THE FUTURE OF COMPUTERS

Three years ago we had a special issue on computers. Published at a crucial time when microcomputers were leading to the expansion of the computer industry worldwide and in Sri Lanka it had a catalytic effect in the country. Just like previous issues of the Economic Review on key subjects such as those on Women, Energy and Transport which described widely for the first time in Sri Lanka a developing area of interest, our issue on Computers had a sensitising effect.

In the intervening three years, computers have been widely discussed in the country, the micro computer revolution has begun to spread on Sri Lanka, a National Computer Policy has been announced and on the international scene, there have been more significant technological changes.

The micro computer revolution started roughly five years ago with machines like the Radio Shack Model 1 and the Apple. The micro computer has since developed into a consumer product that is selling by the hundred thousand. This has been accompanied by a drastic drop in prices. In Sri Lanka micro computers with capacities not very different from the biggest main frame computers, used in the Sri Lanka of a decade ago, are about to break the barrier of the cost of a bicyle. The developments in the last three years have been very rapid. This special feature documents some of the developments in the field, both internationally and in Sri Lanka.

ENIAC the first electronic computer built nearly 40 years ago had a memory capacity of roughly 1000 cells 1K. Thirteen years ago Intel Corporation brought out a silicon chip the size of a thumb-nail with 1K (roughly 1000 storage cells) as a Random Access Memory (RAM). Chips are created by etching of circuits through photographic processes on wafer thin silicon. The amount of circuitry that could be so etched has grown in geometric proportions. Every three years since Intel's introduction of the chip there has been a four-fold increase in the storage density of chips.

Only five years ago the most commonly used memories for micro computers in the RAM category (Rander Access Memories) had a capacity of only 4K. A couple of years ago a major innovation was the 64K RAM, worldwide sales of which in 1983 alone were close upon one billion dollars. The 256K chip is now in the manufacturing stage and its mass production is expected to overtake the sales of 64K RAM's in 1985. A single chip with 256K has the ability, for example, to store 10,000 telephone numbers or written texts of 5200 words, i.e. about 10 pages of text of the *Economic Review*

If a 256K memory on a small chip seems a very significant leap from the 1K computers of the 1940's (which used to fill a large room) there are further qualitative changes in store. The so called Christensen chips that are now under development are designed to store 4000 K on a chip which

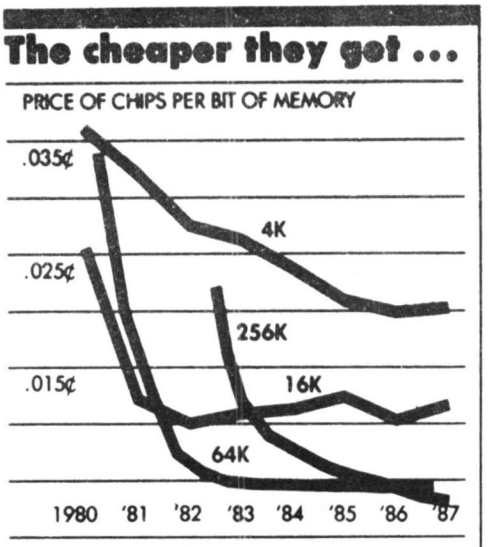
is a capacity 16 times that of a 256K BIT. Behind this development is Christensen a silicon valley innovator who believes that future chips based on this principle would be able to store 400 megabites on a chip.

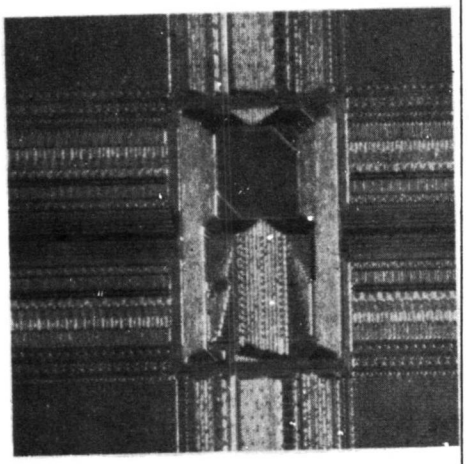
A technical barrier for packing chips had been heat generated by the chip. Chips are so densely packed that they sometimes give as much heat as a light bulb. A new range of low heat generating chips of so called CMOSS chips (Complimentary Metal Oxide Semi-Conductor) is rapidly changing the situation. CMOSS chips combined with liquid crystal displays are expected to lead to a new breed of transportable computers. Since last year a hand held computer, the size of a large desk diary, the Radio Shack model 100 with 24K has been selling rapidly in the United States. A Japanese company announced late last year a computer on a wrist watch with a 1K memory capacity, a far cry from the 1K ENIAC computer which filled a large room.

With mass production because of economies of scale the prices of chips per unit of memory (BIT) came down. Because of this process a chip, with a particular memory capacity, reaches a peak sale six years after its introduction and then drops in sale to be followed by a new generation of chips having a higher memory capacity. The cheaper they get the more chips sell as is shown in the above diagram. This follows a previous pattern set by the transistor radio and the pocket calculator.

Buffs in Silicon Valley have pointed out that if the motor car industry went through the same price reduction and increased in efficiency as has the computer industry, cars would now cost 1 dollar each and run 500 miles on a gallon of gasoline.

Airline booking systems and banking were one of the earliest businesses to be computerised as these activities used very rudimentary and easily describable operations. Computerised Inventory and Accounting systems

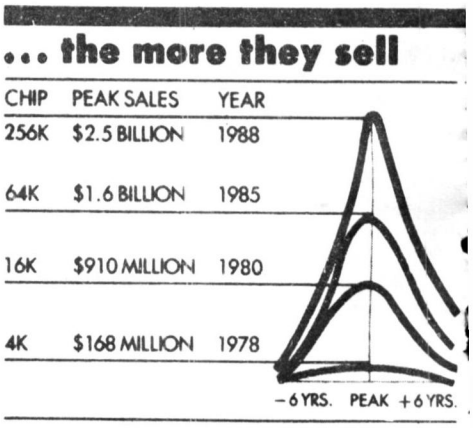




A section of a 256K memory chip

of most firms as well as design aids in engineering are widespread in the developed world.

Thus, in a developed country today, routine banking activities are computerised, replacing bank clerks, the telephone system is computerised replacing telephone operators, the electricity grid is computer controlled replacing lower level engineering personnel, air ticketing is done by computers. In addition routine govermental activities, done by human skills such as billing tax bills, and social security or large warehouses, are done by computer programmes and most car assembly lines are not only to a large extent built by robots, but also have been designed using computer aids, while entire factories are partially controlled by computers. The next development, so called knowledge based expert systems that border on the fifth generation computer, are already available.



Tobogganing down *the learning curve is a way of life in the semiconductor memory business. In price per bit, the 256K should catch up with the 64K in 1985. (Estimates for upper chart from Gnostic Concepts Inc.) As prices fall, volumes keep climbing. (Lower-chart data from Motorola Inc.) The chip in the photograph is Western Electric's.*

Many main frame and micro computer users in the developed countries today have access to large data bases by linking their computers by telephone through a simple device called a Modem. Information systems such as the British Prestel have become the forerunner to widespread information access in the home. With millions of personal computers already installed, there is at the moment an explosion occuring in this information exchange between such computers national data bases and interacting information services such as those of Prestel. (Aldrich 1982) One could have access to some of these data banks from Sri Lanka too by using international telephone links. There are no acccessible data banks in Sri Lanka as yet. Computers exchange information using modems—the basis for the decentralised office, where the office worker stays at home and interacts with the information world outside through a modem connected personal computer.

An exciting development on the horizon due to occur over the next ten years arises from a new breed of computers that would do very many tasks normally classified as thinking. These are the so called fifth generation

computers first announced as a major goal by the Japanese and now also sought for by research and development teams in both the US and Europe. The previous "generations" of computers corresponded largely with developments in hardware, but the new ones aim at a qualitative leap in software capacity.

The fifth generation computer is expected to understand normal speech, read documents, process images and mimick both deductive and inductive thinking. Such a development would blur the barrier between man and machine beyond recognition. Some of the features of the fifth generation computer are already available in rudimentary form.

Speech output devices for even the most simple of micro computers have been available for at least five years. Already consumer products are on sale that can "talk". Examples are appliances such as cooking stoves or washing machines that announce the state of the cooking or washing to the user. Electronic spelling devices have been selling for over five years.

Speech input devices which are essential for machines to which one can talk to, are more complicated as they require much larger memory power and sophicticated pattern recognition abilities. With the availability in the near future of very large memories at cheap cost such devices are not very far away. These devices would for instance, enable, the development of typewriters to which one could talk to and which would give as an output,a typewritten document.

There has been considerable debate over the last three decades on whether machines can think or whether they could surpass humans in mental capacity. Even the very earliest computing machines were capable of very fast calculation but these activities were dismissed as being that of a speeded up abacus. However, with sophisticated programming techniques and greater insights into what is meant by "thinking" the line between man and machine thinking is becoming thinner.

Today there are chess playing programmes which are used even in micro computers which could defeat the majority of Sri Lankan chess players. There are also more sophicticated chess playing programmes operating on main frame computers that are on the level of a Master and these programmes could of course beat any Sri Lankan chess player. Since 1977 a new breed of chess programmes have begun beating some of the best humans.

The best programmes can beat half the rated players in the world, that is those who compete in official tournaments almost everytime. At the end of 1982 there were six machines that could beat the best 30 percent of players, and programmes have become champions of some U.S. states whilst computers have already beaten players on the grand master level. It is widely believed that within the next few years the world chess champion would be a computer programme. However, it should be noted that chess programmes are successful more because of their power of reliable and rapid calculation than of the Major Programming techniques which of course have helped. The more sophisticated computer programmes, which are being looked at in the field of artificial intelligence (A1), are bound to increase the intelligence aspect of chess programmes.

One of the founders of computer science Turing described over forty years ago a universal computing "machine" using a moving paper tape and a pencil that could mimic any mental behaviour that could be described. Turing also published a test which would decide whether a computer thinks or not.

The Turing test is based on a person communicating through a tele typewriter with a machine or a human being. On the basis of the answers given through the teletypewriter to his questions, the operator of the test has to decide whether the replies are given by a machine or a human being. If the interrogator cannot distinguish on the basis of the answers between machine, which is answering the questions, and a human being, then the machine is supposed to have passed the Turing test and would be considered thinking.

However, as early as 1965 a programme called Doctor or Elisa Programme designed by Weizenbaum was able to answer in a realistic manner questions put by human interrogators and seems to pass the Turing test. The programme was based on sophisticated analysis of grammar and some carried replies not on an understanding of the subject.

Doctors, nurses and patients were Weizenbaum was to later record were foll: ed into believing that the machine was thinking. There is intense research being carried on artificial intelligence in major centres in the world. Some are developing programmes that help a computer have an internal model of the external world in the way living and growing in the world help humans to have it. In the decades to come Artificial Intelligence will still further blur the division between man and machine.

In the Hindu-Buddhistic tradition, the problem of the mind has been a major philosophical and psychological concern in the last 2500 years or so. The new capacity of machines that mimic the mental functions will raise important questions for these traditions.

The Corpenican, Darwinian and Freudian revolutions have not shaken these religious traditions in the way it shook Christianity and Judaism.

The challenge of artificial intelligence is bound to question the South Asian tradition as deeply as the other scientific revolutions questioned the Judaio-Christian ones.

TOWARDS MACHINE INTELLIGENCE

Large amounts of information are today stored, processed and transormed by machines. Increasingly they have taken over activities that were hitherto limited to the human mind.

The border line between men and machines in information processing capacity is, however, becoming increasingly thinner and strict definitions that demarcate human thinking as something exceptional is getting to be difficult with today's machines.

One of the key formal breakthroughs in the mechanisation of thought processess was in Turing's theorm of nearly 50 years ago. He demonstrated that a simple machine consisting of a moving tape on which simple marks could be written and erased could mimic any activity that a mathematician could do with pencil and paper.

Since then, and in the 60's particularly, there have been formal research programmes specifically designed to mimic human thought. A necessary adjunct to this activity was the need to define what was uniquely human intelligent thought and how one could recognise an intelligent machine. One of tne key tests had been again provided by Turing. His test was based on a person interrogating a human being or a machine through a teletypewriter. The interrogator, has to decide on the basis of the answers given to his questions whether he is communicating with a human or a machine. The Turing test holds that, if after adequate questioning through the teletypewriter, no difference between man and machine could be established, then the machine is supposed to "think".

This test evoked a large amount of literature and programmes were produced which seem to have passed the test. One of the better known of such programmes is the Eliza programme by Weisenbaum. The programme eimulates a psychiatrist, the human questioner acting as a patient. The "conversation" that ensues is very life like and has even followed professional doctors and nurses to such an extent that Weizenbaum had to later write a book about the experience. He was specially disturbed that the programme which "created the most remarkable illusion of having understood in the minds of the many people who conversed with it "would result in people often" demanding to be permitted to converse with the system in private, and would, after conversing with it for a time, insist inspite of my explanations, that the machine really understood them." Because of this phenomenon certain writers have even suggested changing the Turing test. But there doesn't seem to be a reliable replacement in sight. It seems that the human mental domain as an exclusive area, is gradually getting eroded.

Non trivial mental functions attempted by artificial intelligence research include, for example, game playing, translation, music composition, production of natural languages, understanding of languages, visual and aural recognition, thinking analogously, as well as learning.

In games like back gammon, draughts and chess, computer programmes have progressed to such an extent that they can often beat human players. Thus a checkers (draughts) programme by Samuel has been consistently beating its programmer and chess playing programmes have begun beating some of the best humans. The best such programmes can beat half the rated players in the world, that is, those who compete in official tournaments almost everytime. As at the end of 1982 there were six machines that could beat the best 30 percent rated players and programmes have recently become champions of some U S states whilst some computers have already beaten players on the grand master level. It is widely believed that within the next few years the world chess champion could be a computer programme. However, it should be noted that these successful chess programmes are a combination of brute computing

Eliza is a programme that simulates the rôle of a psychiatrist. A sample of an Eliza dialogue follows which programme designed in the mid – 1960's has fooled many professional psychiatrists. Eliza's comments are in capitals, the "patients" in lower case,

P Men are all alike,
E IN WHAT WAY
P They're always bugging us about something or other.
E CAN YOU THINK OF A SPECIFIC EXAMPLE
P Well, my boyfriend made me come here.
E YOUR BOYFRIEND MADE YOU COME HERE
P He says I'm depressed much of the t time.
E I AM SORRY TO HEAR THAT YOU ARE DEPRESSED
P It's true. I am unhappy.
E DO YOU THINK COMING HERE WILL HELP YOU NOT TO BE UNHAPPY
P I need some help, that much seems certain.
E WHAT WOULD IT MEAN TO YOU IF YOU GOT SOME HELP
P Perhaps I could learn to get along with my mother.
E TELL ME MORE ABOUT YOUR FAMILY
P My mother takes care of me.
E WHO ELSE IN YOUR FAMILY TAKES CARE OF YOU
P My father.
E YOUR FATHER
P You are like my father in some ways.
E WHAT RESEMBLANCE DO YOU SEE
P You are not very aggressive but I think you don't want me to notice that.
E WHAT MAKES YOU THINK I AM NOT VERY AGGRESSIVE
P You don't argue with me.
E WHY DO YOU THINK I DON'T ARGUE WITH YOU
P You are afraid of me.
E DOES IT PLEASE YOU TO THINK I AM AFRAID OF YOU
P My father is afraid of everybody.
E WHAT ELSE COMES TO MIND FATHER
P Bullies;
E DOES THAT HAVE ANYTHING TO DO WITH THE FACT THAT YOUR BOYFRIEND MADE YOU COME HERE

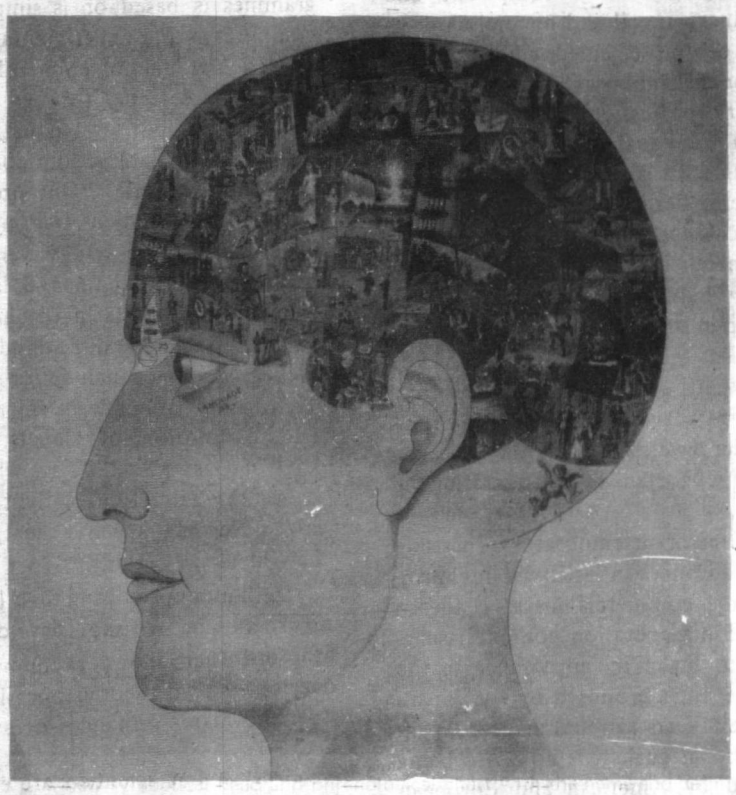
P- Patient
E-Eliza

force and heuristics (rules of thumb) which are provided by the programmers inspite of their proven powers, and are not yet versatile intelligence.

Language translation through a word for word dictionary look-up have been attempted for over two decades now. Such simplistic efforts though useful were often subjected to errors arising from idioms and context, for example, the term "hydraulic ram" is mistranslated as "water goat." More recent attempts to translation have realised that real translation would imply that the translating programme possesses also a model of the external world internalised by it in the same way as humans. Easy language to language translation is one of the qualities expected of the 5th generation of computers expected in the 1990's.

The field of vision and pattern recognition is another one where rapid advances have been made. There are devices that can recognise shapes and manipulate them and which have already been included in existing robots. Advances have also been made in the use of artificial vision devices for recognising pictorial material. Some devices can locate specified objects in photographs, break up a scene into separate objects and identify objects one by one in a scene and recognise shapes including those of human faces. Some devices can recognise Latin script handwriting and also the Chinese and Japanese printed characters and even handwritten characters. In aural pattern recognition there are devices that have a rudimentary ability to "understand" spoken words and can be taught to recognise particular voices, whilst devices with voice output are becoming increasingly common even in micro computers.

Computers even without strong artificial intelligence characteristics are entering into areas that have hitherto been the preserve of relatively creative human workers in professional fields. So called expert systems fall into this category. The work on expert systems was begun in the 1970's. Such systems would act as consultants and teachers in a wide variety of technical subjects. An expert system would be built up by compiling a bank of basic data on a particular area, that is presently held by human professionals. The result is a general consultancy system that could be interrogated by users.



'A new symbolical head and phrenological chart with the name and definition of each organ'. Natural philosophers of the past thought of the brain as containing many distinct personalities. The author of this nineteenth century engraving postulated organs of ,amativeness', 'conjugality', 'parental love', 'sublimity', 'ideality', 'tune', 'destructiveness', and many more.

These knowledge based systems are expected to answer questions given to them by both professionals and laymen. Already the first generation of such systems that give answers based on rules of experience and guided by so-called surface knowledge are already available. By 1982 there were over 50 such systems in operation largely in the US. A surface knowledge expert system incorporates the codified knowledge on a particular field. A second generation of such knowledge machines provide answers from first principles. "Deep knowledge" systems are now in the pipe line. Deep knowledge systems are expected to be far more powerful and exceed the performance of surface knowledge systems. Existing systems using surface knowledge include those that are used for the identification of chemical compounds from laboratory data, diagnosis of diseases etc.

There already exists expert systems in the medical field that can advise on respiratory diseases, bacterial infections and eye diseases. Some of these expert systems have already proved to be more reliable than humans. Thus, a medical expert system called 'Mycil' already has a better record than human physicians in its ability to identify and treat Meningitis and blood infections. The machines have beaten the humans not only in the accuracy of identifying Pathogens, but also in avoiding over prescription, a very important factor in treatment.

Similarly, expert research system called Dendral and Secs has had a very high success in the field of chemistry. The Dendral system has been used by chemists to test hypothesis

and gather evidence. It has been said by those professionals familiar with it that this programme "has as much reasoning power in chemistry as most graduates students and some PhD's in the subject."

Recent expert systems have also been produced for arriving at computer configurations, trouble shooting and repairing of heavy equipment and machinery in oil and mineral exploration, computer aided education and also in the military. It is expected, by military professionals, that machines would be equal partners in decision making with humans. Expert systems are being designed to computerise the practical decisions taken in the field by generals. The assumption is that as in any bureaucracy those who reach the top in the military are a mixture of "good" generals and "dumb". An expert system with judgemental ability at a level of a general is currently under development by the Pentagon and is expected to be operating by 1990.

A major attempt at synthesising recent advances in 'artificial intelligence', on a commercial basis, is the so called 5th Generation computer scheduled to make its appearance in the 1990's. First proposed by the Japanese a few years ago and made a Japanese national goal, it is now also being pursued by American and European research teams.

A 5th Generation computer has several human like characteristics. It would automatically translate from English to Japanese and vice versa. (Thus, an advanced 5th generation computer would enable a telephone caller in America, phoning Tokyo, to speak in English, whilst being received in Tokyo in Japanese and vice versa.) Such a computer would also have an advanced speech recognition ability so that it would understand verbal commands. It would also be able to act as a very large expert system. It would have inference capacities and judgement and decision making abilities. Such a computer would in all probability be able to hold an intelligent conversation with a human being in several separate fields.

There are several already existing programmes that mimic more creative scientific work apart from those that we have already mentioned under expert systems. Expert systems work on received knowledge. The creative systems help generate this knowledge base.

One of the most widely discussed of such programmes is the BACON programme developed by Patric Langley and others (Gardener 1983 p.87). The principle on which such programmes is based on is simple. The computer is fed experimental data on a particular phenomenon. The computer then searches through this data to arrive at low level equations that would fit the data, a common feature in scientific work. This programme once given data about the outcome of experiments have re-discovered some of the major fundamental laws that were turning points in the history of science. Such laws discovered through such programmes include for example, Archimedes principle, Kepler's Third Law of Motion of Planets, Boyle's Law of Gases, Snell's Law which describes the refraction of light, Black's law governing specific heat, Ohm's Law Electricity (Ibid).

Still more promising than Bacon is a programme Urisko developed at Stanford that allows a computer to develop its own theories once it is fed with the major principles of a discipline.

Only a few scientists are engaged in the field of creative thinking. Most scientists do repetitious mundane research. Increasingly computers and computer based systems are entering this field.

Chemists have been increasingly turning to computers to study exotic molecules through the discipline of computational quantum chemistry. These attempt the predicting of properties of patterns and molecules using quantum theory Sophisticated programmes such as ALCHEMY, ATMOL, MOLECULE AND POLYATOM have been devised to automate this process.

Chemists not only do calculations from first principles as in the above example, but many engage in experimental work. Falling prices of robots is resulting in the introduction of the unmanned laboratory; the lab being one of the few places still untouched by automation.

One of the most exciting experimental fields at the moment is in gene splicing where biochemical processes change the basic templates of life. Since 1981 a Canadian company has been selling computerised gene machines. The computer in this machine, times the entry of chemicals and the sequences of chemical bases in the genetic chain. It has been calculated that such a machine promptly does what a fully trained genetic engineer would do in six months.

Computers have been used for observation in astronomy (they had been used for well over a generation to process astronomical numerical data). It is now being increasingly used for observation purposes where star photographs are regularly counted and classified using computers, leaving only the most creative tasks for humans.

Computers have been used for quite some time in the design, as well as the manufacture of computers. The growing complexity of designing tightly packed integrated circuits have been eased by computer techniques. Today many computer designs are being made which would not have been possible without the intervention of computers. There are also several programmes today which transform one computer language to another automatically and act as higher level programme writers.

A combination of both energy and information based machines are taking over the functions of human muscle and nerve, in physical activities as is evidenced by the recent explosion of the robot population, specially in Japan. Robots are today running large sections of industrial plants, particularly in places that are dangerous to humans or are boring. In applications such as motor car assembly, robots are today much cheaper than human labour (specially in developed countries) which is three times as costly as a robot.

Engelberger, one of the pioneer manufacturers of robots in the US, has spoken of a second generation of robots that are about to emerge in the coming decade. These would have flexible mobility, voice instruction, general vision facilities, touch facilities and several arms. These developments according to Engelberger's predictions would be such that by the turn of the century robots would be so cheap that a large amount of production of material wealth would be carried out by robots.

ARTHUR C CLARKE IN CONVERSATION WITH SUSANTHA GOONETILLAKE

FUTURE OF COMPUTERS

S. G.

Since we are going to talk on the immediate past and the future I would like to first begin on a personal note; to recall a similar meeting with you about 20 years ago, when as an undergraduate editor of the University Maths magazine, I came to you for an article on Space. Over 25 years ago you also wrote the book "Profiles of the Future". What have been the major developments in computer hardware and software that you did not envisage in that book ?

A. C.

It isn't easy for me to answer. (Incidentally the "Profiles of the Future" was re-issued in a new edition a couple of years ago).
But the most astonishing thing, which nobody ever anticipated or could have anticipated, is the micro-chip. Twenty years ago, a computer filled many rooms and consumed kilowatts of power. Now their function could be done with something the size of your finger nail. It is absolutely incredible. A thing which I can't get used to is the fact that I spent all my youth and early manhood, using a slide rule and mathematical tables — it was a basic tool of all scientists and all engineers. No one ever dreamt that within five years of introduction of calculators, based on chips, the slide rules would no longer even be manufactured. This extraordinary development in micro chips is the greatest revolution I think in recent human technology.

S. G.

Suppose we now stretch our horizens over the next 25 years and attempt to predict developments ahead.

A. C.

It's impossible. So, there's no point in stretching out over so many years. I mean anything one could imagine can be done in the next 25 years.

S. G.

Shall we then consider a shorter time horizon, say 5 years. What do you think would be the hardware developments over the next 5 years, say in minuaturization of components and the increase in packing densities.

A. C.

I do not think there is any point in getting any smaller for ordinary applications. Anything you want to do for ordinary purposes can be done by the existing personal computer, which is as small as a portable typewriter and getting even smaller. Limits in miniaturization are now set entirely by humar hands. You obviously can't make a keyboard smaller than the limits set by our fingers. In fact some key boards are already much too small so that you have to pick at them with tooth picks. As far as packing density of chips is concerned; this is only important, say, in very high-powered scientific applications, when you want to do hundreds of millions of calculations in a second. For commercial applications and for routine everyday work, we have already reached the ultimate.

S. G.

That is about processing. How about memory capacity ? Do you think that one would see, for all practical purposes, limits to packing densites in personal computers in the next few years?

A. C.

No. One won't see the limits. But it doesn't matter. I mean the personal computer I have on my desk today could hold the equivalent of 10 books, in its hard disc. In fact I haven't even used a quarter of the memory capacity in the machine I have, even though it is now already obsolete. So far as most business purposes are concerned - certainly for most personal computers — we've already got everything we will ever need. It is only the scientists and the big corporations that will need any more capacity, any more memory. What we do need is more "user friendliness", that is my problem. And we need standardization.. I mean I have 6 or 7 computers none of which can "talk" to each other, and that's a great difficulty. We have to get common standards.

S. G.

The trade was of the view last year that with the arrival of the IMB PC standardization was on its way. 'Because of its market penetration, and IMB's strong image, the PC will probably bring about standardization'. How soon do you think standardization would occur ?

A. C.

Some day it has got to be done. Today it is a great battle between Apple and IMB. IBM and Apple are the two gladiators — you can say— in the field at the moment. Some computer firms are going to fall by the wayside — it's already happened to some.

S. G.

With economies of scale, the prices of personal computers have been going down and seem

to be following a path already set by other electronic products like transistor radios and pocket calculators. It seems therefore that computers, would be affordable; in fact very affordable in the Third World, much more for example, than "Hard" products like cars.

A. C.

Yes. Certainly in comparison with cars. A computer or calculator already costs only a fraction of the cost of a car and it costs virtually nothing to run. But my particular theme now is what the developing world needs is a telephone. And that is one thing the Arthur Clarke Centre in Moratuwa is concerned with, solar powered telephones and then solar powered radios, so that there is no need to worry about batteries. And computers and information storage devices would then follow.

S. G.

Solar powered telephones with wires or radio links.

A. C.

Today, you just can't afford them with wires anywhere, they are too expensive, and they get stolen.

S. G.

Yes. Specially in Sri Lanka. Ever since the advent of computers there has been anxiety about them, that they would be taking more and more of the intelligent functions of humans. Do you think that artificial intelligence would make significant jumps in the near future. For example in your film 2001 there was the talking computer HAL, and there are now devices for personal computers which one can buy for about $ 20/= which give a crude voice output.

A. C.

Nothing like HAL is going to be a reality in the foreseeable future. In my Apple I have a programme with which you can type anything, it will say it. However, you have to play around with it because English spelling is a bit peculiar. The bigger problem is for computers to understand spoken language, particularly English. I do not think we will have machines which can really understand, in the sense that say HAL on the film, by 2001, but I'm sure we will have them some day.

Incidentally we have started shooting 'Odessy 11" the sequel to 2001. I am on line several hours a day on my computer to the producer in Hollywood. I just loaded up today's despatch and I'm doing a live interview on my keyboard, for the 'Los Angeles Times'. That means my life has been totally revolutionised by my personal computer and the telephone link. These could put everybody in the electronic global network and here again the problem is of standardization.

S. G.

The Japanese and now the Americans and the Europeans are working on the 5th generation computer, which they hope will come in the 1990's. It is supposed to have voice recognition and several other intelligent functions.

A. C.

We sure will have a lot of voice recognition by then, but the question is whether we will have comprehension.

S. G.

You implied that there would be a strong impact on the emergence of artificial intelligence on mankind, could you perhaps elaborate?

A. C.

Well, obviously, when we have entities that can talk to us, do a conversation, you know, that will have a great impact. But its a question of how quickly people adapt to computers. The younger generation will take them for granted, younger people for example do not get much excitement of going to the moon anymore.

S. G.

A few years before you wrote your article on Satellite transmission to *Wireless World*. in the 1940's Turing wrote a very significant paper on computing. He showed that with a piece of paper and "scratches" on it, one could simulate almost any mental activity. That is, mechanisation of almost any thought process was possible in principle.

Now Sri Lanka belongs to the South Asian religious traditions which place a strong emphasis on the mind, very much more than the Judaic-Christian tradition. What in your opinion would developments in artificial intelligence have on cultures like ours, which are, say, "mind" centered.

A. C.

I think it will have a strong influence on all cultures. It happened earlier with the Corpenican revolution when the earth was dethroned from the centre of the universe, and the Darwinian revolution when man was dethroned from the top of the animal kingdom and just became another animal. And artificial intelligence

is a final stage, when we realise that ours are not the only intelligence possible, and that we may even create our own successors.

S. G.

Of course, we should remember that Corpenicus and Darwin had a particularly strong impact and were resisted in the Western world because the Western religious system was strongly man centred. In the more philosophical and broader Hindu-Buddhistic world it is somewhat different.

A. C.

Yes. One could also mention China. The Chinese had a correct view of the Universe; that the universe is enormous. But then, the Jesuit priests arrived and talked them out of it.

S. G.

("Bringing what was then called "western learning").

In computers there is a sequence of machine "evolution", which perhaps parallels the biological evolution that has been underway for roughly the last 4,000 million years. There are indications that the machine "evolution" would take place at an accelerating pace, and that one would have an exponential growth of machine intelligence. Would such an exponential growth flatten out ?

A. C.

Of course every such growth will eventually flatten out. Then again what happens is that another exponential curve starts at a higher level using different technology, giving a series of such curves.

S.G

Limits to growth may occur on physical resource based systems, but when you talk of growth of information based phenomena there may not be limits in that sense.

A. C.

Even the limits to growth in energy and material is from an earth based viewpoint. Getting out to space means that there are no limits.

S. G.

Computers seem to be almost a new information processing species which are accelerating its rate of evolution. A new "generation" appears every few years. A large amount of information processing and "mental" phenomena are in the future going to be done by this new "species" This would mean that humans become more and more marginal to the information system. Do you think that a hypothetical film script "2100" would be written by a future HAL in 2050. I mean would you as a science fiction writer become marginal and disposable ?

A. C.

Well; science fiction changes its attitudes, its view points, and its objectives. I mean, it would continue.

S. G.

Reading through the science fiction literature, one finds that by and large they had been anthromorphic, a projection as it were of the man centred view of the world. As a genre science fiction could be considered a historical outcome of the hopes and fears of the 19th and 20th century when human centred scientific progress was rapid. Would 21st century science fiction have to phase itself out and become marginalised, because the information processing, the "thinking" system would no longer be human based?

A. C.

Science fiction would always have been there in some way or another as fantasy or whatever way you may want to call it. No one ever agrees on definitions. It just changes bases. First science fiction was the first voyages out to sea, than you had religious myths and so forth. And the science fiction tradition of the 19th century was superceded by the first flight to the moon. That's all finished now. We are just changing the direction again now. With robots and artificial intelligence especially, more science fiction is written now; but it changes and it is far more realistic and on a much

firmer basis. So I'm surely not worried about science fiction writers being out of job.

S. G.

There is a continuing debate in Artificial Intelligence (AI) circles about whether human consciousness could be programmed and be simulated. Now, discussions on the nature of consciousness, have pervaded philosophy both in the East and the West very early times. Do you feel that such discussion would become irrelevant ?

A. C.

Probably. I mean, it might be like many of these ancient debates which turned out finally to be meaningless, and now you forget about them. Like say "angels dancing on the head of a pin". One realises that most, if not all theological discussions are meaningless. Certainly the development of AI is going to have a profound effect on the debate.

S. G.

What would you like to see happen in Sri Lanka in, say, 15 years through the Arthur C. Clarke Centre ?

A. C.

Well in 15 years from now it will take us up to nearly 2,001. I would like to see everybody have a communication link.. They also need transportation. But communication is more important than transportation. I would like to see everybody within walking distance of a telephone for emergencies, to call their friends. Well, we have the potential for islandwide television now. We could have good programmes as well. We will then be able to get programmes from all over the world by small satellite receivers. I also expect a good measure of computer literacy in the country and of course literacy of all kinds. I would like to see a completely bilingual nation, is not a trilingual one.

S. G.

Trilinguism, with perhaps computer interphases with which one could talk in Tamil and be understood in Sinhalese ?

A. C.

No, I like to see people able to do that without the use of a computer. I do not think that in 15 years we will have computers that could do that. There will be computers that do scientific and technical translations from any language to any other. But no more than that, I think all children should be brought up speaking two languages; preferably two in entirely different linguistic frames. I mean an Eastern and a Western language.

S. G.

15 years, as you said, would be 2001. This year, however is 1984; and the Orwell industry is big business. Orwell's "1984" has yet not occurred in any developed country, although there are some near examples, such as when in the early seventies the US government monitored every telegram that went out of the country. The fear of dictatorship, is there, I think, today more in the developing world than in the developed. A succession of sometimes brutal dictatorships have taken over in many Latin American, African and Asian countries. How could the computer and the technological revolution effect this tendency towards dictatorship ? Do you think it would strengthen the tendency or weaken it ?

A. C.

I think it will weaken dictatorship. A wise statesman once said: "A free press can give you hell; but it can save your skin'. That is even more true of TV reporting — which, thanks to satelites, will soon be transformed out of all recognition.

Today there are electronic cameras. However, even the electronic cameraman still has to get his cassettes through an obstacle course of postal authorities and customs officials and censors. But not for much longer; very soon he will need only a small collapsible dish, about the size and shape of a beach umbrella and he will be able to beam his pictures upto the nearest satellite, and straight to his country

Exposures of scandals or political abuses — especially by visiting television teams that go home and make rude documentaries — can be painful, but also very valuable. Many rulers may still have been in power, or even alive, had they known what was really happening in their own country.

A. C.

The implications of the new technology are truly enormous. Just one example: how many soldiers would shoot a cameraman, if they knew that millions of people were watching ? And if you think that some countries would not admit TV teams under these conditions — well, as equipment becomes so compact that a single man could carry it, the more difficult would it be to keep him out. And the harder closed societies try, the harder will they have to explain what it is they are so anxious to hide. In the end. they will give up.

COMPUTER DEVELOPMENT POLICY AND ORGANISATION IN SRI LANKA

In March 1981 the government decided on the setting up of a Computer Centre to service government departments and corporations that need computing. The Ministry of Industries & Scientific Affairs was asked to report on the feasibility of expanding computer capability.

Following this decision the government also asked the UNDP to study the use of computers in Sri Lanka and to make a recommendation for National Computer Policy in Sri Lanka. On these studies and recommendations the President of Sri Lanka requested the Natural Resources Energy and Science Authority (NARESA) to set up the National Computer Policy Committee (COMPOL) in November 1982 to formulate policy guidelines and recommend a practical framework and action programme for implementing such policies. The Committee's April 1983 report was accepted by the government, including its principal recommendation to set up a national level advisory body on computers, functioning directly under the President.

This 10 member Computer and Information Technology Council (CINTEC) will advise the government in formulating, coordinating and implementing policy. CINTEC would provide a guiding framework within which Sri Lankan public and private sector institutions in the computer field can develop and interact fruitfully, without unnecessary duplication, wastage of scarce resources, and policy conflicts. The emphasis will be on promotion, encouragement and coordination, rather than controls and regulation that can stifle initiative in this rapidly progressing field.

The government also gazetted a Bill on 12th January '84 for the setting up of a Computer and Information Technology Council of Sri Lanka. The functions and duties of the Council will be:

(a) to advise the Minister on

(i) the formulation and implementation of a national policy on computer and information technology;

(ii) measures to promote, facilitate and assist, the use of and application of computer and information technology in Sri Lanka with a view to improving the quality of life of its people and enabling Sri Lanka to acquire the necessary capability to meet the challenge of technological change;

(iii) measures to develop and improve the infrastructural facilities necessary for the introduction of computer and information technology to Sri Lanka;

(iv) measures to develop education in computers and information technology in all its aspects;

(v) measures to advance the skill and knowledge of persons employed in the computer and information technology industry;

(vi) measures to establish professional standards in the computer and information technology industry with particular reference to the integrity of data in computer and information technology installations and the abuse of personal information in such installations;

(vii) measures to assess the manpower requirements necessary for the development of the computer and information technology industry in Sri Lanka and the training of such manpower; and

(vii) measures to promote the export of computer and information technology services;

(b) to promote and conduct research on all aspects of computer and information technology;

(c) to monitor developments in computer and information technology and to adopt these developments for use in Sri Lanka;

(d) to collect and disseminate information on computer and information technology and related subjects; and

(e) to do such other things as may be necessary for the performance and discharge of the duties and functions of the Council and for the development of computer and information technology in Sri Lanka.

According to the Chairman of the National Computer Policy Committee and advisor to H.E. the President "the use of computers in Sri Lanka is in its infancy, both in terms of the number of systems installed and their level of sophistication. However the establishment of CINTEC is based on the conviction that given the support and guidance of the government, and a commitment of resources that will be very modest in terms of our overall national investment programme, the resulting developments in computers and information technology will bring about fundamental improvements in our lifestyles and contribute significantly not only towards material progress but also to sociopolitical development and national cohesiveness".

The new policy in computers has a short-term programme (2 to 3 years) of introducing the use of computers to raise productive efficiency of both private and public sectors. Also there will be a major effort in computer education, encompassing schools, universities, industry and commerce, and the general public.

The medium-term (5 to 10 years) is expected to lead to the development of Sri Lanka as an Asian Service Centre for computerized international banking and trade. Sri Lanka's assets include the attractive economic poli-

cies of the government and stable climate for investment, convenient geographic location, highly educated manpower base, and acceptability among all countries in the region. In this time frame, we also expect the development of more decentralized domestic institutions, to meet the needs of administration, finance, production and exchange of goods and services. The use of computers will significantly improve the flexibility of citizens to make use of their skills and talents. This will provide an additional impetus for entrepreneurial activities more in keeping with national character and temperament. Exports of computer software and hardware as well as programmers and analysts provide encouraging prospects. By this time, carefully nurtured centres of excellence will be making significant contributions. CINTEC hopes to play the leading role in coordinating and guiding the sustained and systematic national effort necessary to bring about this scenario.

National Computer Policy Objectives

The following broad national computer policy objectives were identified in the National Computer Policy Committee's report of April 1983, and subsequently approved by the government.

(a) Harness computer technology in all its aspects, for the benefit of the people of Sri Lanka, and to further the socio-economic development of the nation.

(b) Promote and guide the development of computer-related resources and their application, to anticipate and meet the future needs of the national economy.

(c) Enhance and supplement manpower resources and increase the efficiency and productivity of management and workers at all possible levels.

(d) Improve the quality of life of the people of Sri Lanka, including the job satisfaction and working conditions of employees.

(e) Increase the flexibility and dynamism of Sri Lankan society to enable it to successfully meet the challenges of thefuture, arising from the ever increasing pace of world-wide scientific and technological advances.

Policy Guidelines

The following is an initial set of national policy guidelines that CINTEC will revise and update as appropriate in the future on a regular basis:

(a) Acquisition

Potential users should be encouraged to treat the acquisition of a computer and/or related items as any other investment, including clearcut identification of computer needs and technical, economic and financial evaluation of the project. Government imposed regulations, rules, or financial disincentives that would restrict or delay purchasing of computers and related items should be minimized wherever possible.

(b) Utilization and Access

Sharing of computer hardware, software and data resources should be promoted. Computer installations should be fully utilized by permitting access to users during as many hours of the day as possible. However, it would be undesirable and impracticable for the government to attempt to compel owners of computer facilities to share their resources. Interchange of information regarding computer hardware and software resources available among different users should be promoted.

(c) Computer Education, Public Sector Application, Computer Literacy and Appreciation of the Potential of Computers:

The Government should take immediate steps to improve computer related skills and promote their application as widely as possible, especially in the following areas: scientific analysis, higher education, industry, business and financial management and schools. The establishment of standards for computer education should also have high priority. Particular attention should be paid to identifying and encouraging the application of computers in the public sector. Efforts should be made, as soon as possible, to ensure adequate financial incentives and job satisfaction, in order to attract and retain the services of computer personnel in Sri Lanka. Computer literacy and appreciation of the potential of computers among the general public should be increased.

(d) Self-reliance, Export of Computer Services

Efforts should be made to make the country as self-reliant as possible in computer skills, establish a sound indigenous capability to evaluate and acquire foreign computer technology when necessary and also export computer services (both software, and hardware, especially assembled products).

(e) Computer-Related Infrastructure and Local Environment

The Government should give high priority to improving infrastructural facilities that are essential for developing computer use in Sri Lanka, including: local and overseas telecommunications services, and electricity supply. An adequate legal environment should also be created which recognizes the role of computers, as well as its impact on society.

(f) Other Areas Related to Computers

Developments in areas related to Computers such as satellite communications, other telecommunications, and robotics should be closely monitored and adapted for application in Sri Lanka whenever appropriate, by both the Government and other interested groups.

Organisation of the Computer Sector and Policy Implementation;

CINTEC is expected to create a Central Computer Secretariat (CEC–SEC) to service its needs and those of the sector,

The growth and development of several Centres of Excellence, identified in the first instance as, the Arthur Clarke Centre, the Universities of Colombo, Moratuwa and Peradeniya, and the National Institute of Business Management, will be supported. CINTEC also hopes to establish channels of communication with and draw on the contributions of the Computer Society of Sri Lanka, and other private special interest groups and companies. Such non-governmental bodies will have a key role to play in assisting CINTEC within the decentralized organisation envisaged, especially in areas such as:

(a) establishing and maintaining a code of conduct for computer professionals;
(b) maintaining the standards of computer education, among private organisations;
(c) providing a regular forum for exchanging ideas, and disseminating in Sri Lanka, the latest information on computers; and
(d) helping to ensure the integrity and security of data in computer installations, and prevent abuse of privacy.

One of the first items on CINTEC's 1984 work programme would be the organizing of several regional/international workshops on the latest applications of computers in science, technology and business. Leading foreign and local experts will lecture and demonstrate; thus enabling a large number of Sri Lankan participants to obtain valuable up-to-date training and skills in these areas. Specific studies concerning the scope of application and impact of computers in different sectors will be initiated. Other organizations will be encouraged to assist in these efforts.

(Extracted from a paper on "Planning for Future Computer Development in Sri Lanka" by Dr. Mohan Munasinghe, Chairman, National Computer Policy Committee).

THE MINISTRY OF EDUCATION COMPUTERS PROGRAMME MICRO ELECTRONICS EDUCATION PROJECT

The following are extracts from a paper presented by S. Yogendran, Systems/Software Manager, D M S Electronics Limited on the micro-electronics programme formulated by the Sri Lanka's Ministry of Education.

Educationists are currently engaged in exploring the impact of innovation in micro-electronics, computers, and communication on children's education in schools and other educational institutions. The implication of those developments for educational planning and curriculum development are profound. Significant changes are taking place in the content and methodology of school education. Children will need different skills for tomorrow than the current generation have today. In order to meet this need and recognising that learning about computers or computer literacy has emerged as a subject in its own right, the Ministry of Education launched a Micro-electronics Education Programme (MEP) in schools.

Aim

The aim of the programme is to help schools to prepare children for life in a society in which devices and systems based on micro electronics are monplace and pervasive. These technologies form the basis of the new scientific revolution that is taking place in the developed world.

Scope of Programme

The programme is concerned with micro electronics application in schools at upper secondary and GCE (AL) courses. In the Sri Lankan context, the initial use of those technologies will come from those who have covered this span of education.

There are two parts in the programme. The first covers the investigation of he most appropriate ways of using the computer as an aid to teaching and learning, as a guide to the individual child, as a learning aid for small groups of children, or as a system which involves the whole class. In principle, sofeware can be developed for computer based learning across the curriculum, but the programme will give priority to applications in mathematics and the sciences. As the programme develops some attention will also be given to geography, languages, commerce and the humanites, and assist appropriate developments in remedies and special education.

The second part of the programme is concerned with the introduction of new topics in the curriculum, either as separate disciplines or as new elements of existing subjects. The new topics will include;

* micro electronics in control technology
* computer studies
* Computer linked studies, including computer aided design, data logging and data processing
* word processing and other "electronic office" techniques
* use of the computer as a means of information retrieval from data bases.

Programme Activities

The programme will cover three main areas;

1) Curriculum development
2) Teacher training
3) Resource organisation and support

The work involved under each of these areas is examined in some detail below.

1) Curriculum Development

New materials for teaching and learning are needed to meet the following needs:

* materials which make use of micro computers and other areas based on micro processors to assist with the learning of "traditional" subjects:

* materials which support the teaching and learning of the "new topics" previously mentioned.

* supporting decumentation which will help teachers make the most effective use of the new equipment and its associated curriculum materials.

Such resources may be developed at different levels. National level projects may be undertaken by organisations such as the Sri Lanka Association for the Advancement of Science and the Computer Society. The universities too will undertake projects. The Computer Education Centres referred to below and the individual schools linked to the Centres will develop projects at the local level.

2) **Teacher Training**

Teachers require both information about micro electronics and professional skills to apply the technology effectively in the classroom. The training of teachers, both in service and pre-service must therefore be organised in such a way as to support the curriculum changes envisaged in new topics. Training is required at a number of levels:

* courses aimed at improving general awareness and familiarisation are needed for teachers of all kinds.

* short specialist familiarisation courses are required for teachers who have been enthused by the awareness courses and for those wishing to modify their subject teaching to include new topics, for example, teachers of commerce requiring knowledge of word processing and biology teachers requiring knowledge of data logging.

* longer specialist courses aimed at teachers requiring additional training in particular fields. Examples would include science . teachers wishing to expand their knowledge of electronics; and teachers wishing to acquire the skills needed to develop computer based learning materials.

* for these courses to be effective, resources also need to be devoted to the training of trainers and to the refresher courses.

3) **Resources Organisation and Support**

Access to information, materials for teaching and learning, and advice, are important for teachers and their work in schools. Knowledge about technological developmentsand about the range of supplementary materials which are available must be made as accessible as possible and they should be able, so far as is practicable, to explore and experiment with equipment and materials with a minimum of difficulty.

The Education Ministry envisages, the following groups organised centrally to support the Microelectronics Education Programme.

Pilot Project

The first phase of the project is a pilot project in about 110 schools which will be equipped with micro computers. Individual schools will be linked to the pilot centres. Each pilot centre will be responsible for:

* dissemination of information
* inservice training of teachers, and
* development of material for teaching and learning.

Training Centres

Colombo Educational District

* Ananda College
* Royal College
* Devi Balika M.V.
* Anula Vidyalaya, Nugegoda

Kandy Educational District

* Girls' High School, Kandy

Gampaha Educational District

*

* Sapugaskanda M.M.V.

Supporting Institutions and Consultants

* University of Colombo - Computer Centre

* DMS Electronics Limited

* Moratuwa University - Faculty of Engineering

* Peradeniya University - Faculty of Engineering.

Achievements to Date

* 05 teachers and 05 officers from the Ministry of Education and the Curriculum Centre have been trained to be in charge of the Training Centres.

* 55 teachers have been trained at the Royal College Centre and the Ananda College Centre. They are from 50 schools from 13 Educational Regions. A few teachers, depending on their performance, will be selected from this course as trainers t train the second and third batch of teachers.

* The training of the second batch of 55 teachers was completed at the Kandy Girls' High School and the Sapugaskanda M.M.V. Centres.

* The training of the third batch of teachers commenced in November 1983 at Devi

Balika and Anula B.M.V. Centres and was succussfully completed in December 1983.

* Computers were supplied to 110 schools last year. At least one teacher from each school was trained.

Plans for the Future

* Teaching of computer awareness at school level will be started at the above 110 schools from January 1984. Initially, this awareness will be given to A/L Science Students

* This programme will be conducted as a pilot project until 1985. The project staff will conduct a feasibility study at the pilot stage regarding the use of these computers as a teaching aid at school level in Science, Mathematics, Commerce and Social Science subjects.

* A glossary of computer terms and a syllabus are being prepared. All those documents will be distributed among schools by end January 1984.

* All the Training Centres will be used for training of teachers Students Residential Courses and Seminars will be conducted during week ends and school vacations specially for students and teachers in distant areas of these training centres.

TRAINING – PRIVATE SECTOR

Apart from the courses of study and training being introduced at the Universities and Schools, there are a wide variety of private institutions providing programming languages and basic computing courses to small children (9+), school leavers, unemployed graduates and allied professionals. There are at least 25 of these private institutions which advertise their services regularly in the press. Some of these firms are listed in the table below:

1. Data Serve Ltd.
2. Colombo Polytechnic.
3. Data Processing Aides.
4. Institute of Computer Studies (Bartleet Electronics).
5. Institute of Computer Studies.
6. Ladies' College.
7. Metro Lanka.
8. National Institute of Business Management.
9. Professional & Business Consultants.
10. Rainford Computers Limited.
11. Stafford Institute of Higher Education.
12. Wetherby Training Institute.

TELECOMMUNICATIONS

Efficient telecommunications facilities are an essential part of basic infrastructure that is required to support the Government's development programme, and also more important for connecting and maintaining in operation remote terminals to computers in the Colombo area. It is for reasons such as this that the Government gave priority for implementation of its Telecommunication Plans for modernising and expanding the telecommunication network

It has been found that introduction of a computer terminal for the Government was not feasible due to telecommunication difficulties, particularly the cable connections were wholly inadequate. This short coming is now being remmedied with the new Telecommunications Development Programme.

The plans of the Department of Telecommunications fall into the categories of:

(a) Rural Sri Lanka; and
(b) Colombo Area (sub-divided into exchange and cables).

For *Rural Sri Lanka* the plan is to :

(a) Provide in 28 districts modern Stored Program Control Public Branch Exchanges (SPC-PBX); of these 4 have already been completed, work on another 15 is in hand, and planning for a further 2 has commenced, with that on the balance 7 to start shortly;

(b) establish 14 District Switching Centres with microwave communication facilities;

For the *Colombo Area Exchange* the plan is to:

(a) complete by end 1984 the installation of Stored Program Control Public Branch Exchanges (SPC-PBX);

(b) increase thereby the availability of direct-dialling (currently the Colombo Central Exchange serves 14,000 subscribers and has to cope manually with 2 million calls daily thus causing delays and cross-connections; it has been in service for the last 15 years and uses old out-of-date technology);

(c) finance these projects from funds provided by the World Bank/IDA (US$ 35 million) and the Sri Lanka Government U.S.$ 10 million), using technical advice from Swiss consultants as required by the World Bank.

This US$ 35 million project, which is funded by the International Development Association, provides for the following:

(a) Expansion of the subscriber network,

(b) Replacement of electro mechanical exchanges by SPC/Digital exchanges,

(c) Improvement of underground cable networks,

(d) Provision of new services to rural areas and,

(e) Computerisation of telephone and telex billing services.

This project is presently underway in the many different areas including the installation and commissioning of a computerised telephone and telex billing system. BC Computers Ltd. was awarded the contract for this aspect of the project and work is presently underway. The contract is on a turnkey basis and will be implemented over an eighteen-month period.

Toward a National Computer Programme Distribution; "Report of the UNDP/ILO Study Team" and Paper presented by Sunil Wijesinghe, Managing Director, BC Computers Limited.

EXPORT CAPABILITY AND ASSOCIATED PROBLEMS

From a paper on "THE EXPORT OF COMPUTER SOFTWARE" by Dr Maya Sittampalam Rainford, Managing Director, A-Z Computer Services Ltd.

The major problem associated with indigenous software development capability remains the lack of growth of the supporting infrastructure of the computer user base in SL. This is, in effect, a chicken-and-egg situation-development of the infrastructure would, in turn, fuel indigenous capability, setting up a positive feedback effect, each urging the other onwards.

The problems may briefly be set out as follows:

(1) The lack of advice from 'above'—potential buyers taking the initial step towards computerisation have to rely on hearsay evidence,, on computer scieman, on newly-promoted programmers into advisory positions or on under-experienced systems consultants. Thus greater priority is given to hardware identification, even by 'software consultants', than on a machine-independent assessment of the system solution. This lack could well be dissipated by an active National Computer Policy Committee, capable of deploying personnel to give expert advice on acquisition and usage of computing equipment.

(ii) The tendency, as in most developing countries, to make experts out of returning Computer Science graduates, computer salesman, semi-experienced computing professionals, other disciplinary personnel who have undergone brief computer courses or exposure to computing environments or external consultants with little or no checking up as to the suitability or otherwise of their prior fields of expertise.

(iii) The clinging to the traditional concepts of promotion within an organisation such that programmers with barely two years of on-the-job programming experience can, before becoming masters of their own craft, find themselves entirely at sea in an analysis, design, project management or dp-management post. The concept of adequate training, whether initial or on-the-job, is highly important in an environment with a scarcity of trained manpower. Compromise on the quality required, either through time, inadequacy or knowledge-inadequacy, can only lead to long term degradation of the total situation. The entry of the microcomputer has only accentuated the problem, the cottage-industry approach to software being encouraged with hobbyists and small, hastily set-up programming teams dictating on micro acquisition and usage.

The recognition of software as a specialist science requiring a high level of expertise in order to develop the complex, integrated systems required in the developed nations and using complex environmental software must emerge before we are able to develop a viable software industry for local usage as well as export. This means relinguishing the idea that quality software can be produced by one or two programmers working for a period of weeks on cheap equipment employing unsophisticated systems software.

SL cannot possibly hope to comp ete in the retail sector of microprocessor based software which is cottage-industry based, fiercely competitive and already well provided for by an army of highly experienced and competent systems programmers. Our hope lies in advanced software products requiring many years of man effort, for it is in the development of labour intensive systems that we can be sufficiently competitive to emerge victorious. This means heavy concentration on the following:

(1) Software products for minis and main frames in specialist applications;

(ii) systems software products for interaction in sophisticated real time environments

(iii) specialist products employing novel software techniques for use as development aids, control systems, interfaces etc.

The key lies in the clever deployment of manpower. The controlling and usage of this vital resource will be the basis of our future as a software exporter.

CONSULTANTS, SOFTWARE HOUSES, SERVICE BUREAUX

There are also several specialised consultants, software bureaux and servicing agencies. Some of them are listed in the table below:

1. Associated Management Services.
2. A—Z Computer Services Limited.
3. Bank of Ceylon Merchant Banking & Management Consultancy Division.
4. Chemanex Limited.
5. Computer Management Services Limited.
6. Computer Systems Consultants.
7. Computer Systems Limited.
8. Management Services Limited.

Source: *Toward a National Computer Policy in Sri Lanka Report of the UNDP/ILO Study team 1982.*

COMPUTERS IN SRI LANKA

Nearly 30 makes/manufacturers of computers have now entered the country and are competing keenly for what is forecast to be a booming market in the years ahead. Among them are:

1.	APPLE	14.	ICL
2.	ACORN	15.	KIENZLE
3.	AQUARIUS	16.	MULTITECH
4.	BBC	17.	NEC
5.	BROTHER	18.	NIXDORF
6.	BURROUGHS	19.	OLIVETTI
7.	CANNON	20.	RADIOSHACK
8.	COMMODORE	21.	SHARP
9.	CONSOLE ELECTRONICS	22.	SINCLIAIR
10.	CASIO	23.	SOLA
11.	DATA GENERAL	24.	SYSTIME
12.	HEWLETT PACKARD	25.	TOSHIBA
13.	IBM	26.	WANG

S. G. and C. G.