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PROGRAMMING THE UNPROGRAMMABLE

By S. B. Jaiyesimi

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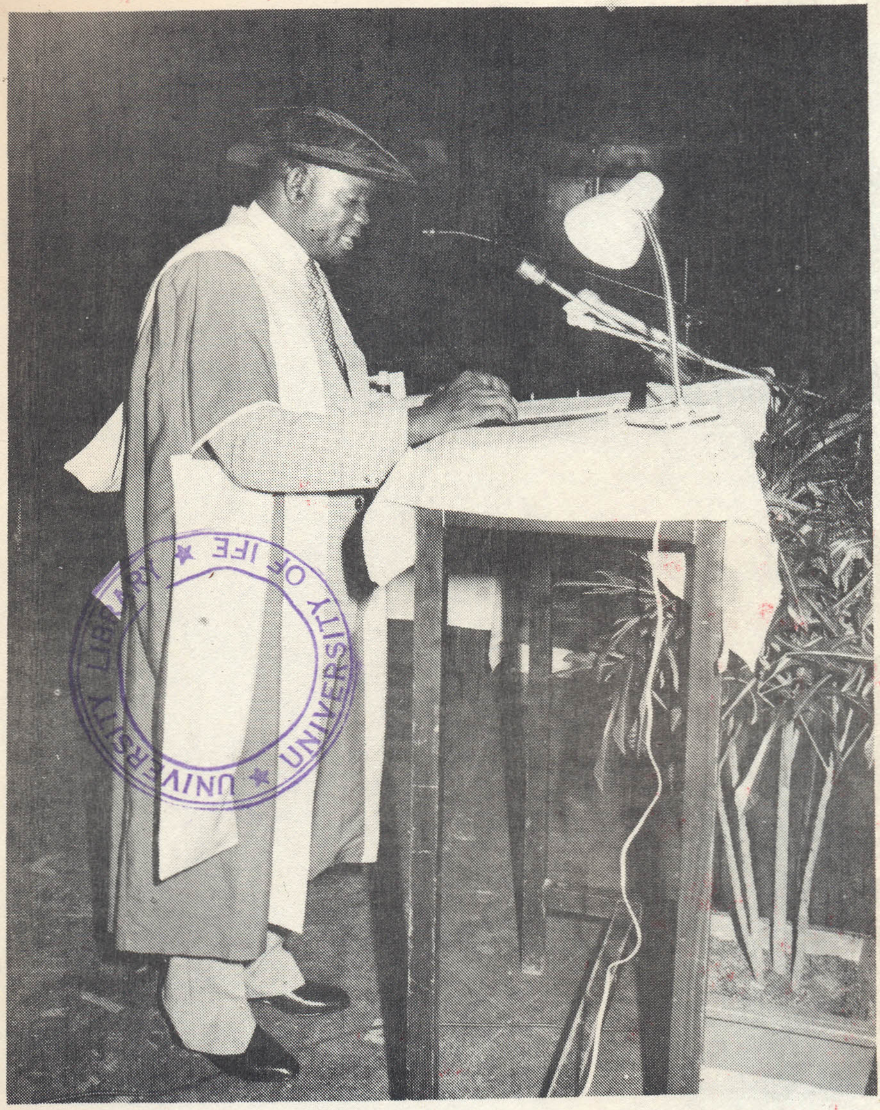

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In this lecture I will like to address myself to the 'now-ology' (so to speak) of our society and the possible futuristic fifteen years ahead. Major trends in computing are expected to develop in this period, and may become very significant for mankind. This is important because it is considered that many of the changes that will occur after 1990 need to be taken into account when formulating policy for the subsequent ten years.

The essential prerequisite to the formulation of a general policy must be the study and the thorough evaluation of policy alternatives. Such studies are particularly necessary in the case of computing because the situation is changing so rapidly that the formulation of a forward-looking policy is extremely difficult.

METHODOLOGY

In a recent study on the Computer Utility in Nigeria I have sought to present the current status of the industry and the use of computing in as broad a manner as possible. This was done through discussions with knowledgeable individuals and by the evaluation of published information. Projections into the future have been based on this information and have been derived by consideration of analogous situations, case studies and analytical discussions. Particularly emphasis was placed on the consideration of relevant historical examples of technology diffusion. The overall technique is best described as one of intelligent extrapolation, which obviously is both subjective and imaginative.

A typical and supposedly enlightened society in a developing economy such as ours is examined in the context of economic and technological progress. I shall endeavour to discuss in general terms, for the purposes of provoking your thoughts and engaging the individual in further challenging discusses, the impact of computer technology and the changes it will bring about. You will then be in a better position to argue and judge whether or not this society is ready for a vital technological change.

STATE OF THE ART

A definitive history of computation is yet to be written. Some aspects of the subject are treated in works on the history of mathematics and in surveys of calculating devices; in addition, some participants in the development of computers have produced monographs detailing more recent events. However, a comprehensive study tracing the evolution of the concepts, methods and devices associated with computation may be a long time in the making. The extraordinary complexity of such a study is revealed in the following passage from *Thomas M. Smith (1970).*

> The appearance of computers late in the long history of counting and calculating provides a classic illustration of the phenomenon of convergence. Both historically and logically, computers owe their existence to many prior traditions. Among these are counting and reckoning, writing and the written record, the concept of quality, the engineering tradition, and many more. Before there were computers, there were calculators, before calculators there were adders, and before adders there were counters. Before all of these there occurred to men whose names are lost to history notions of quantity. Probably before abstract ideas of quantity emerged there was already an ages-old tradition of enumerating. The origins of this presumed tradition, too, are shrouded in prehistory.

The Birth of the Modern Computer

Efforts to design and build computing devices intensified under the wartime conditions of the late 1930s and have continued unabated ever since. Our proximity to the events of this era would argue against any claims to completeness or objectivity, but it is desirable to sketch the major developments and trace some of the interconnections among them. Let us very briefly examine the growth of computer technology from the late 1930s to the early post-war period.

The earliest general-purpose program-controlled computer was built in Nazi-Germany. Konrad Zuse had conceived the basic design for a tape-controlled, floating-point, binary computer by 1936. The plan was put into practical form with some support from the government, the result being a floating-point binary machine with a 64-word store. This machine is known as the Z3 computer and was operational in 1941. It did not survive the war and Zuse's work was virtually unknown outside of Germany until quite recently.

The mainstream of early computer developments centred in the United States and Great Britain. Howard Aiken of Harvard University, in cooperation with IBM, designed and built the Automatic Sequence Controlled Calculator, more commonly known as the Harvard Mark I. This largely mechanical device was operational in 1944, and first used on classified work for the United States Navy. Although the initial program-control of the Mark I did not allow for conditional branching, such facilities were later added in the form of a subsidiary sequence-control mechanism. Aiken designed several other machines at Harvard. The Mark II, completed in 1947 for the U.S. Naval Proving Ground in Dahlgren, Virginia, used electromagnetic relays and paper-tape sequence control. These were followed by Mark III in 1950 and Mark IV in 1952.

IBM's experience with the development of Aiken's Mark I launched the business-machine company in the computer field. The first effort after Mark I yielded the Pluggable Sequence Relay followed by the Selective Sequence Electronic Calculator (SSEC), a partly electronic machine with electromagnetic relays which appeared in 1948. An important feature of this machine was its ability to modify and then execute stored instructions. These early efforts provided invaluable experience for the scientists and engineers who were to design the commercially successful IBM 650 and later the IBM 701. The Bell Telephone Laboratories' work on switching technology made it a natural environment in which to experiment with the use of electromagnetic relays for computing devices. George Stibiz and S.B. Williams designed a machine (Complex Number Computer) for performing arithmetic on complex numbers. This was completed in 1939 to become the first in a series of relay calculators built by Bell Labs. Stibitz's work on automatic sequencing and error detecting codes on the eve of United States' involvement in World War II led to the design of the Relay Interpolater, a special purpose, tape-controlled device designed for use in fire-control problems. This was followed by three other models designed for military applications, the last of which was a general-purpose, program-controlled computer with conditional branching facilities.

Two further innovations on the way to the present day computer involved the exploitation of electronics technology and the implementation of the stored program concept. John V. Atanasoff is credited with the first attempt to build an electronic digital calculating machine. Atanasoff's work at Iowa State College in the mid-1930s led him to the idea of a system using memory and logic circuits. During the 1930s and 1940s, several groups explored the possibilities of replacing mechanical or electromechanical devices by digital electronic circuits. The efforts of Zuse and Helmut Schreyeer in Germany constituted perhaps the first attempts at utilizing electronics technology in the design of a general-purpose program-controlled computer.

The first major advance issued from the Moore School of Electrical Engineering at the University of Pennsylvania with the design and construction of the Electronic Numerical Integrator and Calculator (ENIAC). The germ of the ENIAC concept was contained in a memorandum of John Mauchly in 1942 which discussed the use of vacuum tube devices for calculating. Like most other computing efforts of the period, this one was in response to military needs. The Moore School group, directed by J.G. Brainerd with Mauchly as principal consultant and J. Presper Eckert as chief engineer, completed the ENIAC in 1946. The massive machine with its 18,000 vacuum tubes was the first electronic computer to become operational.

The final conceptual leap in the development of the computer was the idea of stored programs which appears to have originated with the ENIAC group, although there are some unresolved questions concerning the parentage of the stored program concept. This critical idea, first documented in a 1945 draft report on the Electronic Discrete Variable Computer (EDVAC). was written by John von Neumann of the Institute for Advanced Studies at Princeton. John von Neumann became associated with the ENIAC effort in 1944 as a result of his work at the Los Alamos Scientific Laboratory (Manhattan Project). Details of the EDVAC project were presented in a series of lectures given at the Moore School in 1946 and thereby exerted a powerful influence on subsequent developments.

The earliest operational stored-program computer was machine-built at Manchester University (England) in 1948 primarily for the purpose of exploring the potentialities of the cathode ray-tube as a storage medium. Although this machine was not a practical computer, the Manchester project is historically significant in that it constitutes a line of development of the Moore School influence. Moreover, the experience led to the design of more powerful devices, in particular MADM (Manchester Automatic Digital Machine) which was built in cooperation with Ferranti Ltd. The first practical stored program computer was the EDSAC (Electronic Delay Storage Automatic Computer) built at Cambridge University. The Cambridge group was led by Maurice Wilkes who was a participant in the Moore School Symposium. Although the EDSAC was based on the design of the EDVAC, the former was in operation by 1949; the EDVAC did not become operational until 1951.

Eckert and Mauchly left the Moore School to form the Eckert-Mauchly Computer Corporation, which designed and built the Universal Automatic Computer (UNIVAC). UNIVAC was intended for both commercial and scientific applications and the first one was delivered to the Bureau of the Census in 1951. The EDVAC group was further depleted by the departure of von Neumann. At the Institute for Advanced Study, von Neumann and colleagues designed the Immediate Access Storage (IAS) computer which was completed in 1952. This random-access machine using electrostatic storage and parallel binary arithmetic provided a basis for several other computers. In particular, it influenced the development of the IBM 701, the first of IBM's 700 series. Also of considerable importance in the development of computer technology was the appearance in 1952 of the Massachusetts Institute of Technology's Whirlwind I computer. This machine marked a major advance in storage capacity, with its introduction of a coincident-current magnetic-core memory.

The evolution of computer technology since the emergence of the general-purpose, stored-program, electronic, digital computer is at least as complex as earlier developments. Indeed, the details cover more than one semester course of study. Since part of our principal aim in this lecture is to indicate the interaction of computer technology with social forces, presenting further technical details would be inappropriate. One of the most disturbing features of the birth of the computer is its intimate association with military problems, an association whose legacy is still very much in evidence. If this were simply a historical accident, a practical necessity born of a war for survival, it would be of relatively minor importance for society as a whole. But developments in the modern world suggest otherwise.

The marriage of science and government has its roots in the French Revolution, during which the improving spirit of the eighteenth century found practical expression. Government became a systematic patron of the sciences during this period. Napoleon was himself scientifically trained and had a shrewd appreciation for the practical utility of scientific investigation, especially for military purposes. What began as a partnership evolved into an intimate relationship. The demonstrable success in recent decades of society's ability to mobilize scientific resources testifies to this intimacy. The apparent freedom to use technology as we see fit diminishes in proportion as it becomes critical for the functioning of social institutions in a centralized state.

I have attempted to show here that the computer has a past which holds the key to its likely future in society. From the fifteenth century onward, the computational needs of society increased relentlessly. Under the tutelage of scientific and industrial expansion, modern man has cultivated a reductionist attitude toward experience. As industrial processes were resolved into simple component tasks, so computational processes were resolved into primitive operations and control mechanisms elaborated in the one sphere were eventually translated into the other. Trade and the factory system of production aided by modern methods of transportation and communication institutionalized the conquest of space and time. The managerial revolution made possible by the emergence of computers with the ability to control complex chains of simple operations threatens to institutionalize the conquest of will.

It has been shown clearly here that the theoretical aspects of computer design rely heavily upon the works of mathematicians. The development of computers has been traced over four generations. The first generation computers was ENIAC's circuitry which arrived in about 1950. The second generation computers, notably the UNIVAC, was fully introduced about 1958. The third generation computers, the silicon chips machine, was first employed by the Radio Corporation of America in its RCA Spectra 70 series in 1965. This went on till the early 1970s. Computers that were built with monolithic integrated circuitry are generally designated as third-generation computers. Computers in the IBM 360 series, built with hybrid integrated circuitry, have also been referred to as third-generation computers. In 1970, minicomputers were introduced into commercial applications from their specialised laboratory and dedicated application of the 1960s.

In 1972, the fourth, and now current generation computers, appeared on the scene. These are microcomputers, simply extensions of the minicomputers. Today there are more than 500 brands of microcomputers in the world market. Of these there are about a dozen different types in Nigeria.

In the 1990s it is expected that the fifth generation computers will be in wide use. This idea began in Japan which is currently playing a leading role worldwide in the field of computer technology development. The fifth generation computer is expected to compare more favourably in the following areas: improved cost and performance, light weight and compactness; high-speed, large-capacity to meet new applications, increased diversification and adaptability, high reliability functions with built-in sophisticated data security unit.

This ambitious project was initiated by a Japanese team of computer experts led by T. Moto-oka in the 1970s. The main results were made public in 1982 and the implications to the rest of the world were highlighted by T. Moto-oka and H.S. Stone in September, 1984. The system is predominated by new advanced architectures with customised VLSI (Very Large Scale Integration).

At the University of Ife, and indeed in Nigeria, the philosophy evolved has, since 1976, been in the direction of the Japanese concept. Efforts had been singlehanded until 1980 when a goal was determined for a unique computer hardware design. Initially it was necessary to carry out an in-depth study of the possible ways of improving on data communication techniques as they are presently known. Possible cases of unconventional problems involving numerical data handling were examined. Interesting and unusual results were obtained.

Jaiyesimi (1976) demonstrated the existence of compacted data whenever the problem is expressed linearly and of any arbitrarily high order. This helps to identify associable data elements at different levels of hierarchy. This work was extended and Jaiyesimi (1977) obtained in a closed form the first numerical result in the compacting of multi-dimensional series which has since generated a large number of requests from colleagues in Europe and South East Asia as well as invitation to lead workshops in the United Kingdom. Jaiyesimi (1978) proved that every data bundle processed via certain Difference Equations has a majorant with identifiable predeterminable properties. These results were applied to certain local problems. Jaiyesimi (1980), (1981), Jaiyesimi and Adewumi (1981) and Jaiyesimi and Adebayo (1982) obtained staggering and fundamental results on the computer simulation of dynamic systems as well as stochastic systems prevailed upon by Poisson processes. Having laid a foundation for a design philosophy akin to the Japanese fifth generation system, Jaiyesimi (1981), Jaiyesimi and Adebayo (1982) proceeded to define specifications of a desirable language for an Ife Computer using infinite tress. Jaiyesimi and Adebayo (1984) successfully defined and simulated the architecture of an operating system for a hardware in view.

This system, when built and implemented, is envisaged to be the first truly and seriously fashioned economic computer made in Nigeria. One however feels restrained to make much noise about this, unlike others, until we are ready to announce the product. Thus we prefer to keep a low profile. A major limitation in an early realisation of this computer system is the lack of funds to acquire the necessary equipment. The Federal Ministry of Education, Science and Technology has had our application for over one year now but nothing has been forthcoming.

It was the knowledge of our efforts through some of the published works that has recently brought about some cooperation with Sazena, Gulati and Kaul respectively of Hong Kong Polytechnic and the Indian Institute of Management to model the architecture of a Dss generator.

Computer Literacy and Index of Change

My view of computer literacy follows from my sense of what the impact of computers will be and from my understanding of what is commonly meant by the term literacy. When I consider a person literate, I usually mean that he/she can read and write well and can use reading and writing fluently in a variety of contexts. Further, a literate person in our society will have had a range of experiences with the literature of our common cultural heritage. He/she will be able to read, understand, interpret and make judgements about a news article or a literary work and will be able to compare the works of different writers.

A more complex aspect of literacy is its effect on a person's intellectual functioning. Without going into detail here, I will simply assert that a literate person can make use of a wider range of intellectual strategies than someone who is non-literate. Children grow into literate adults by growing up in a culture pervaded by literacy and pro-literacy values. Older playmates and siblings, parents and teachers, are all carriers of the culture. For the earliest years, at home and in school, children use literacy skills in a wide variety of every day tasks of importance to them.

My concept of "computer literacy" goes beyond its common definition as a body of information primarily about computers, how they work, how they are used, and their impact on society (Ball and Charp, 1977; Billings and Moursund, 1979; Johnson *et al.,* 1980). I believe that such a body of subject matter should more appropriately be termed "computer awareness" (Luehrmann, August,1980). Rather, I think of computer literacy as a cultural phenomenon which includes the full range of skills, knowledge, understanding, values and relationships necessary to function effectively and comfortably. The computer literacy needs of any individual will vary according to that person's particular involvement with computers, but computer literacy requirements for the average person should expand dramatically during the next decade.

To make this notion of computer literacy more specific, I have divided it into four distinct but interrelated categories.

1. The ability to control and program a computer to achieve a variety of personal, academic and professional goals.
2. The ability to use a variety of pre-programmed computer applications in personal, academic and professional contexts.
3. The ability to make use of ideas from the cultures

surrounding computer programming and computer applications as part of an individual's collection of strategies for information retrieval, communication and problem solving.

4. The ability to understand the growing economic, social and psychological impact of computers on individuals and groups within our society and on society as a whole.

Education for computer literacy, as I have defined it, should be thought of as more like the life-long process of acquiring a culture than like the mastery of a well defined body of subject matter. Education for computer literacy requires many years of experience with computers and a long-term fostering of concerns and values related to the use of computers and their impact on society. Above all, education for computer literacy implies the need for a computer literate culture of parents, teachers and older students for a child to grow into. The growth of computer literacy among teachers and the gradual incorporation of computers and ideas relating to computers into all subject areas should be of the highest priority to a school system trying to educate a computer literate public.

Education for computer literacy is occuring in many places outside of formal education institutions. Companies that use and manufacture computers provide training for their employees and their customers' employees. Computer stores, popular computer magazines, and local and national interest groups are all aiding the growth of knowledge about personal computers and their use. Adult education courses in computer programming are now being offered in many areas. Public access to computers in libraries, museums and community centres is also likely to contribute significantly to the growth of computer literacy.

Nevertheless, I believe that there is a clear need for an all-out-effort by school educators. Only schools can help ensure that all citizens have equal access to the opportunity of computer literacy education, and only the schools in our society have responsibility for the mass education of citizens who, in future, can make effective decisions about the impact of technology on their society.

The BUG In The Program: Computer Phobia

The experience gained in discussions with many individuals from many organisations suggests that the barriers towards both innovation and the diffusion of uses of computing and its device embodiments vary enormously between individuals and organisations.

Perhaps the most important barrier concerns awareness of the potential (and achieved) capability of computing. There is widespread awareness of particular possibilities but among particular people, or particular organisations. A collective awareness of possible overall developments which could undoubtedly impinge upon those same particular people or organisations, is exceptionally rare. And yet it is a thesis of this lecture that what is in the offing is a pervasive and restructuring change towards an information society. Coupled to this lack of a sufficiently comprehensive awareness is a lack of experience and a lack of technical knowledge. Incredibly, several examples have been found where individuals show good knowledge of a particular development in a field currently unrelated to their interest and yet show total surprise when informed of the analogues and appropriate application already in use in their own field. A striking example is the manager of a factory producing a simple electromechanical product who admits to having been surprised by the sudden victory of the electronics-based substitute – although he had owned one personally for several years and found it satisfactory. It is probable that the step-function advance in electronic capability is too great for many people to assimilate unconsciously.

At this point I wish to note with great concern and distress that Nigeria has been blessed with too many academically qualified persons who do not seem to be applying themselves to locally identified problems of this country. Most of this category of people have visited a number of the advanced countries where things work with the aid of computers.

Some other identifiable barriers to effective computing in Nigeria include

(i) our hot, humid and dusty climate;

(ii) the non-existent telephones and other communications media suitable for data transfer. There is however some hope that an NCR data-link (Lagos-Ohio) will materialise in the next few months;

(iii) inadequacy of properly trained personnel;

(iv) poor image created by some briefcase carrying quacks hovering around as computer salesmen and half-baked directors who constantly mislead the ignorant 'masses' and helping to make incorrect decisions;

(v) cost differential: the ratio of costs in Nigeria to that of Europe is approximately 4:1, even when foreign exchange is obtained through the "white market";

(vi) lack of a well defined computer policy for Nigeria. This has been exploited by a good number of selfish opportunists in our society to their own benefit.

We live in a country where the postal system is most unreliable. The answer to a viable and reliable postal system lies in a computer system.

We live in a country where there is No Electrical Power *Always* (NEPA). No environmental/electrical planning data are available on the dot of time. An application of available computing techniques will go a long way toward stabilising our power output, other things being equal.

It is a country where you exist at the mercy, and, at the discretion of your bank where you may have to wait for hours on-end for service and even get your account mutilated without the possibility of being able to raise a voice unless you are peculiarly meticulous. It is well known today that a computerized approach to banking increases the efficiency of the bank and customer's satisfaction with very minimal waiting time.

Many are the reports currently read about insurance brokers unable to account for years of premiums paid by innocent clients, financial houses sustaining heavy losses due to defaulters of loans who cannot be easily tracked down. Yet, a computer approach seeks to annihilate such problems.

Traffic offences continue to be on the increase. Many are road-safety programmes but such do not stop the reckless driver of an unroadworthy vehicle from leading his innocent passengers to the slaughter. Proposals made to the government for the application of the computer to diminish these incidents are yet to see the light of day. One hundred highway police patrols on Ife-Ibadan Road may only succeed in slowing down impatient drivers on that route but not on others unless a similar number can be mounted on all our roads. But this is impossible! The German model of computerized road safety system is a good lesson for a serious nation.

There are hundreds of thousands of vehicles without valid vehicle papers daily on Nigerian roads in spite of police checks. A computer-based traffic revenue generator is a viable way of combatting this and substantially enriching the nation.

Institutions of higher learning (including universities), government ministries, hospitals and similar organisations in the country are not data conscious and therefore give little premium to organisation and processing of data vital to taking management decisions and economic stability. It is most unfortunate that several computer installations in some developing countries are not meeting the challenges of our time because there are too many peripheralists attempting to turn the wheel. Computing is a profession where mediocrity just does not work. Clearly, there is massive scope for improving the economy, power and the nation's growth through efficient computerisation.

In developing countries, particularly Nigeria, one observes that the application of computer technology has a limited scope mainly because, as is the case with most technologies, it is imported. Typical with our previous approach to industrialisation, we imported computer technology without building the infrastuctural base which would have widened the scope and range of its applications similar to what obtains in the industrialised societies. Presently, the advanced application of computer technology in the industrial sector of the Nigerian economy is limited to those projects which were implemented on a turnkey basis such as the refineries, steel projects, hydro and thermal electricity generation and distribution, telecommunications and to a limited extent in other manufacturing concerns. There are only few instances where the introduction of computer technology involved a complete systems change. Most applications are limited to the computerisation of accounting and management information systems only. The users of computer technology in the private sector would include banks, airlines and some manufacturing companies, while the typical applications are payroll, inventory control, inter-branch reconciliations, airlines reservations and storage of statistical data for general use.

In the public sector, the range of applications are narrower in scope and are limited to areas such as payroll accounting. Whereas the developed countries evolved the technology to meet the changing needs and challenges of an industrialised society, most developing countries tended to expend their energies and resources to import ready made technology. In addition, on a day to day basis, series of pressures exist in developed societies for businesses or industries to expand or introduce a range of computer applications. These pressures would include such things as competition which would force a company to computerise aspects of its operations in order to improve customer service or product quality. Other typical pressures would also include the need to replace or conserve a resource which is either becoming too costly or scarce. But in some cases, the pressures could be a mere desire to explore the potentiality of new technologies (i.e. computers) by such companies which are innovators in their approach to decision making.

Our private sector industries are still in their infancy and most of the afore-mentioned pressures are not significantly present in Nigeria. Consequently, this inhibits a desired momentum in the expansion of the scope of computer applications in Nigeria. However, the most limiting factor would appear to be the absence of a stable infrastructural base conducive to the development of a wide range of computer applications. The inefficiency of our public utilities, especially power and telecommunication, are legend and need no greater emphasis. Unless and until the lapses are corrected, this would continue to limit the expansion of the technology in Nigeria.

I am not trying to suggest or recommend a wholesale adoption of computer technology. It is quite obvious that the stage of development of our economy, particularly the infancy of our industrial base and the structure of our labour force (quality and quantity) would preclude a wholesale adoption of computer technology. However, this does not prevent us from seeking ways of optimising possible benefits of an information technology by adopting in piece-meal such applications that are amenable to our particular environment and whose positive contributions are quite discernible.

The main barrier to Nigeria's exploitation of computing technology is the *lack of awareness,* in a sufficiently collective of focussed way, of its potential.

Other barriers in Nigeria are rooted in our present politico-industrial uncertainty and particularly the inability *to assess and agree on the pattern of benefits and its distribution.*

The consequence, for Nigeria, of such barriers being *differently greater than in some major countries* is likely to be an awareness *too late.*

CONCLUSION

In view of the foregoing, and the fact that man has incessantly remained reluctant to be an agent of a computer technological change in the developing states of the world in general and in Nigeria in particular, I wish to make the following recommendations.

1. The government should promulgate a decree to evolve a viable computer policy and regulate the professional practice in computing through the setting up of a National Computer Council which will endeavour to enforce the code of professional practice and establish meaningful and desirable standards in computing in Nigeria.

2. The necessary machinery should be set in motion to introduce the teaching of computing in secondary schools. This is the best time to do so especially now that the government is introducing the new 6-3-3-4 scheme. The future of the technology in Nigeria lies very much in the hands of the younger generations to come.

3. The government should give necessary assistance toward the computer literacy programme soon to be embarked upon in the country, particularly for the young ones in primary schools.

4. A high priority and encouragement should be given toward research efforts aimed at establishing the local manufacture of computers and computer consumables so as to further conserve our foreign reserve. It has been shown that Nigeria may be spending more than N200 million before the end of 1990 on direct importation of these very vital equipments and materials.

5. The government should as a matter of urgency budget for the training of teachers for computing subjects in schools.

6. Parents and teachers of primary and secondary schools should take interest in the computer literacy programme now being launched for school children.

7. Computer industrialists in Nigeria should take a cue from Eckert, Aiken and IBM and voluntarily invest in computer education and research in universities in Nigeria.

8. Computing laboratories should be set up in higher institutions in the country for research and development works.

9. The Nigerian armed forces should get more involved and invest resources in computer research projects as there is likely to be a greater measure of success in such result-oriented works carried out in an environment of strict discipline and which can easily be tested for quick results in a war-conscious environment.

10. The military environment should work more closely with the universities and other higher institutions and research centres in areas of:

(a) Computer software system development
(b) System hardware
(c) Training
(d) Consultancy and other related services
(e) Researches

11. The Nigerian Defence Academy should be gradually developed and equipped to become a research institution especially in computer technology and applications.

12. Necessary and basic infrastructure must be provided for effective, reliable and efficient computer applications to succeed now and in the future. This should include the provision of reliable communications lines to accommodate present and future data communications and computer networks.

Having said all this, I will now like to join all those of you who would still like to ask, perhaps with more meaning now; Is there any hope for Nigeria? Can she make it in the computer world? When Japan announces her final invention (the fifth generation computer) toward the end of 1985, what will happen to Nigeria?

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