Robin Bradbeer • Peter De Bono • Peter Laurie

The Beginner's Guide to Computers

If you don't know a bit from a byte, here's the straight talk about computers—what they are, what they can do, and how you can use them.

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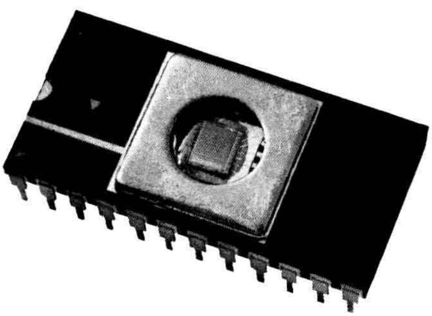
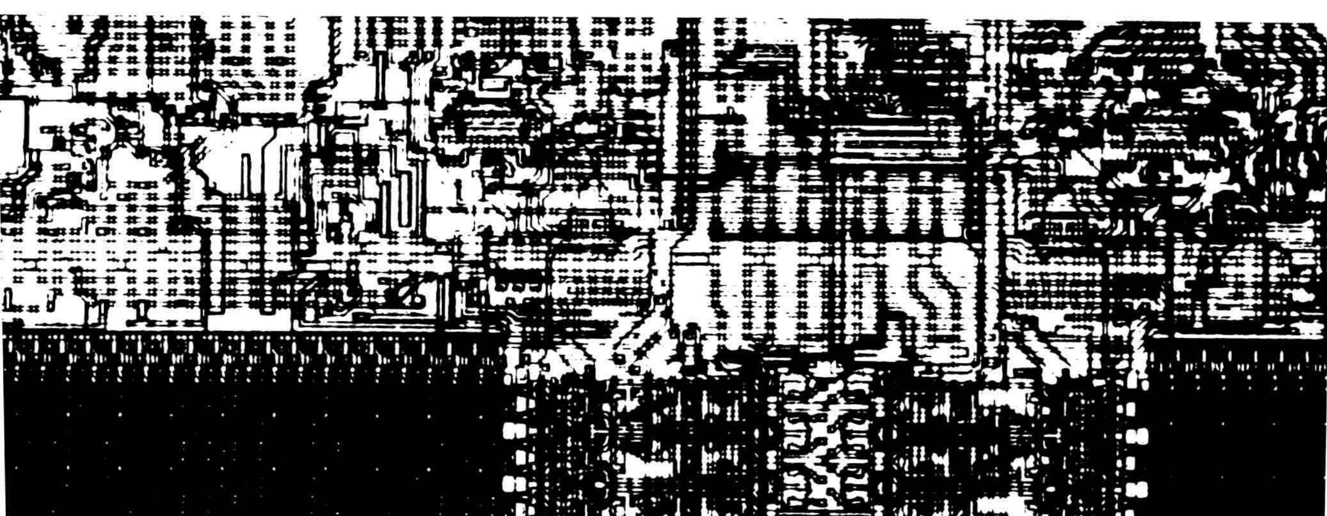
Contents

Introduction



Microelectronics, the silicon chip technology which has made the cheap microcomputer possible, is transforming the economy of the industrialized nations and increasingly affecting the jobs and the lives of many people. Computing power is virtually the only commodity which is falling in cost each year. It's now becoming so cheap that the personal microcomputer is something that will soon find its way into innumerable homes. Even now it's in shopping centers rubbing shoulders with its slightly younger brothers, the calculators and the digital watches, which were virtually unknown a decade ago. Unlike them, it offers a growing number of people an intellectual challenge as well as being a practical and versatile new tool just as capable of controlling *things* as of juggling information.

In terms of computing power what the big computer does today the little computer could do tomorrow. Whether big or small, all computers function in very similar ways. But what can they do? How do they work? How can they be used in solving problems? Where is the technology taking us? What are its limitations? The purpose of this book is to answer these questions and to encourage a new kind of literacy – 'computer literacy'.



Why 'computer literacy'?

Since microcomputers and other similar devices are not very different from many other technological innovations that have changed the face of society, it helps to look back in history. The last time something as dramatic as this happened was perhaps when engineering came into being during the Industrial Revolution. At that time a small group of predominantly youthful men who mastered a new technology were vigorously transforming their world. Consider Brunel who, at the age of 27, was the chief engineer of the Great Western Railway, hurling his broad gauge lines like spears across a landscape that had not changed since the time of the enclosures. What did their contemporaries think of these arrogant youngsters, with their new ideas and amazing powers?

Ordinary, well-educated people then lacked the 'engineering literacy' which we all have now. They thought that to travel faster than 30 mph would kill you. They thought the pressure of

The heirs to the Industrial Revolution.
Shareholders riding in a broad gauge train try out the Metropolitan Line, London's first underground railway, just before the opening on January 10th, 1863

steam in a boiler would infallibly burst it. They 'knew' that steel ships would sink. On the other hand, they thought it not unlikely that a man could pedal hard enough to lift himself into the air.

Their notions were shapeless because they did not understand the basic laws of physics – simple enough laws that most of us now absorb from our culture without even knowing that we have done so. Do you not, for instance, at least have a vague idea how an old-fashioned clock works? Even if you are not a mechanic you have some notion of cog wheels driving each other: a spring, a pendulum swinging to and fro, and so on. Few people nowadays are baffled by a steam locomotive or a gasoline engine, even if they do not know the subleties of its operation.

We are the heirs to nearly 200 years of engineering literacy; we can distinguish the practical from the absurd; we have a grasp of the basic rules and can apply them sensibly to situations we see around us. Computing is just the same, except that only a few of us have yet been let into the basic secrets. The result is

The heirs to the Microelectronics Revolution.
Learning to use the computer in the primary school.

exactly the same attitudes that could be found at the start of engineering: belief in the impossible, refusal to believe the obvious – a general instability of opinion. However, it all turned out to be quite easy last time; computing need be no different.

What we are trying to do in this book is to show that the fundamentals are not as difficult as many people might think. Of course, we can't, in this short introduction, teach you to build your own computer; but that is something few of us need to know, just as most people manage to drive a car perfectly well without knowing how to build one – or even, in most cases, how to repair it.

We hope to put across some of the basic ideas which will enable you to treat the computer as a tool which you will come across more and more often, and which you will find useful in your daily life – much, in fact, as we treat cars today.

Some readers will doubtless have access to computers – either their own computers, or computers at their school, college or work. We hope this book will give them some interesting new ideas. However, it is not necessary to make use of a computer to follow the book, nor do we assume that you already know anything about computers, about electronics, or about mathematics.

This is not a practical handbook to any particular computer. It is not a course in computer programming (though we do look at the basics of programming). It is an introduction to computers, what they are and what they do, which we hope will give you the confidence to go on and learn more. If you choose not to learn more, what you read here should still give you an insight into the new technology which is fast changing our modern world.

Using this book

This book is not intended just for you to read through from cover to cover. Of course, you can read it through chapter by chapter, and it will make sense if you do. We hope you will use it, too, as a source of reference, to dip into when you need some explanation. With this in mind, we have tried to provide plenty of cross-references.

The glossary at the back should provide an explanation of many of the technical words used in computing. In the text we try to keep these to a minimum and to explain them as they first occur.

1 Setting the scene

Computers are essentially stupid. They only do what they are told to do in instructions given to them by human beings. Nevertheless, the things they *can* do – and are being asked to do today – are many and various and are vital to our modern way of life.

Working out the weather

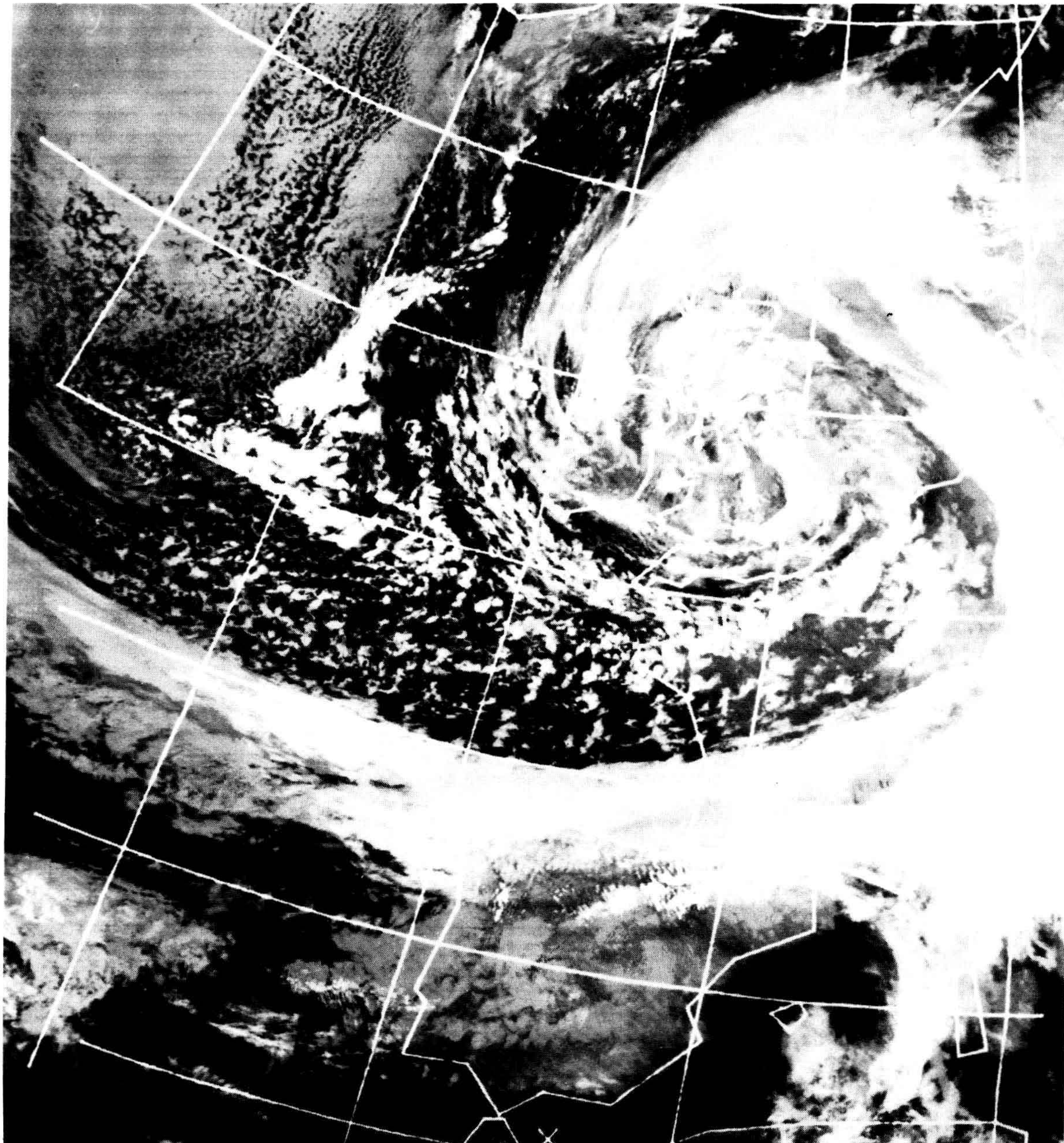
On the evening's television weather spot we see the pictures from space of clouds and winds and then the forecasters' maps with their symbols for sleet, hurricane, rain and fog. Although the computer doesn't come forward to take its bow, it has done most of the work that leads up to the predictions.

The process starts with the collection of weather information. Hundreds of weather stations round the world – on light ships, at airports, in military bases – send information to their national weather centers by radio and telex. Satellites take pictures of cloud patterns and, using infrared cameras, of the temperature of the earth below. This information is stored in the satellite by a small computer and transmitted by radio to earth-based stations when the satellite is overhead. Staff at these stations forward it by radio and telex to the weather center.

In the weather center, a picture of today's weather is built up in the computer – a very big computer this time, for the problem is enormous. Values for the air pressure, temperature, wind speed and direction and humidity for the hundreds of weather stations are fed in. The computer fits them all into a big overall pattern. It then has to do a most complicated calculation: taking the current conditions in the air over each square kilometer of the earth's surface it has to calculate – using the well-known laws of physics – what effect the air masses in neighboring squares will have on it, and vice versa. This involves such calculation and recalculation that it needs to be done on the very largest machines if the calculation is to be done faster than the weather happens outside the computer room. Even then, the forecast is not terribly accurate, but it's better than wetting a finger and holding it up to the wind. At the end of all this, the

Deep depression over England — as seen by a weather satellite.

weather forecaster can say 'Light winds, some showers and bright spells – warmer than yesterday'.

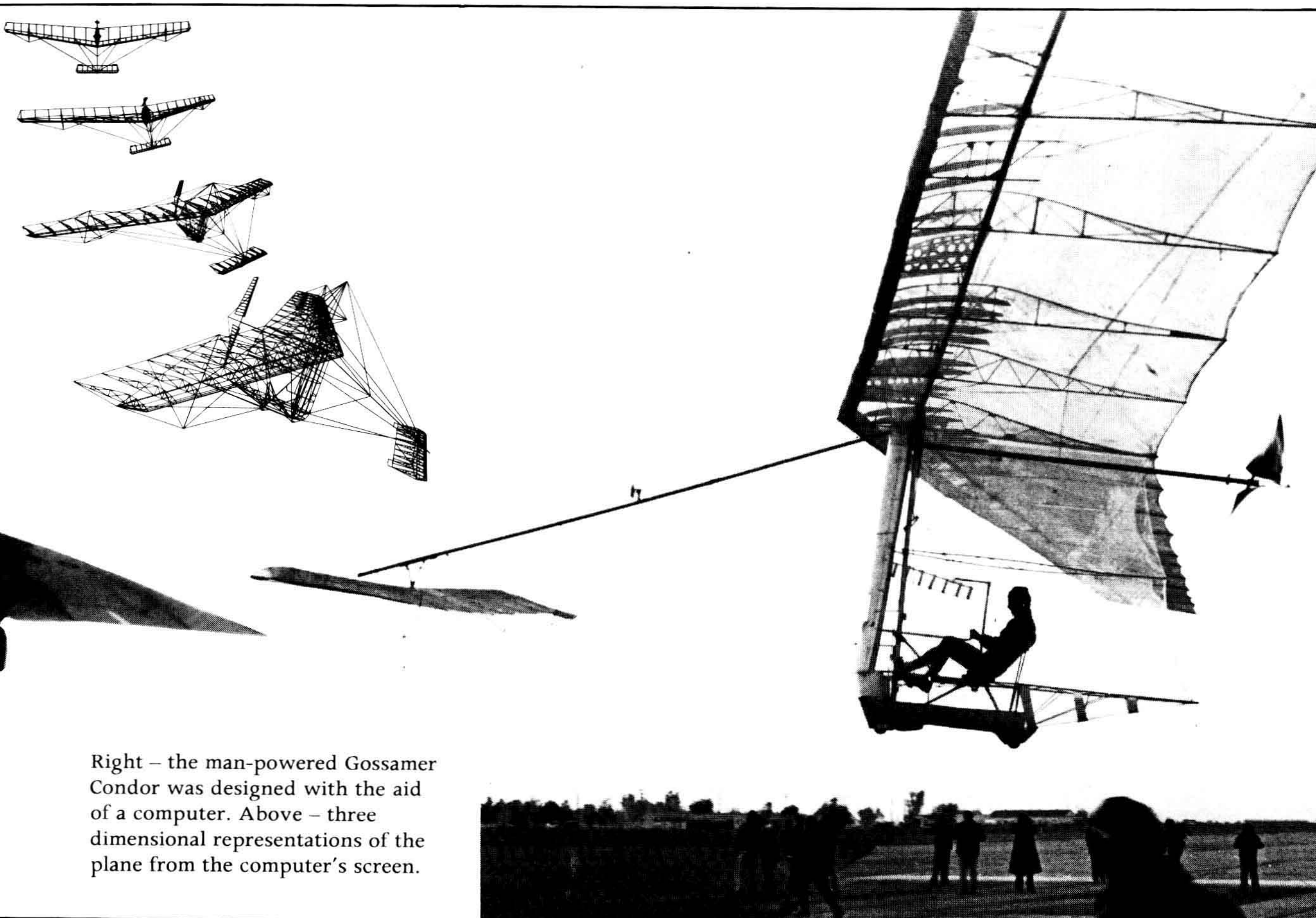


Keeping the engine cool

In movies, the dashing pilot puts on his dark glasses, vaults into the cockpit of his aircraft and zooms off into the blue. In real life he has a few more things to do. One of them is managing his jet engines, for they are temperamental beasts. As the aircraft accelerates down the runway, air is blown into the engine intakes at greater pressure and in larger volume because the aircraft is moving forwards. At the same time, the jet flow comes out more easily and therefore the machine gives more thrust. This means that the internal temperature changes. If the fuel inside the engine burns too hot the turbines melt; if it burns too cold the engine doesn't give enough thrust. So, as well as guiding the aircraft down the runway, the pilot has to juggle with the fuel flow to keep the turbine temperature just right.

Computers take to the air.
Concorde has 8 on-board computers to help with navigation, communications and the control of cabin conditions like pressure, as well as control of the engines.

Life is made much easier and safer for the dashing aeronaut – and for his passengers – if a computer takes over the whole job. It will have temperature sensors in the combustion chamber. It will measure the temperature and pressure of the outside air (a jet engine gives much less thrust at a hot, high airport like Khartoum in the Sudan than a cold, low one like Benbecula in the Hebrides). It will measure the forward push of the engine by measuring the pressure in the final jet tube. It will measure the fuel flow and the air speed, and the weight of the aircraft. With all these figures, the computer will calculate and deliver the right amount of fuel to the engine each second. Meanwhile, the pilot can concentrate on getting the passengers from A to B without alarm or dismemberment.



Right – the man-powered Gossamer Condor was designed with the aid of a computer. Above – three dimensional representations of the plane from the computer's screen.

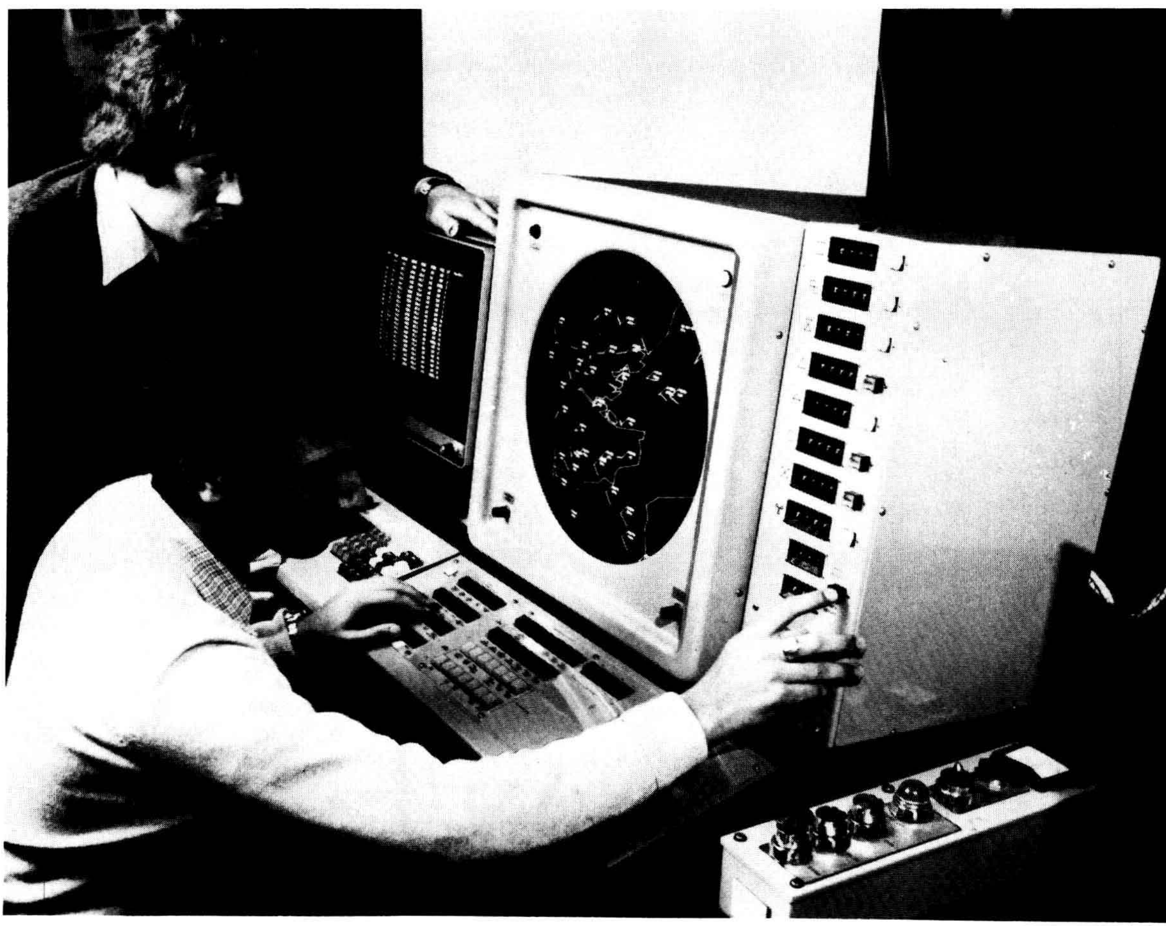
Tracking the traffic

Once in the air, our hawk-eyed friend rushes along at 600 mph. His brother birdmen, rushing at 600 mph – possibly in the opposite direction – have little chance of seeing him coming. If fate wills that their paths cross, an accident is almost inevitable.

To prevent these mishaps, nations with heavy airport traffic provide an air traffic control service. This consists of a network of radars whose plots are brought to one or two central offices, where people well-trained in mental gymnastics keep track of each aircraft and steer it round those other – invisible – aircraft that might bang into it. Usually they are successful; very occasionally they fail.

In recent years, experiments have been made with *automatic* air traffic control – at least with the collision avoidance part. A

The latest generation of air-traffic control radar equipment being tested. Aircraft do not just appear as 'blips' on the screen; their flight numbers and heights appear as well, as a result of signals coming from the planes themselves.

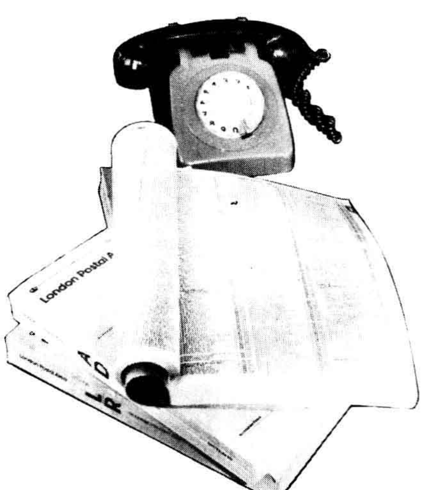


computer watches the radars, calculates the position of each aircraft, 5, 10, 15 minutes ahead and warns the controller if a collision (or a 'conflict' as it is known technically) is likely. The controller can then try out various decisions – if he orders aircraft A to turn 10 degrees to port and climb 500 feet to avoid B, will it now collide with aircraft K?

The computing required to do this isn't easy. For a start, the blips on the screens as the radars go round and round have to be joined up with each other. They may deflect from the straight lines that you'd expect. The blip may disappear altogether from time to time; the computer has to be able to work out where the aircraft may have gone in the meantime so that when the blips reappear they can be attached to the right track. When two tracks cross, the computer must not think that two aircraft flew up to each other and turned around. On the other hand, if that's what happened, the computer must be able to follow it! It's no good the controller telling BA323 to turn left, when the blip he's looking at is actually KL96. This kind of predictive computing requires a powerful machine and well-written programs.

The search for Mr Right

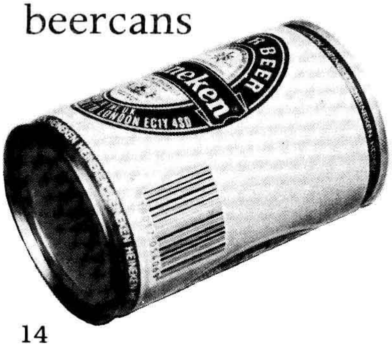
Computers are best at doing massive, highly defined jobs. One of the best examples is searching through a telephone directory to find a number. Of course, the computer needs to have all its information stored in its electronic memory and not on paper, but once the information is there it can search very fast indeed. It can even be asked to find a number when the exact spelling of the name is not known. Take Mr Bryzinski – or is it Brznski? Type in the name as accurately as you know it and a reasonably modest modern computer with the right program will find the number in a few seconds or will list out the alternatives. If you know an initial or part of his address it will then give you just the man you're looking for, his number and his address.



Can you imagine a more redundant and costly source of useless information than the New York telephone directory – nearly 4,000 pages of telephone numbers, many out of date and only a few of which you will ever look up? Not surprisingly, therefore, the French Post Office has proposed to issue every telephone owner with an electronic way of finding telephone numbers using a keyboard and a small screen attached to the telephone which can communicate with a central computer. They claim the costs will easily be borne by the savings in paper by not printing directories. Electronic directory enquiries enable other, usually impossibly tedious searches to be made. Knowing just an address could enable the user to find the name and number of the owner of a house just as easily. Equally, a search for all the Jones in New York, involving looking at every entry, would take about half a minute. These last two searches would normally not be carried out for you for ethical as well as practical reasons by the human directory information service. Yet the information is there, publicly, in the telephone book. Looking for it using hand and eye might be a week's work; for the computer it's no bother at all.

Home 'phone of the future?
One prototype for the proposed all-in-one French telephone system. Besides the electronic directory information service, subscribers will be able to send typed messages electronically and receive pages of information on the screen.

Bars on the beercans



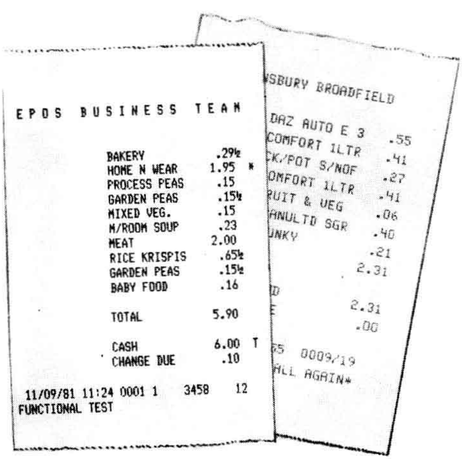
Have you noticed how soup and cornflake packages have started decorating themselves with smart patterns of black lines? They haven't joined some secret army – it's a way of identifying the items using bar codes, in a way the computer can read with relative ease. How does it read the bar code? A simple optical wand, which looks like a fat pencil attached to the computer by a wire, has inside it a light and a lens to focus the image of the bars on to an electronic sensor. As the cashier runs the tip of the wand across the bars, the sensing element detects the alternation of dark and light. The differing widths of the bars form the code of a number (which is often also printed at one side of the pattern). That number identifies the particular item to the machine.

What's the point of all this? Well, it means that the owner of the store can change his prices whenever he likes. Instead of having to employ people to go around – at great expense – to stick new labels on old cans of soup, he just tells the computer that the produce with the bar code '34217854' now costs 19¢ instead of 17¢. When the cashier reads that code into the machine with a wipe of the wand, 19¢ will appear on the till and the customer's slip will have a full, printed description of what's been bought.

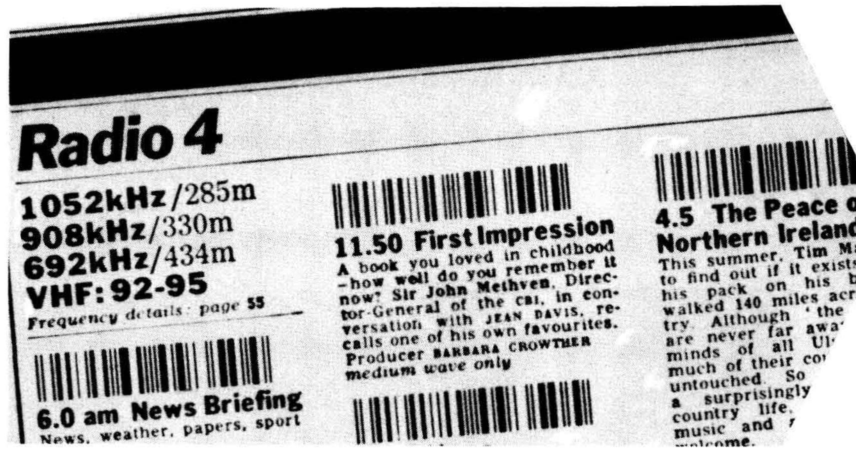
The same effect could have been produced by asking the cashier to type '34217854' – but experience shows that she'll just as likely type '34271854', which might be the code for nylon stockings at $2.25.

Bar codes also make it possible for the store owner to keep instant, accurate records of what he has on his shelves. He can see instantly which lines are selling, and which are not. He need keep in stock only what he needs; in these days of high interest rates, stores make money more by cutting down their stock than by increasing their sales.

Bar codes on the groceries being 'read' by passing them over a laser beam – which is faster and easier to use than a wand. The beam is reflected back to a photosensor. The result for the customer is faster service and an itemized receipt – useful for next week's shopping list.



One idea for the future – a bar-coded Radio Times.
A few wipes of the wand feed the computer in the special radio receiver with the list of programs not to be missed during the week. It then knows when to switch on and off. Note that the first part of each code is the same – it identifies the frequency. Right – how the light from the wand is reflected back from the bar-coded 'finger prints'.



Computing the coughs

There can be few experiences more unnerving than to hear a group of doctors gravely discussing your chest X-rays.

The first holds the smudgy picture up to the light. 'Well, at least we needn't worry about the lungs. Clear as a bell.'

'No, no, my dear fellow,' says the second, 'there are patches all over. Can't you see?' and his finger stabs at the film.

'I wouldn't go as far as Charles,' says the third, 'but there's a very worrying shadow here.'

An 'expert system' in a Scottish hospital.
Left: A patient with acute abdominal pain is examined by a resident.
Center: The doctor's clinical findings are systematically recorded on paper then entered into the computer in a coded form. Note the doctor's judgement '?Appendicitis' and her note of the computer's diagnosis.
Right: The computer compares the pattern of symptoms with a large number of earlier case histories and comes up with its likely diagnosis in this case, a 61% probability of appendicitis.