

The Micro Millennium

This book is about the future.

Not some distant future which we can blissfully ignore, but one which is imminent. It will involve a transformation of world society at all levels, and while taking place slowly at first, will gather pace with sudden force. It's a future which is largely molded by a single, startling development in technology. The piece of technology is, of course,

the computer.

Christopher Evans

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THE VIKING PRESS · NEW YORK

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First published in 1980 by The Viking Press
625 Madison Avenue, New York, N.Y. 10022
Published in Great Britain as *The Mighty Micro*

LIBRARY OF CONGRESS CATALOGING IN PUBLICATION DATA

Evans, Christopher Richie.

The micro millennium.

Includes index.

1. Computers and civilization.

2. Micro-computers. I. Title.

QA76.9.C66E9 001.6'4 79-23459

ISBN 0-670-47400-2

Printed in the United States of America
Set in Plantin

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CHAPTER FIVE

Of Gadgets and Gimmicks

THIS CHAPTER IS concerned with changes that are likely to take place in the immediate or short-term future, a future which comes to a close in 1982 or thereabouts. I have taken the Computer Revolution as beginning in 1975—at about the time that the first primitive microprocessors came on the market. Thus, in 1980, it is five years old and its first era has about another two years to run. It will be largely concerned with gadgetry and gimmicks—the sharp end of an immense commercial market, which will be lifting computers to the world's number one industry by the end of the period.

The second phase, the medium-term future, should run from approximately 1983 to 1990, and it is then that computers will have their most important social effects. In the third, and for all practical purposes, final phase, running from 1991 onwards, we will move out of the era of industrialization which began in the early part of the nineteenth century, and into a radically different world. The precise chronology of all this will be largely determined by the relative successes of the forces of inhibition and facilitation we discussed in the last chapter. If the inhibiting forces are dominant we might not emerge from the first phase before the late '80s, and from the second before the late '90s. If the forces of facilitation turn out to be unopposed we could be in the second phase within a year or so, and the third as early as 1985. In any case, most people alive today can expect to be staggered witnesses of the changes which the Revolution will bring.

In trying to get some idea of what form these changes will take we need to remember that there is a causal chain involved in all technological development. A need or demand of some kind leads to the development of a new piece of technology which is

converted into products or applications. This in turn brings about changes, great or small, in the lives of the product's users.

In the short term the over-riding technological feature is that computers will continue to become quite dramatically smaller, while the amount of information they can hold in their spatially-diminishing memories will continue to increase. The trend is already firmly established and this forecast is based on knowledge of what the electronics industry is working on at the present time in its advanced research laboratories. At the moment, for example, ten thousand words—roughly the length of a daily newspaper—can, without any difficulty, be crammed on a silicon chip less than a centimetre square and a millimetre thick. Any item of information on the chip can be accessed and displayed on a TV screen in far less than a thousandth of a second.

But this degree of compression is no more than Stone-Age technology in comparison with what will be marketable in the early '80s, when a hundred thousand words—a longish novel rather than just a newspaper—will be storable in an equivalent chip. And even this is just the beginning: microcomputer manufacturers in America and Japan are presently working on chips which will hold a million words, something like the contents of a small encyclopaedia, while the long-term planners (those concerned with the technology we shall be using in the far-off days of the late '80s) are looking at even more stupendous compression of information. They expect to achieve this by using a new variety of storage techniques, of which the most promising seems to be "bubble memory". In this technique the individual words, coded into binary form, are stored in tiny magnetic areas which progress endlessly round and round like chains of bubbles and at a colossal speed, deep in the micro-structure of an electronic chip.

It is not just memory that is shrinking out of sight, but also the controlling and calculating elements of the computer. The central processors of the very latest systems, which would have been the size of a room ten years ago, are now so small that you can barely see them. This kind of mind-twisting size reduction can lead to some odd happenings. Recently I was showing some friends a tiny central processor which I was holding with some

tweezers (my fingers were too small). Unfortunately, even the tweezer computer dropped onto the junction of my desk. My friends joined enthusiastically and the chip managed to escape and has

In case this has conjured up visions of a reduce in size almost against the odds of the universe altogether, like the trend in the worth saying that while the computer program unit, memory, etc.—the overall physical size of a work will not reduce to the same extent. If the computer simply be unable to operate the computer enough to be operated by giant computers, output devices must be large enough to handle and phrases which humans like to use. Computers will not be reduced to the size of a stuffed into their memories and the number of users will steadily increase.

You might imagine that because the computer is very tiny, the task of testing it is indescribably difficult—it is huge. It is like big things like cars—and the task is astronomically. No doubt it will be attempted in the course of the next few years. Semi-conductor firms use the computer out in huge numbers and giving the computer a "work" test at the end. This leads to a reject rate as high as eighty per cent—a huge waste of money. For a type of manufacturer a psychotest is used to find the tiny cost of each rejected computer. The tiny cost of each rejected computer is irrelevant. This high reject rate means that computers that actually end up being unreliable; another is that, as the computer start working they tend to go on working.

But cost is going to come down. The computer knowing just why this is so.

Firstly, and perhaps rather o

tweezers (my fingers were too clumsy to handle it properly). Unfortunately, even the tweezers were a bit cumbersome and the computer dropped onto the jumble which covers the surface of my desk. My friends joined enthusiastically in the search, but the chip managed to escape and hasn't been seen again.

In case this has conjured up visions of computers continuing to reduce in size almost against our will until they pass out of our universe altogether, like the Incredible Shrinking Man, it is worth saying that while the component units—central processor, program unit, memory, etc.—will undoubtedly get smaller, the overall physical size of a working computer will be unlikely to reduce to the same extent. If the things get too small humans will simply be unable to operate them. Input devices must be big enough to be operated by giant human fingers and thumbs, and output devices must be large enough to display the sizeable words and phrases which humans like to read. The overall size of the computers will not be reduced much, but more and more will be stuffed into their memories and the power of their central processors will steadily increase.

You might imagine that because you are dealing with something very tiny, the task of testing and quality control would be indescribably difficult—it is hard enough, as we all know, with big things like cars—and that this might push the price up astronomically. No doubt it would, if on-the-spot checking was attempted in the course of the chip's manufacture. Instead, the semi-conductor firms use the cavalier strategy of churning them out in huge numbers and giving them all a simple "work-or-not-work" test at the end. This leads to a ruthless reject rate which can be as high as eighty per cent—a figure which could give any other type of manufacturer a psychotic seizure—but which, because of the tiny cost of each rejected chip, is dismissed as economically irrelevant. This high reject rate is one reason why the microcomputers that actually end up being sold are so dramatically reliable; another is that, as they have no moving parts, once they start working they tend to go on indefinitely.

But cost is going to come down as well as size, and it is worth knowing just why this is so.

Firstly, and perhaps rather obviously, the smaller the computer

is, the less raw material it uses up. This would be much more significant if the raw materials involved in modern microelectronics were rare, but by a quirk of fate, nature has decreed that their main constituent should be silicon, which is extremely common—you sit on great masses of it at the seaside. The second significant feature of size reduction *vis-à-vis* cheapness is that once you can design tiny computers which act as one integrated circuit on a single slice of silicon, it becomes possible to mass produce them. The initial design of the master—like the initial design of a motor car—is massively expensive. Model One of the latest Ford probably costs several million pounds to manufacture from scratch, but its offspring fall off the end of the production line at a fraction of the cost. Exactly the same applies to computers. Finally, minute computers with minute working components need only minute amounts of power to supply them, which means that they will run on small dry batteries and become portable in a way that no one could have dreamed of even a decade ago.

I keep emphasizing how dramatically things have changed; this is necessary because the scale of change is so enormous that it is far too easy to under-estimate it. A useful analogy can be made with motor cars to put things in perspective. Today's car differs from those of the immediate post-war years on a number of counts. It is cheaper, allowing for the ravages of inflation, and it is more economical and efficient. All this can be put down to advances in automobile engineering, more efficient methods of production, and a wider market. But suppose for a moment that the automobile industry had developed at the same rate as computers and over the same period: how much cheaper and more efficient would the current models be? If you have not already heard the analogy the answer is shattering. Today you would be able to buy a Rolls-Royce for \$2.75, it would do three million miles to the gallon, and it would deliver enough power to drive the *Queen Elizabeth II*. And if you were interested in miniaturization, you could place half a dozen of them on a pinhead.

The outcome of these reductions in cost and size, and the huge increases in memory capacity and reliability, must be that computers will be widely used in areas which would have been

inconceivable before the advent of the computer. As a parallel bonus, certain aspects of microelectronics which have been available at a low cost in the past will also be available in the future. Some computers have the capability to recognize the human voice, and even, with a bit of digital processing, can also recognize the human face and phrases. On the output side, computers have the ability to communicate with the human world, to show pictures on TV screens, and also to produce the vocal equivalent of moog music. Words and phrases are created by the computer, and in this category, since we are talking about the future, we must place their ability to recognize shapes. These developments are the result of the strivings of computers to interact with the human world in a passive, way with their environment. The pieces of hardware appearing on the scene are the power to "recognize" a shape, to respond to some kind of control system, to do something useful" on the basis of the input. This would be a simple robot with a camera eye, which would recognize the border between the human world and a motorized device to cut the grass, to respond to a programmed to understand a human voice, to say RIGHT, STOP, etc. spoken by an

Already one can sniff mass-manufactured goods in a capitalist society the first step towards the Revolution will be loaded with the power to own and operate toys. Whether this is something that the consumer society or whether it is something that much further back in time, it is determining design and market-based industries. One can deplore the triviality of the products, but it will arise truly useful products

inconceivable before the advent of microprocessors. As a kind of parallel bonus, certain aspects of special-purpose computing which have been available at high cost and with only marginal reliability in the past will also become cheaply available. Already some computers have the capacity to "read" typescript, printed text, and even, with a bit of difficulty, human handwriting; they can also recognize the human voice and understand spoken words and phrases. On the output side, one must also mention their ability to communicate with the user by drawing diagrams or pictures on TV screens, and also by the use of synthetic speech—the vocal equivalent of moog in which, instead of music, words and phrases are created by the computer itself. In the same category, since we are talking about the rough equivalent of the senses, we must place their feeble, but developing ability to recognize shapes. These developments, which are only the first strivings of computers to interact in a dynamic, rather than a passive, way with their environment will lead to some interesting pieces of hardware appearing on the scene. Once a computer has the power to "recognize" a shape or pattern, it could be hooked up to some kind of control system which would allow it to "do something useful" on the basis of the recognition—an example would be a simple robot with a scanning TV camera which could recognize the border between a lawn and a path, and control a motorized device to cut the grass. As a safety feature, it might be programmed to understand a few useful words like START, GO RIGHT, STOP, etc. spoken by any human voice.

Already one can sniff mass-market gimmicks in the air, and this being a capitalist society the first manifestations of the Computer Revolution will be loaded with gimmickry. Man is highly motivated to own and operate toys and gadgets. Without going into whether this is something that has been programmed into him by the consumer society or whether, as I suspect, it has its origins much further back in time, it is undeniably a major factor in determining design and marketing procedures for consumer-based industries. One can deplore the motivation and despise the triviality of the products, but on the back of this trivial gadgetry will arise truly useful products whose manufacture and wide-

spread sale could only get under way after the initial development costs have been broken.

The real importance of the spread of the pocket calculator as a gimmick is that it has led to a huge sales outlet for chips which do routine mathematical computation—everything that Babbage ever hoped to do with his Difference Engine—and which are now manufactured by the billion at a cost of a few cents each. Riding on the coat-tails of any successful gimmick will come a second generation of devices capable of tackling a far wider range of tasks. I was one of the first customers for a calculator with a built-in 24-hour clock, a stopwatch and a bleeping “reminder” facility. I got hold of this gadget—the first calculator to be something other than just a calculator—about two years ago, and was amazed to find, barely a year later, its almost exact equivalent built into a wristwatch. Trivial? Well, maybe, but watch calculators like this are now selling by the hundred thousand.

But let us move on from this marginal product to the next phase of development where the number-only displays and the number-only keyboards of calculators are replaced by a full alphabetical array, and the calculator/computer can input and output words and phrases instead of just numbers. As it happens I have been involved in the creation of just such a device, initially designed to do simple word-to-word translation. Inside its fairly substantial memory is stored an English-French (or any other language which uses Western alphabets) dictionary, and to get a translation one simply types in a word, whereupon its opposite number appears on the display. A similar device enables one to enter words and phrases into its memory which can later be “played out” by hooking it up to an electrical typewriter—a pocket shorthand typist so to speak. Already it should be obvious that what we had originally identified as a gimmick is evolving into something with genuine practical value. But even this is just the beginning. These miniature computers—they graduate from calculators the moment they become programmable and multi-purpose—will themselves breed still more powerful offspring, whose importance we will consider later.

I have already mentioned the fiddly nature of ultra-miniaturized gadgets. Wristwatch calculators fall into this category even now.

On the other hand, the objection buttons would be overcome if the other than routine calculations. already on the market, which can other numerical reminders. Later and words as well as numbers, names and addresses, reminder the main difficulty of minuscule when speech recognition devices they can actually be built into mechanisms will then become will be performed and telephone into the watches' memories by majority of machines will probably

The other side of the coin—com an extremely rapid phase of development are diminishing in size and cost. been a talking calculator, which no deliberation in the usual array of them aloud in the voice of a s Ludicrous gimmick? Not really if or if you are doing chains of calc eyes on what you are writing. He will shortly be on the market and book is published. Another gimm you are blind or need to put on y unless you are a pilot and do not instruments, or unless you would night without switching on the b

But even if we discount this kind about instruments which speak tainers which tell you how much altimeters, airspeed indicators and aviation. At home there will be freezers which remind you to re you how the meat is coming along many people have rung in your form you how many visitors you

On the other hand, the objection to picking away at their tiny buttons would be overcome if they could be used for something other than routine calculations. Watches with memories are already on the market, which can store telephone numbers and other numerical reminders. Later, when they can display letters and words as well as numbers, they will also be able to store names and addresses, reminder notes and so on. Furthermore, the main difficulty of minuscule keyboards will be overcome when speech recognition devices shrink down to the point where they can actually be built into wristwatches. Buttons as input mechanisms will then become largely redundant; calculations will be performed and telephone numbers or whatever entered into the watches' memories by spoken instructions. Indeed the majority of machines will probably become voice-controllable.

The other side of the coin—computer voice output—is also in an extremely rapid phase of development and speech synthesizers are diminishing in size and cost. One of the first applications has been a talking calculator, which not only displays the results of its deliberation in the usual array of red numerals but also speaks them aloud in the voice of a shrunken American astronaut. Ludicrous gimmick? Not really if you are blind or poorly sighted, or if you are doing chains of calculations and like to keep your eyes on what you are writing. How about a talking watch? One will shortly be on the market and may well be by the time this book is published. Another gimmick? Possibly—again unless you are blind or need to put on your glasses to read the time, or unless you are a pilot and do not want to take your eyes off your instruments, or unless you would like to be able to tell the time at night without switching on the bedside lamp.

But even if we discount this kind of development as trivial, how about instruments which speak their measurements, or containers which tell you how much they have in them? Talking altimeters, airspeed indicators and the like will be invaluable in aviation. At home there will be speaking bathroom scales, freezers which remind you to restock them, cookers which tell you how the meat is coming along, telephones that tell you how many people have rung in your absence, doorbells which inform you how many visitors you've had and when they came,

thermometers which advise you what to wear before you get up. The list is endless. And despite the fact that it sounds like science fiction, most of it is technically realizable at this moment, and will be in widespread use before the end of the short-term period.

On the subject of houses, a familiar old gadget which has been around for hundreds of years is just about to get pensioned off forever—the key. Already you can obtain electronic locks which open when you punch in the appropriate combination, though they do rely on you remembering what the combination is. Human memory being as fallible as it is, the next development must be a lock which opens only when it has had the chance to scan the electronic chip built into a watch or signet ring. By the mid-1980s no one will ever need to hide a key under the doormat again.

Another place where microprocessors are just about to appear in a puff of smoke is in the motor car. For some time now it has been possible to buy a (very expensive) car with computer-controlled carburation—supremely efficient incidentally—and it will only be a matter of a year or so before these will filter down into the family car market. Speedometers which compute your average speed and fuel gauges which “tell” you in synthetic speech when gas is low will also be around shortly, and so will headlights which come on automatically when ambient light falls below a certain level. Another useful device will be a microprocessor which computes the speed of the car travelling in front and assesses whether the two vehicles are being driven at a safe distance. This kind of thing will, presumably, encourage more careful driving, once motorists have got used to the idea of being ticked off by their own cars, but vehicles which pepper one with spoken warnings and instructions—a horrific new breed of back-seat driver—may never be popular.

Less easily assailed on the grounds of triviality will be the impressive incursion of the computer into the home and office. We’ve already talked about domestic gadgets, but these are just a special-purpose application of computer power. A more interesting development will be the use of small computers to file all kinds of information from cooking recipes and telephone numbers to shopping lists and family correspondence, and to

cope with the important but tedious accounts. Ten years ago the notion of some day make use of computers in the home seemed on the edge of nonsense. To do just this kind of thing for less and taking up less room than a

Anyone doubting that personal computers should pop into one of the numerous stores which are springing up all over the weird and wonderful range of gear available which are devoted entirely to the computer and part industry. My favourite is the “computer word” consisting of electronic which has a circulation in excess of 100,000 which many longer-established publications, cooking or sport might envy. The magazine is composed of enthusiastic articles on the computer when you speak to them, computer lighting, heating and security of your home, mate income tax returns, and other useful information. A voluminous correspondence page where comments in software are heatedly debated. Written in that unique language known as IOK ROM, 5K RAM and MINIFLOPPY. The magazine has a THIRTY WORD VOCABULARY SPEED test. Typical examples.

One of my favourite ads, an expensive colour, shows a man sitting at a computer finishing touches to his own DIY project. In soft focus, we see his smiling wife looking at the dishes to gaze admiringly and wonder. One ponders the significance of the fact that her place is firmly in the home while her husband attends to the computer? Or are her eyes glowing

cope with the important but boring details of household accounts. Ten years ago the notion that the average family might some day make use of computers in this way—when a computer capable of coping with domestic requirements would cost two hundred thousand dollars and fill up half an attic—would have seemed on the edge of nonsense. Today, you can buy something to do just this kind of thing for a few hundred dollars, costing less and taking up less room than a colour TV.

Anyone doubting that personal computing is big business should pop into one of the numerous Do-It-Yourself computer stores which are springing up all over the place, and look at the weird and wonderful range of gear on offer. Better still, pick up a copy of one of the enormously successful magazines now available which are devoted entirely to this new mixture of part hobby and part industry. My favourite is the magazine *Byte* (a *byte* is a “computer word” consisting of eight “bits” or binary digits), which has a circulation in excess of a hundred thousand—a figure which many longer-established publications on politics, motor-ing, cooking or sport might envy. Its editorial matter is largely composed of enthusiastic articles on doors which open and close when you speak to them, computer systems which control the lighting, heating and security of your house, programs to automate income tax returns, and other similar delights. There is also a voluminous correspondence page in which the latest developments in software are heatedly debated. The advertisements are written in that unique language known as Computaspeak. NOW! 10K ROM, 5K RAM and MINIFLOPPY BACKUP ALL FOR UNDER \$300 OR THIRTY WORD VOCABULARY SPEECH RECOGNIZER FOR \$190 are typical examples.

One of my favourite ads, an expensively produced page in full colour, shows a man sitting at the kitchen table putting the finishing touches to his own DIY computer. In the background, in soft focus, we see his smiling wife, turning momentarily from the dishes to gaze admiringly and approvingly at her husband. One ponders the significance of the scene. Is she tacitly admitting that her place is firmly in the home, particularly over the sink, while her husband attends to the manly job of building his own computer? Or are her eyes glowing because she recognizes the

attractive collection of electronic doo-dads as the marvellous device all women have been seeking for millennia and which will at last free her from all household chores?

This ambiguous domestic scene may lead one, mistakenly, to dismiss personal computing as just another male "winter evening" obsession, akin to model airplane making, stamp collecting or hi-fi tinkering. It is probably true to say that the fad is being kicked off in this way—the number of women seen hanging around in microprocessor shops is still very small—but its wider applications will be appreciated in due course, as people become more tuned into what computers can actually do. This educational process will be greatly aided by developments such as the British Post Office's PRESTEL system, (or VIEWDATA as it was originally known), now in experimental service, and scheduled for full operation in the '80s. PRESTEL, as many people will already know, will connect users via a special console and TV-like screen to a huge central computer offering a wide range of information services, and a message-swapping facility. The present plan is to charge a small rental for the terminal and computer time *pro rata*. Enormously in advance of its time when it was conceived, PRESTEL has been overtaken by the gallop of microprocessor technology, and it is not obvious just what the giant Post Office computer will offer its users that they won't have by the mid '80s on their own home microprocessors. Access to huge banks of public data or library information is certainly one area, as is the personal communication facilities that it can establish between users. PRESTEL users will be able to send messages to other PRESTEL users via the computer, a kind of instant mail which must at some time make inroads into the regular postal service.

The first users of PRESTEL on any scale could well be small businesses, anxious to experiment with the possibilities of computers without committing themselves to any capital expenditure. On the other hand, the rival attractions of the new generation of off-the-shelf computers, complete with a suite of tailor-made programs for a total price of less than five hundred pounds could be overwhelming. They will be able to teach their new owners how to use them, and will also be programmed to

record and store all financial transactions, to assess taxes at each stage of business, to assess taxes at each stage of stock control, order new stock automatically, record orders, issue invoices and remittance advice, and evaluate market trends.

The usefulness of the computer extends far beyond its capacity to juggle numbers. Its word-handling capacity is almost as important, a shift of balance into the 1980s. The phrase now used is "word processing"—more or less self-explanatory—you feed information into the computer, store them in its memory and retrieve them when you like.

To give a simple example: if you manage a large number of customers most of whom have different requirements, you probably use a very large filing cabinet. With a bit of special coding you can break down the data into particular requirements so that a key can be used to inspect any customer's basic needs quite easily. It is an easy task, though, and the average person has a large amount of file-space. On a computerized system, the space occupied by the "filing cabinets" might be the size of a cigarette box. To extract information you require—let us say the name of the customer who has ordered a computer does a search through its file and returns a list of names relevant to that keyword. The keywords are the things stored in the system, and it would be possible to find out what was wanted to know, say, all the customers in the system whose names began with A and who had ordered a computer in the past six months. Key in the appropriate keyword and you would be eagerly fed to you by the computer.

Any words stored in the system can be retrieved at any time with great accuracy and it is not difficult to see how much routine filing, searching, deleting and eliminating, as an aside, how much copying and pasting, is saved.

There is another use for word processors. They can take a letter or manuscript, corrects errors here and there, and the complete text regenerates automatically.

record and store all financial transactions connected with the business, to assess taxes at each stage of the operation, check on stock control, order new stock automatically when required, record orders, issue invoices and reminder notices and even evaluate market trends.

The usefulness of the computer extends way beyond its capacity to juggle numbers. Its word-handling powers are nowadays almost as important, a shift of balance which will continue into the 1980s. The phrase now used is "word processing" and is more or less self-explanatory—you feed words, *as words*, into the computer, store them in its memory and call them up whenever you like.

To give a simple example: if you manage a business with a large number of customers most of whom have slightly different requirements, you probably use a very large card-index system. With a bit of special coding you can break the data down according to particular requirements so that a knowledgeable clerk can inspect any customer's basic needs quite quickly. It will never be an easy task, though, and the average business needs a large amount of file-space. On a computerized filing system, the space occupied by the "filing cabinets" might be no bigger than a cigarette box. To extract information you key in the word you require—let us say the name of the customer—whereupon the computer does a search through its file and pulls out all information relevant to that keyword. The keywords can relate to anything stored in the system, and it would be a simple matter if you wanted to know, say, all the customers in a particular area whose names began with A and who had ordered some particular item in the past six months. Key in the appropriate words and the data would be eagerly fed to you by the computer.

Any words stored in the system can be inspected by the computer at any time with great accuracy and speed, and it is not difficult to see how much routine filing, sorting and paperwork is eliminated and, as an aside, how much could be saved on clerical wages.

There is another use for word processors in offices: one types a letter or manuscript, corrects errors here and there, and then the complete text regenerates automatically with all amendments

made and spaces and lines adjusted appropriately.

We may as well face up to the fact that in this role the word processor is beginning to eliminate the job of the copy typist and the consequences will be felt in the early '80s. Without touching on the next phase of development—word processors communicating with each other directly without going through the performance of translating their messages into letters, which then have to clump around the ponderous mail system—it is clear that the impact of computing on routine office work in the period leading up to 1982 will be substantial.

Microprocessors will be just as useful in other kinds of businesses, including the professions of medicine, dentistry and even teaching, where information storage and retrieval problems are encountered. These areas have more in common than one might think. Doctors and teachers both have to go through a long period of expensive professional training at the end of which they are expected to divide their time and skills among a large number of supplicants—hundreds of patients or pupils. It is not surprising that they are unable to give a wholly satisfactory service. The problem is that no society on earth is wealthy enough to train, let alone employ, doctors and teachers in the right kind of numbers. But computers will make significant inroads into these areas. When a patient appears in the GP's surgery, for example, his or her name will be tapped into the terminal, whereupon a complete record will immediately appear with assorted useful family details and special warnings about drugs to be avoided, etc. Fresh details will be typed in by the doctor on the spot and absorbed into the computer's limitless store.

In hospitals and clinics computers will screen patients before they see a doctor. In schools, computer teaching—initially for “drill-and-practice”—will begin to spread as costs spiral downwards. Curiously perhaps, fears that patients or pupils would resent being interviewed by a medical computer or taught by a teaching computer have proved unfounded in experiments currently in progress in both hospitals and schools.

I referred earlier to our limitless fascination with toys and games, pointing out that the microprocessor industry is already engaged in a vigorous exploitation of this obsession. Initially, as

always, the first fruits will be trivial almost: dolls and Action Man soldiers which make computer-generated voices, toys which operate through a limited repertoire of activities, electric train sets which buzz back and forth under control, and so forth. But these represent a vast potential market, and commercial interests in the expanding “leisure” industry will be quick to find applications of computers for entertainment. Further developments will spring from their microprocessor-driven games.

In 1976 I was driving across Texas on my way to a radio station when I picked up an interview with a man who would shortly be marketing a computer-based chess game. The interviewer sounded incredulous, not because I couldn't conceive of a computer actually playing chess, but because I couldn't see how one could get a good game onto a cheap computer so soon. I had heard of elaborate and cumbersome chess programs for some time, but they had generally beaten me—I am a poor and impatient player. I shudder at the logistical difficulties of getting such a program into action and at the ponderous nature of the process. Much more than a year after I had listened to the radio broadcast, a micro-based chess game, with a small, luminous display to announce the computer's moves, was on the market. Not much later I was playing chess and being beaten. They are still a bit expensive, but they are all the time. Furthermore their chess-playing ability is improving and there are versions which already give a good game. Being beaten by a computer is an odd sensation, but it will before too long be experienced by many more chess players.

Other two-person board games, chess and checkers, and even more complex games such as Go and Backgammon, built-in computer opponents. But the real revolution will occur in the realm of games employing microprocessors where a tremendous market is already open.

always, the first fruits will be trivial almost to the point of banality—dolls and Action Man soldiers which address their owners in computer-generated voices, toys which stop, start and progress through a limited repertoire of activities on voice command, electric train sets which buzz back and forth under computer control, and so forth. But these represent only a fragment of the potential market, and commercial interests seeking to tap the expanding “leisure” industry will recognize the limitless applications of computers for entertainment. The first big developments will spring from their incursion into micro-processor-driven games.

In 1976 I was driving across Texas listening to a local radio station when I picked up an interview with a man claiming that he would shortly be marketing a computer-controlled chess player. The interviewer sounded incredulous, mainly because he couldn't conceive of a computer actually playing chess. I, too, was incredulous, not because I couldn't accept the idea but because I couldn't see how one could get a good chess-playing program onto a cheap computer so soon. I had been playing against cumbersome chess programs for some years and while they had generally beaten me—I am a poor and careless player—I used to shudder at the logistical difficulties of getting the huge programs into action and at the ponderous nature of their play. But not much more than a year after I had listened sceptically to the broadcast, a micro-based chess game, complete with board and luminous display to announce the computer's moves, was on the market. Not much later I was playing one myself—and getting beaten. They are still a bit expensive, but they are getting cheaper all the time. Furthermore their chess-playing strength is rising and there are versions which already give club players a thrashing. Being beaten by a computer is an odd sensation, but it's one that will before too long be experienced by even the world's leading chess players.

Other two-person board games, checkers, Chinese checkers, and even more complex games such as Go will soon come with built-in computer opponents. But the most spectacular growth will occur in the realm of games employing the domestic TV set, where a tremendous market is already opening up.

TV games have been around for over five years, but because their importance lies more than skin-deep I want to say a bit about their principles of operation. The essence of any TV game, from the simple to the most complex, lies in the fact that computers can push out information to the external world in a variety of different ways. In the very earliest computers, numbers appeared in a window, sequences of lights flashed, or patterns of holes were punched in cards or tapes. A later development allowed them to control electric typewriters or teletype terminals. The trouble with these mechanical methods is that they are hideously slow in terms of what the computer could do, and the next logical development was to arrange for it to generate photoluminescent spots on cathode-ray tubes, a technique which is employed in a slightly different way in the re-creation of the picture on our TV sets. In the case of TV, of course, no "intelligence" or processing power is employed at either end, and the set is merely a display unit which slavishly captures and reproduces the signals generated at the TV transmitter. In the case of the units used for computer output, in contrast, the end product is sequences of luminous characters which are actually under the control of the computer.

Now, if the computer can control a cathode-ray tube so that it can create patterns in the form of letters and words, it can obviously also create other patterns—geometric shapes for example. Using the simplest programs and the cheapest forms of display, the shapes or patterns are generally square or angular luminous areas—like the squares which form the "bats" and "balls" of the first TV games of table tennis. These games were limited only by the processing power of the chip and later, as the chips grew "smarter"—to use the latest expression for increased processing power—they were able to keep automatic score, add sound effects, and more recently to handle more complex dynamics—extra playing pieces, different angles and speeds, etc. At the time of writing, quite elaborate battle games can be played—warfare seems particularly suitable for TV simulation—with the microprocessor using its intelligence to control the movements of one set of pieces—tanks, bombers, UFOs and so on—while the human player responds by operating a simple

control lever or wheel to change the direction of fire off missiles appropriately. Direction of light and satisfying bangs and booms announces the winner at the end. Other battles between cowboys, with cover and bullet deflectors, or motor races in which a car follows a twisty track by using a miniature model of the track. The popularity of these games is already common in the home and by 1980 they will be widely available on TVs.

Hot on their heels will come even more sophisticated versions, some of which are already being developed on computers. They are on the edge of a new compulsion which is genuinely addictive. Exposed to them one's sole goal in life is to win at playing them. My favourite at the moment is a most scientific and business orientated game through to the public within the next few years. It attempts to land a space capsule on the moon.

A realistic picture of the lunar surface is shown on screen, with mountains, valleys and craters depicted. In the top left-hand corner a small object appears, retro-rockets blazing, and it moves across the lunar surface. The object is controlled by the direction of thrust of the rockets and the player is touching a "light pen" to a set of controls. The light pen is a device which is connected to the computer by emitting a pulse of electricity when touched. To increase or decrease power the player touches and down a luminous scale. To change direction the light pen at one of a set of arrows and the capsule moves in the required direction. There is a gauge displayed conveniently on a gauge which shows the amount of time as the capsule relentlessly moves across the surface. First efforts are inevitably clumsy, the capsule crashing with humiliating bangs, but slowly one begins to master the controls.

When the rocket gets below a threshold

control lever or wheel to change the position of his own units and fire off missiles appropriately. Direct hits are recorded by flashes of light and satisfying bangs and the computer notes and announces the winner at the end. Other variations feature gun battles between cowboys, with covered wagons and cacti acting as bullet deflectors, or motor races in which one steers the car down a twisty track by using a miniature steering wheel. This generation of games is already common in amusement arcades and pubs, and by 1980 they will be widely available for attachment to home TVs.

Hot on their heels will come even more elaborate and exciting versions, some of which are already being testbedded on large computers. They are on the edge of the incredible and have a compulsion which is genuinely alarming. Once one has been exposed to them one's sole goal in life seems to be to continue playing them. My favourite at the moment—it is available on most scientific and business oriented computers, and will filter through to the public within the next year or so—involves an attempt to land a space capsule on the moon.

A realistic picture of the lunar landscape comes up on the screen, with mountains, valleys and volcanic areas clearly depicted. In the top left-hand corner a cartoon space capsule appears, retro-rockets blazing, and begins a slanting descent to the lunar surface. The object is to effect a soft-landing. The direction of thrust of the rockets and their power are controlled by touching a "light pen" to a set of controls displayed on the screen. The light pen is a device which signals information to the computer by emitting a pulse of electrons whenever the screen is touched. To increase or decrease power you slide the light pen up and down a luminous scale. To change direction you point the light pen at one of a set of arrows and this makes the capsule rotate in the required direction. There is a limited amount of fuel, displayed conveniently on a gauge and, of course, a limited amount of time as the capsule relentlessly slips down towards the surface. First efforts are inevitably met with abject failure, the capsule crashing with humiliating biffs and showers of dust, but slowly one begins to master the complex skills involved.

When the rocket gets below a thousand metres in height, the

initial large-scale picture vanishes and you are treated to a vivid close-up of the appropriate area of the lunar surface, complete with pock-marked craters, boulders and the wrecks of previous crashes (the computer remembers them all!). This close-up gives you the detail necessary to effect a proper soft-landing. Slowly you improve (people, scientists included, are prepared to spend an awful lot of time learning how to land a rocket), and finally the grand moment comes when you make your first soft-landing. At this point the computer delivers a congratulatory message and a tiny astronaut steps out of the capsule and plants a little flag.

But that is not all. With increased skill and familiarity you begin to notice novel features on the moon's surface. For example, on one stretch of plain, near a cluster of boulders and by a tricky volcano, a MacDonald's hamburger stand is to be found. True *aficionados* learn not only how to find this particular portion of the lunar landscape whenever they want to, but also how to land their capsule right by the stand, achieving the satisfaction of seeing their astronaut get out, walk up to it, order two cheeseburgers and a Big Mac "to go", and march back to the rocket which takes off in a cloud of dust.

I have gone into the details of this fantastic—there really is no other word—computer simulation to give an idea of what the present generation of such games can do, and a hint of what might be expected from subsequent generations. It is not necessary to talk in detail about other existing games such as computer Monopoly, in which one drives a car through a cartoon town featuring the familiar streets and utilities of the Monopoly board, or the superbly hair-raising space battles featuring the spaceships and personalities of *Star Wars*, but they are mentioned because they are the shape of games to come.

Large industries will grow along with them, but their real significance lies in the fact that their intellect-grabbing capabilities—they are very real—will one day be harnessed in the service of the colossally powerful teaching computers which will appear on the scene in the mid-to-late 1980s.

Political, Econ

IN THE PREVIOUS chapter we discussed changes which, because of their relatively easy to identify and of their variable duration, between changes which follow in a more confident on the political that will occur within such a time can hope to do is to highlight change, even upheaval, in the significance of the changes in the areas most ripe for change, necessarily the most sensitive.

Firstly, we will witness the changes of the 1970s, the computer period of extremely rapid change of the microprocessor, which will become the world's number one of IBM spearheading the phenomenal. Their order of example, exceed the total years 1950 to 1979! Which watched them hoisting the list of the world's great companies as Gulf Oil in the process of the present trends continuing from the number one spot.

The unseating of the throne of capitalistic economic significance, the motoring era which began

About the Astounding Microprocessor

- If the efficiency and cheapness of the car had improved at the same rate as the computer's over the last two decades, a Rolls-Royce would cost about \$3.00, would get three million miles to the gallon, and would deliver enough power to drive the QE2.
- Today a single silicon chip can store 10,000 words; very soon it will be able to encompass an entire novel; by the end of the '80s, a whole set of books—and at a tenth of the production cost.
- Fifteen years ago experts said no computer could be programmed to play a decent game of chess; today there are computers which can beat 99.5 percent of the world's chess players, and very soon they will reach the International Master level.
- Thirty years ago a computer with the same number of functions as a human brain would have had to be the size of New York City and would have used more power than the subway system; today, that computer would be the size of a TV set; by the end of the '80s, it will be as small as a human brain and will run on a transistor radio battery.
- In just ten years, machines have attained the intelligence level of an earwig—an unimpressive accomplishment until one realizes it took man's ancestors several million centuries to make the same leap.

THE VIKING PRESS

PUBLISHERS

NEW YORK