A public interest forum was arranged by the Border Chapter of the Computer Society of South Africa during June 1976, with the purpose of discussing the role of the computer in society and the dangers associated therewith. The speakers were: Dr Derek Henderson, Vice Chancellor of Rhodes University and Prof Guy Butler, Head of the Dept of English at Rhodes University.

THE COMPUTER: servant or master?

Introduction by the Chairman:

We are enmeshed in the throes of the computer revolution and our individual lives are becoming increasingly affected and even controlled by these machines. To see this in a realistic historical perspective we could consider the time scale since the creation of our planet to be represented by the distance between Johannesburg and East London. Man would be considered to have existed through the last half kilometre of this distance, and civilisation to have occupied only the last metre. The computer revolution has then taken place within the last five millimetres. In this accelerating scale we might expect the next one or two millimetres of time to be of a somewhat cataclysmic effect, thus it is these few millimetres that we wish to discuss.

PART I

Dr Derek Henderson

The secret of producing H. G. Wells's time-machine, which offered trips into the past for go-getter Californians, was a restriction which prevented travellers from disturbing anything. This was because nobody knew what the effect would be in history of even the minutest disturbance. Unfortunately, on being shown the Grand Canyon thousands of years ago, one little girl couldn't resist the temptation of picking a flower. The result of this was that a certain bee didn't get enough pollen that day and it died. Its hive was at a very critical stage and the result of one bee disappearing, was that the hive disappeared and a whole lot of plants were not pollinated. Thus a minute effect blossomed forth, and by not obeying instructions this girl changed the course of history. We are reminded of the nursery adage: for want of a nail a shoe was lost; for want of a shoe a horse was lost; etc. The point which I am illustrating is that we do not know what momentous consequences can flow from the least of our actions and in an age of innocence, comparable to the child referred to, we are not even aware that there can be a problem. As we grow older we realise that there may in fact be problems arising from the fact that we are unable to predict the effects of our actions.

The three stages

I would like to structure my talk by suggesting that just as there are three stages in human life; childhood, adolescence and adulthood, a similar three major stages can be delineated in our understanding of technology (including of course computers which are almost the prime example). First of all there is the age of innocence, concerning which I will draw an analogy with human childhood. This age, we might say, started way back with the first person who rubbed two sticks together in order to produce a fire, or the first person who produced a wheel. However the most paradine representatives of the age of innocence would probably be the 18th and 19th centuries. The prime manner of approaching technological problems in those days was: with a direct problem to be solved, the inventor or technologist attacks the problem without thought for, or awareness of concomittent consequences. In doing this he is truly as innocent as the little girl who picked the flower on that trip in the time-machine. I am sure that if we think of some of the great names of that period we will see this in their outlook. Watt was interested only in a source of mechanical power and Jenner was totally concerned with a means to cure smallpox. I. K. Brunel, that most famous of all British engineers, built tunnels under the Thames and created bridges with a verve that none of his predecessors had exhibited. But I am sure that consequences, other than those intended by him, never entered his head. Thomas Edison, across the Atlantic was, I am sure, of the same frame of mind. So it was with computers, beginning traditionally with Babbage, although early developments in the concepts of modern computers can be traced further back to Leibnitz and Pascal. I think that it is very significant that it was the most philosophical of the mathematicians, such as these two men, who turned their minds to such practical matters. Leibnitz referred to his efforts as an attempt to avoid the enormous labours of brilliant men (such as himself of course) in trivial calculations. He was sure that a means of avoiding years of such labour could be found, and spent painstaking energy trying to produce the first mechanical calculating machines.

Computing innocence

Even the gifted literati of that era exhibited the same form of innocence. Dr Samuel Johnson, who is one of my most favourite literary figures, had this to say: "Nothing amuses more harmlessly than computation and nothing is oftener more applicable to real business or speculative enquiries. A thousand stories that the ignorant tell and believe die away at once when the computist takes them in his grip". Here we have the same direct approach. We see even more clearly this literal-mindedness in the famous letter which Charles Babbage wrote to Wordsworth. Wordsworth had a poem which goes somewhere along the lines that every minute a child is born and every minute a soul departs the earth. Babbage was so literal-minded as to write: that in point of fact, in order to correctly compute the world population, we would have to say that 1,008 people were born for each departing soul. Would Mr Wordswoth please try and accommodate this in his poem. Well, this attitude of direct approach to a problem in hand, without regard for side effects or consequences, persisted through to more recent times with the inventors

cepts of Babbage. Babbage, we recall, was concerned primarily with computing nautical tables and Aiken with ballistic calculations for the US Army at the Aberdeen proving ground. Now this age of computing innocence was appropriate as long as it was confined to PhDs with long hair and dirty finger-nails using computers to help them with abstruse calculations. However, their phenomenal success with this prompted emulation and imitation. One of the first, as we well know, was the Lyon's Corner House group who felt that tedious calculations were occupying a great deal of the time of excellent men. Could this new-fangled toy not solve their problems? On the other side of the Atlantic, the classical major problem was associated with the jet age, where conventional clerical techniques for handling airline reservations were becoming absolutely unmanageable. American airlines, before pioneering in association with IBM the first computerised reservation system, had to resort to hiring an enormous hall. Around the walls of this hall they had models of aeroplanes and in the centre, platoons of girls sat at telephones. As a seat was requested a girl in the middle scanned the models on the wall with a pair of binoculars and searched the plan for the seating arrangement of the particular flight for a vacant seat. Then sent a messenger to put an "x" in it to signify the reservation. Now we see, in the American airlines and Lyons Corner House endeavours and in the more bread-and-butter applications with which we are all familiar (payroll, inventory control, etc), a new characteristic. Namely that people were being directly involved. The lives of ordinary people were being touched in a way that affected them very directly. This happened in the early sixties, being the era of the nervous computer jokes, which exhibited the anxieties which people were beginning to feel about the advent of this new technology in their lives. I remember a cartoon of that period of a managing director who entered his Personnel managers' office and said: "Hire me ten thousand clerks, the computer has broken down". Of course the most popular case which we all know is the story of the bill for R0,00. Suddenly, people were becoming frightened and resentful of all the rigidities of the sort of overhastily and thoughtlessly constructed computer systems with which we have all had some kind of direct experience.

The age of realisation

All this was accepted, albeit somewhat nervously, because in the sixties we reached and entered (in respect of all technology), the second stage: the age of realisation. This was comparable to the age of adolescence in my earlier analogy. An age in which parents can do no right, the system can do no right, and everything must be questioned. Suddenly the awful side-effects and unexpected consequences of our technological civilisation were ushered into our consciousness by that epoch-making book of Rachel Carsons, "Second Spring", in which she described the appalling effects of the indiscriminate use of DDT on fish in lakes, the birds who preyed on the fish and the birds who preyed on those birds, right up through the food chain. A host of evidence began massing all around us. We became generally aware of air and water pollution affecting our lives. DDT was found on the South Pole and Strontium 90 was found in babies' milk. A general questioning of twentieth century life styles and assumptions arose and we became aware of the rather superficial proposals for the applications of computers in hospitals, libraries, education etc. Applications which would affect our lives even more drastically and intimately than simple business applications. The way in which we are taught; the quence to us than the somewhat external irritations which we had suffered at the computer's hands up to that time. But if we stop to think about this period of realisation and shock, we realise that it hasn't really lasted more than 10 years and that we are already coming out of it. The reason for this is that the shock period had of necessity to be transitional, as adolescence is for most of us a fortunately rather short stage in our lives. This is because the attitudes engendered by the original shock are essentially inconsistent.

Although we now realise, for instance, that there are problems in technology, we are not about to do without our automobiles, telephones, lights, computers. Not even extreme commune dwellers, health-food fanatics or ecology buffs seriously suggest that. Although of course we still have our extremist Luddites. In order to illustrate what is being suggested here I would like to quote at some considerable length from an article titled "Arguments for a moratorium on the construction of a community information utility".

The kind of millennium and life, which many of us imagined in our younger and more innocent days would be ushered in by computers, is firstly described in rather glowing terms. An influential and comprehensive book was recently published, describing the concept of a Community Information Utility consisting of a computing and video-broadcasting centre, connected to remote terminals. The terminals would be located in all homes in the community, in schools and in various commercial and government offices. Communication between the central facility and the terminals would be via television sets augmented with, at the very least, keyboards for input to the computer and "frame-grabbing" to freeze still pictures on the screen. Several categories of service are projected for the "CIU". These categories are: Education; Library services; on-line polling and voting; home shopping; miscellaneous personal services; entertainment; and news distribution. Much municipal information processing would be done and many industrial and vocational services would also be provided. The most radical impact would seem to be on the home-services. We see the provision of education, from pre-school to University, through television and computer-assisted instruction. Housewives shop for food and watch fashion shows and their husbands authorise payment of bills and balance the family budget with the aid of the computer. Wide selections of entertainment and selectively distributed news-coverage are projected, culminating in live coverage of all news. The entire community, and ultimately the nation, is envisaged as being able to vote on an issue or to participate in a marketing research survey without leaving the TV set. It is even suggested that we will make friends in our alienated world by seeing neighbours with similar interests on TV. As the CIU proponents recognise, considerable cost and social risk is involved in such an undertaking.

To reduce this risk, they advocate the immediate creation of a prototype CIU. For instance, we find consensus among the authors of various papers that a well-designed, scientifically evaluated prototype would reduce the long-term social risk. A prototype information utility could be made available to every urban home or community in the United States by 1985.

Many of us, in our more ambitious moments, do envisage this type of life, particularly for the more wealthy communities in the world. In fact the Japanese are already planning for this by the year 2000 and have set up a national plan for the maximal use of computers in their society by this date. All of this sounds tremendous and I am sure that in the back of our minds we all imagine that this is the kind of world that we, by our individual bits of programming and teaching, are

going to bring about. But the point is that we don't really know how to do it nor what the consequences will be. We like to think that we understand the technology, but technology will change and with it the economics will change. The social and political effects are an entirely closed book and we have to admit this. To indicate to what extent this dream of the millennium could go wrong the turn into a nightmare the theme of a short story called "The machine stops" by E. M. Forster, could be paraphrased.

Underground

The world has moved underground where each individual inhabits his or her own room. All communication is electronic and goods services and information are delivered to the rooms. One seldom leaves the room and visiting the surface of the earth is outlawed. The inhabitants of Forster's world are physically changed. A woman is described as "a swaddled lump of flesh, about 5 feet high with a face as white as fungus". People are barely able to walk short distances or hold objects and can no longer breathe air. They are deluged with input and are fanatic about saving time. Direct evidence of any sort repels them and they value only one thing, having ideas. The inhabitants of this machine are well adapted. For instance, artificial grapes with no bouquet and images without nuance or expression are good enough. When the machine begins to fail they readily adapt to putrid food and stinking baths. The people are totally dependent upon their CIU and no one understands it fully. When it begins to deteriorate they begin to deify and worship it. Eventually when it fails totally mankind perishes.

This is an alternative vision of the millennium. The solution which is put forward by the authors for this problem is: let us put a moratorium on all kinds of development for the next 24 years until 2000. They argue that if a prototype is built, vested interests will arise and with a great deal of capital invested there will be an almost irresistible pressure to go along with the consequences, although everybody might admit serious shortcomings. The view is finally summed up in a manner which is extraordinary for a computer scientist (a notoriously impatient being) as a CIU by 1980 or 2080 makes little cosmic difference except that it will be implemented by different people.

We have often been imprudent and irresponsible with our technology in the past. This has been understood by the general public but not always by ourselves. We come now to an intriguing problem and this is a question which I particularly want to pose. Will we ever totally understand what we are doing? Even if we declare a moratoruim of 24 years in order to study the thing properly.

We are beginning to appreciate, I submit, that we never will totally understand the full and final consequences of anything that we do. This means that we are beginning to enter the area of trade-offs or compromise. This is typical of adulthood in life. The idealogical simple-minded commitment is no longer there. In this compromise situation we make serious, concerted but importantly, not exhaustive efforts to foresee all reasonable implications and risks associated with what we are trying to implement.

The 100 per cent solution

There is here a very interesting paradox which is aired in a paper by M. O. Rabin which he read at IFIP 1974. Rabin is incidentally the Vice Chancellor at the Hebrew University in Jerusalem, so that Rhodes is apparently not unique in feeling that Vice Chancellors with computer experience might be of some utility. Rabin illustrated the main point in his talk by saying "let us suppose that you are a stickler for detail, a perfectionist and one of the things which you have to do is travel". For instance, suppose that you had to plan a journey from East London to Fairbanks Alaska. Suppose that you asked your travel agent not just to plan your trip but to check and double check, no matter what it cost, to make sure that every detail of the trip was exactly right. To realise this in practice, such an army of travel agents would have work for so long on your business that you would never leave at all. If you were content with a very competent travel agent whose plan would be successful nearly all of the time, say 99,9 per cent of the time, the journey would be feasible. If we insist fanatically, that every solution to a problem must be 100 per cent correct, then strangely no solutions are ever implemented. This phenomenon applies to our understanding of the consequences of technological innovations and if we insist from an ecologically pure point of view on knowing all the consequences of any small technological improvement, then we are dooming the whole human race to a state of paralysis.

To quote Rabin more formally: "Another venue of exploration involves the idea of accepting algorithms and computations which are known to produce errors in certain cases. We know that the human problem solver is not infallible. He argues, makes deductions, often solves problems, but not infrequently produces wrong solutions. Could it be that our success as humans is in part attributable to the laxity of our procedures". The argument is plausible and certainly fits in with our everyday experience. Trying to double-check every step can impede us to such an extent that we never finish a task. However, errors have no official place in programming. In fact error represents the original sin to the programmer, and every possible measure is taken to avoid it. Rabin refers to a somewhat artifical example which he constructed, being a computational problem with the following features: If we are content with being right almost all of the time, in the mathematicians sense, but do allow a very occasional error, then we can solve the problem in what he calls "polynomial time". This means that if the problem has some kind of characteristic parameter, such as the number of cities to be visited in the "travelling salesman problem", then polynomial time of solution means the number of time steps that have to be taken is given by the parameter raised to some constant power. On the other hand, if we insist on algorithms which always produce the correct answer, then we have no algorithm which is better than "exponential time". This means that the time taken to produce the solution is given by some constant raised to the power of the parameter. Thus, insisting on being right all of the time must be paid for by huge amounts of computer time.

Conclusion

I submit, therefore, that although we know that there can be serious consequences without technology, we do need our Koeberg nuclear power stations, our roads, and computer networks. Only a few idealists and Luddites are prepared to do without them completely. As the human race we must and will proceed, but hopefully in a mature and responsible way. We can, however, never proceed with absolutely guaranteed safety. The price of complete protection from bad technology is complete paralysis. Ever since the first use of the wheel the human race started on a dark and dangerous odyssy. S

Part 2, the address given by Prof Guy Butler will be printed in our next issue.
