in numbers on the computer's keyboard; they are meaningful to the user but incomprehensible to the computer until they are converted into a succession of electrical pulses.

The commonest method of passing information to a computer is by means of a typewriter keyboard; the keys move switches and send a succession of pulses to the computer. To help the user the computer will usually have some form of output device, most commonly a television unit (visual display unit, VDU, or cathode ray tube, CRT), on which the typed text is displayed so that the operator can check what he or she has entered. It is also possible to print the text on paper as it is entered, thereby giving a permanent record.

Checking the data going into the computer

One of the oldest methods of making information computer readable, commonly used on mainframe computers, is punched cards. The information is first converted to a code which can be punched as a series of holes on a card, and the information can then be automatically read by the computer. This method of input is clumsy because once a card has been punched a mistake cannot be rectified, and a new card has to be punched. A similar technique uses punched paper tape but it suffers from the same problems.

The bar code is a modern method of feeding data into the computer. The information, perhaps a stock number, is converted to binary form and written as a series of dark bars on a light background. The information contained in the pattern of dark bars can be read by passing a light pen over the bars. The pen converts the pattern of thick and thin bars into a computer readable series of electrical pulses which are fed directly into the computer. There are about 20 different methods of coding information in bar code form, and the bar code usually includes some form of internal error check. Bar coding is commonly used in the grocery and footwear industries, where the bar code is actually printed on packages; in the illustration the bar code is used to help in the stock control of a blood bank.

Mark sensing is another technique of entering data directly into the computer. The information is encoded as marks on a card and then read either optically, with the detector reading the pattern of marks, or electronically, with the detector sensing the impedance changes in the paper caused by the pencil marks. This method is used for marking multiple-choice examination papers.

Physiological signals can also be fed directly into a computer but first they must be converted to a digital form which the computer will recognise. The arterial waveform as regularly measured in an intensive care unit is a good example. The pressure waveform, which is in analogue form, is detected by a transducer and a voltage is made to vary exactly in parallel with the pressure. The voltage is then passed to an analogue to digital converter (ADC), which measures the waveform at set intervals and expresses the results in a computer readable digital form. The computer then makes calculations on the arterial waveform virtually as it is generated. The more rapidly a signal changes the more measurements are necessary to describe it in digital form.

One common problem that arises when the computer directly measures a physiological signal is that of recognising artefacts. An artefact in the arterial waveform may be caused by the patient moving or the nurse flushing the cannula. It is often more difficult to write a program to recognise the artefacts than it is to undertake the desired calculations.

No matter how elegant the computer program, if the incoming data are wrong the results will be invalid, and if they are not recognised as such they may be dangerous to patients. Suppose, for example, that the computer needs to know a date so that the number of tablets in a repeat prescription can be calculated. The computer can prompt the non-expert user by displaying the words, "Type in the date; day, month, year," and as the user types the figures are displayed on the VDU. Suppose, however, that the user wants to enter 18 August 1982. If he types "18, 8, 82" all is well, but if he accidentally interchanges the month and the day the computer should recognise an error (because it has been programmed to accept only figures of less than 13 as values for months) and ask the user to retype the date. Further checks could detect the fact that the number of days did not fit with the month of the year. Though a computer can be

Output

programmed to check incoming data, if the data is plausible it may pass all checks—for example, if the date is 4 August 1982 and wrongly entered as “8, 4, 82” the computer will not be able to detect any mistake. The computer can be programmed to be as helpful as possible, prompting the user at each step, but the user is still responsible for checking that the data entered are correct.

The function of the output unit is to convert computer readable information into a form that is usable by the user.

The visual display unit is the most commonly used computer output device. It can rapidly display numerical data, text, and graphics. The computer, for example, may be programmed to undertake a statistical analysis of a general practice's age-sex register and display the results as figures or as a multicoloured graph. Paper, though inefficient as a data storage medium, is important to the user, and most computers can print their output on paper. Of the many types of printer available the two commonest types are matrix and daisywheel printers.

The matrix printer constructs each character individually from a series of dots. Matrix printers are fast (about 150-200 characters per second), cheap, and reasonably quiet but the type quality is often poor and difficult to read—the descending parts of letters may be curtailed, for example. This type of printer is often used for draft documents, where the quality of script is less important. Matrix printers are now being developed which will print in many colours.

The daisywheel printer gives a good quality type, often described as “letter quality.” Like some modern typewriters, daisywheel printers have a printwheel with many radial arms each bearing a letter; the computer instructs the printer to move the daisywheel to the correct part of the paper and the print wheel then revolves to bring the letter to the correct position. The letter is printed by a hammer pressing the letter on to a ribbon which overlies the paper. A print speed of 60 characters per second would be usual for a daisywheel printer.

The barrel printer is an even faster form of printer which is commonly used with mainframe computers in large installations. A barrel printer prints a line at a time and may print several hundred per second. The computer's printed output is not confined to conventional paper; the information can be printed on envelopes or adhesive labels to help in mailing operations.

Instead of being converted to make it user readable the output of a computer may alternatively be directed to control a piece of apparatus—for example, the rate of movement of the plunger in an automatic syringe which is injecting drugs into the patient.

When discussing input to the computer I highlighted the role of the user, and the user is just as important where output is concerned. If the computer output—whether graphs, text, or tables—is incomprehensible to the user it is useless. A common problem with non-expert computer users is that they fail to be critical of the computer output; the neatly arranged rows of figures seem to have an innate correctness.

Dr A J Asbury, FFARCS, PHD, is lecturer in anaesthetics, University of Sheffield.