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COMPUTER PROCESSING: CREATIVITY IN SOLVING SCIENTIFIC PROBLEMS

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INTRODUCTION

This century, the COMPUTER has revolutionized the world of science (and indeed humanity in general) like nothing else before. The invention of semiconductor technology in particular, and the developments of computational methodologies, set the stage for this unprecedented integration of capabilities amongst which are:

programming which allows the use of computers without or with very little human intervention once operations have commenced,

- computational analysis,
- wordprocessing and textual manipulations,
- databases and filing systems,
- graphics including presentation and drawing,
- information network services.

Furthermore, the computer is known to offer clearly a world-wide processing capability with respect to scientific design, simulation, control and prediction; it is a veritable mechanism for information gathering, processing, dissemination, planning, management, and a versatile tool for interaction among people. In addition, it is used in literally every human activity regardless of geographical location, race, religion, sex or creed. The computer also represents one of the most successful illustrations of the benefits of commitment to research and sustained investment as well as a symbiotic relationship between the scientific know-how of academic and research institutions on the one hand, and the entrepreneural concerns of business, industry and government, on the other.

The history of what is now recognized as computers is just about half a century old. The early computers were the first computational machines that could be readily programmed and the first to work with the lightning speed of electronics. Sometimes referred to as ***dinosaurs***, they were large, one-of-a-kind machines mostly devoted to scientific and military uses. This indicates that they were developed essentially for their number-crunching capability (Campbell-Kelly & Aspray, 1996). The modern computer, that is, the electronic digital computer, is a direct product of World War II when the need arose for improvement in the speed of computational machineries. Even though the basic functional specifications of the computer has remained essentially unchanged since about 1945, there has been constant and extraordinarily rapid innovation, particularly in terms of COMPONENTS and MODE OF OPERATION. The innovation has caused the COMPUTER to witness continuous shrinking in size (miniaturization), faster processing speed, increasing

complexity in density, greater storage capacity, improved reliability, reduction in price, improved fault-tolerance, a myriad of novel applications, etc. The academia as well as industry have consistently been in the vanguard of these innovations which have caused, are still causing, and are set to continue to cause outstanding impact on humanity. I am inclined to believe, and may even venture to say convinced, that God's biggest gift to the world this ***20th Century*** is the computer.

My journey into the interesting world of this ubiquitous device started in 1971 in this very University as a final year undergraduate student. This contact was through some sort of extra-mural programme (evening classes) in FORTRAN programming. The journey then continued through a stint at the University College, London, in the United Kingdom, where I landed, so to say, right at the deep end of simulation activities using FORTRAN with respect to studies on tropospheric scattering in my bid to earn an M.Sc. degree. The next port of call was the then Radio and Space Research Station (now Appleton Laboratory) at Slough, United Kingdom, where I not only continued with advanced simulation studies but got into the then new technique of digitization of images. This was in the course of research studies conducted in South East England, as a Postgraduate Trainee Engineer, on the scattering of radio signals by rainfall at microwave frequency of about 36 GHz. Thereafter, I embarked upon perhaps the most eventful and exciting part of my professional journey, namely, in the School of Engineering and Applied Sciences, University of Sussex, Falmer, United Kingdom, where I would spend three years and ten months as a research student. In Sussex, I was privileged to have trained under a distinguished Electronic Engineer and an accomplished computer professional, Professor Richard Lawrence Grimsdale, who incidentally, is from the original stable of British inventors of the MU5 computer. His thorough tuition and supervision as well as his challenge to me upon successful completion of my tutelage under him about twenty years ago continue to provide constant inspiration in my academic and professional career. I remain an active researcher and practitioner and, God willing, I hope to continue to be with respect to computing, until I can no more function in these roles.

Here I am moved, for their provision of invaluable resources for my academic and professional career, to publicly acknowledge and thank the following people:

- Professor Victor Adegbeye Williams, who introduced and, indeed, ***conscripted*** me into the exciting world of research in academia;

- Professor Richard Lawrence Grimsdale, who ***initiated*** me into this most exciting world of computers;
- CHAMS (Nig.) Ltd. and JKK Ltd., who in Lagos provided the much-needed ***test bed*** and laboratory to verify my philosophy in respect of professionalism in Information Technology. To Demola Aladekomo and Tunji Odegbami in particular I say: Many thanks;
- Bassey Ekeng Akinde, for being a pillar of spiritual strength and the much needed support in my pre-occupation with anything computer.

THE TITLE

Perhaps the most pertinent thing to do next is to explain the title of this lecture, since it is intended to depict the highlights of my academic contributions to knowledge. The thrust of my research efforts in computing belong to the realm of applied computing, especially in the areas of processing data that are scientific rather than anything else, e.g. commercial. The sub-title is an entreaty to employ (or is it exploit?) the potentials of the ubiquitous computer to overcome, in accordance with systematic and accurate procedures, any obstacle (real or merely perceived) such that broad segments of our existence are reshaped positively.

The rest of this lecture, which deals mostly with my various contributions, have been organized along my four main areas in computing research efforts:

- Digital System Design and Microprocessor-based Systems
- Electronic Communications
- Robotics
- Informatics Education, Policy and Health Informatics.

THE MICROPROCESSOR AS AN IMPORTANT ELEMENT OF COMPUTER PROCESSING

Since the specification of the basic functional schematic of the computer by the US government about 1945, the functional units have remained largely the same despite the constant rapid changes in computer hardware, software and communications technologies, across all categories of computers, including the newest and easily the most popular: the MICROCOMPUTER, otherwise known as the PERSONAL COMPUTER. The schematic is depicted in the diagram on the screen

The MICROPROCESSOR, a microelectronic digital device, is right at the heart of any personal computer. It can be conceived of as a Central Processing Unit (CPU) usually on a single Integrated Circuit (IC). Otherwise known as a Microprocessing Unit (MPU), the single IC normally contains the Arithmetic Logic Unit (ALU) and the Control Unit (CU). Essentially, the microprocessor is a general-purpose, integrated chip that could be programmed.

The microprocessor, since its development (about 1969-1971), has witnessed dramatic developments (improvements) such as:

Increasing complexity (density)
Minimum feature (physical size, minimization)
Speed of operation increase (current speed is ~ 3-600 MHz and by extrapolation over time, should be about ~ 10 GHz by 2010)

Clearly, the microprocessor has evolved as a veritable and invaluable processing component of computer systems and with its technology to date making available the following, invaluable and common-place facilities

- Video conferencing
- Mobile computing (notebooks, laptops, palmtops, etc.)
- Wireless communications (including vision apart from cellular phones and other GSM devices)
- Digital imaging
- Diverse Web applications
- Virtual reality (e.g. fashion trip, electronic shopping).

DIGITAL SYSTEMS DESIGN, COMPUTER ARCHITECTURE AND MICROPROCESSOR-BASED SYSTEMS

The thrust of my effort in this area of applied computing is on designing fast, efficient and cheap digital systems to solve contemporary scientific problems. The late 1960s and the first half of the decade of the 1970s witnessed a surge in air traffic. A challenge of this period, consequently, was for pilots to be well trained in order to not only sustain the usual high standard of safety characteristic of air travel, but to even improve upon existing standards. In addition, there was a clearly perceived need to subdue high aircraft operating costs. Ground-based simulation thus became an attractive, even preferable, alternative to in-flight training. Modern simulators with cabin instruments, motion and sound effects, provide a realistic environment for the pilot, while the visual system,

which generates the scene from the cockpit, is of utmost importance in providing the trainee with a sense of realism and an indication of the response of the aircraft to the controls.

Until recently, the image has been generated by a television camera traversing a large terrain model in sympathy with the calculated flight path. The large size of the model, the limited depth of field and other problems restrict the usefulness and flexibility of this system. The industry therefore needed to move towards computer generated visual displays, first with night-landing systems in which the image is mainly point light sources. Later there was considerable interest in the generation of day-time scenes.

The Sussex Computer Graphics Group, with funds from the Science Research Council (SRC), U.K. (Akinde *et al*, 1977), (Akinde, 1980), worked on the problem of computer generated visual display of day-time scenes which resulted in a system to generate colour images in sympathy with the flight path from a stored model. The system used a number of special-purpose processors of a novel design, as well as a conventional mini-computer. Each of the special-purpose processors employed discrete digital devices.

Emphasis was placed on the development of techniques to achieve the desired performance with minimum hardware requirement. This contrasts sharply with the extensive hardware commitment of other systems. The generation of the image in a novel way allows some of the problems associated with computer-generated images to be overcome in a manner less complicated than was done previously.

Computer generated images hold enormous potentials for a wide variety of human endeavours. A common bottle neck is the speed of computation, especially for dynamic situations. The conventional microprocessor was employed in the design and implementation of a novel Transformation Processor, specifically for performing rotation, translation and perspective transformation of 3-D real objects to obtain their 2-D perspective equivalent for display on 2-D visual systems. The speed of operation was just adequate for use in dynamic situations, as can be found in flight simulators. However, with the invention of the bit-slice microprocessor, employed by (Akinde, 1988), in the design of the Transformation Processor, the following advantages were obtained:

- Increase in speed

- Reduction in the number of digital devices required, and consequently reduction in cost.

In 1978, the Sussex Computer Graphics Group secured some substantial funding from the Ministry of Defence in the UK to research further into Computer Generation of Images with a view to exploiting it for defence purposes.

A fundamental requirement of meaningful application of the microprocessor is storage facility, especially in respect of its storage capacity; that is, its ability to hold the microprogram which controls the operation of the microprocessor. Generally, this requirement calls for rapid storage and retrieval of information and, as such, memory facility for microprocessor applications may be found in anything between a few integrated circuit chips and up to about a few hundred chips. Therefore, a fault in any of the memory chips may obstruct the enormous advantages which can be envisioned in the application of the microprocessor. Akinde (1982) employed the principle of writing data into computer memory locations, reading the stored data therefrom and comparing the original data written with the read data in succession, for every location, to determine the state of every memory integrated circuit chip. This way, any faulty chip(s) on a computer memory circuit board may be easily identified with negligible delivery. This proved to be an invaluable development in the early days of microprocessor technology.

The microprocessor has found wide application in virtually every facet of human endeavour, in the developed countries mainly, due to the ready availability of the relevant expertise and technologies, which include: circuit analysis, systems engineering, programming, and the necessary support chips at affordable prices. The situation in developing countries is certainly different even though wide-spread use of the microprocessor holds out even better prospects. We (Akinde & Kehinde, 1984), identified compelling and challenging circumstances for applying the microprocessor in a developing country using Nigeria as a case study. The engineering and social problems that would attend these applications were studied and possible solutions proffered. The issues involved in two specific application areas within the then University of Ife were studied, namely:

- microprocessor control of a central air-conditioning system, and
- microprocessor control of an elevator in a tall building.

Graphical display of data is known to convey more information than written data. Consequently, the demand for more efficient graphics systems was set to increase. Conventional graphic systems were known to exist mainly on mainframes and minicomputers up to the mid 1980s. We (Kehinde, Makinwa & Akinde, 1987b) presented a cheap microcomputer-based vector graphic system. The system which was designed and constructed, is a useful tool for teaching the fundamentals of computer graphics even at an advanced level. The design of the tool endowed it with the following properties:

- flexibility
- robustness
- cheapness

A research grant from the URC, Obafemi Awolowo University, Ile-Ife, in the mid 1980s facilitated studies on microprocessor applications with respect to automation in some Nigerian industries. The studies resulted in our (Akinde & Ubaru, 1990a) developing a design that employed the microprocessor in an application of an automated technique in providing effective and efficient process control on the bubble-cap rectification column, as employed in oil refineries. The major advantages of the design would lead to:

- improvement in the capability of the rectification column
- improved reliability
- enhancement flexibility, and
- low-cost.

For the Nigerian society, accurate billing of clients for infrastructural services such as electricity, telephone and water has become a night-mare, seemingly defying solution. The practice in use is to have a monitoring meter for each of the infrastructure, with this resulting in extensive hardware and huge cost of procurement. We (Akinde, Kehinde & Inyang, 1991a) designed a microprocessor-based module/device that can support the billing of consumption of multiple infrastructure including electricity and telephone. The flexibility of the design is such that it can be easily modified to monitor up to four resources simultaneously.

The import of the foregoing ***romance*** with discrete digital devices and the then relatively new high-density chips (called the microprocessor) in the decade of the 1970s is that the microprocessor, which was invented about 1971 and did not become a common-place device until 1973, was to play a catalytic role, not only as embedded devices in calculators,

digital watches, video games, etc., but even a more prominent one in industrial automation, monitoring, test, interface and medical equipment. Perhaps the most outstanding impact of the microprocessor is its role as the ***launching pad*** for the microcomputer revolution which the world has been witnessing these past 15 years.

COMPUTER CONNECTIVITY AND NETWORKS

Dr. Francis Ogwu in his research project for an M.Sc. degree in Computer Science under my supervision in 1985 carried out studies on the use of a microprocessor kit, the MCS-85, as a front-end controller in a Communication System. The result of studies on a generalized computer communication system with rather limited capabilities was presented in an unpublished report (Akinde & Ogwu, 1987c). The technique employed devolved the communication functions from the main computer system to a simple microprocessor kit which will handle all the preliminary functions of:

identification of bonafide users
data formatting
data (user services) routing

We further proposed an appropriate interface between the main computer system and the MCS-85 microprocessor kit.

The microcomputer, otherwise known as the PERSONAL COMPUTER (PC), was a scentific novelty until the close of the decade of the 1970s. In (Campbell-Kelly & Aspray, 1996) the PC is referred to as ***the result of a rich interplay of cultural forces and commercial interests.*** Of course the MICROPROCESSOR has been the enabling technology, offering the irresistible allurement of drastic reduction in the price of the central processor, against the minicomputer where the most expensive part - the Central Processing Unit (CPU), remained much too costly. By the mid 1980s, the PC had virtually succeeded in sending the minicomputer to a ***premature death*** and confined it to ***museums*** and ***archives***. Whether the ***old reliable*** mainframe computers will suffer a similar fate is yet to be determined.

A clear trend is that the PC has made computing/computer power available to ordinary people where and when it is needed. Today, the configuration of a self-contained typewriter-like box, equiped with a screen and keyboard and complemented with disk storage (floppy, hard and compact disk), is widespread and common place. Incidentally, there has

been a commensurate growth on software for PCs with hardware growth. It could be stated that the history of computing over the past two decades is the history of the PC. The development has simply been phenomenal bringing in its trail a ***marriage*** between computers and communications.

I have, in the course of my academic incursion into this field, followed the thinking that connectivity among computers holds potentials for enhancing the capabilities of such computers. This is the idea commonly referred to as NETWORKING. Thus, my contributions in this sphere of knowledge (of computer connectivity and networks) have been made essentially through indigenous projects with a view to establishing technical and managerial standards for nation-wide data handling on computer-based networks.

As a result of a perceived scientific challenge to maximize the rather limited computer facilities common in Nigerian communities between the era of minicomputers (up to about the mid 1980s) and the emergence of microcomputers, we set ourselves to solve another scientific problem to greatly enhance the capabilities of a minicomputer by judiciously interfacing it with a microcomputer. This arrangement allowed a processing element/board which would otherwise have been queued up, in the event of the minicomputer's capacity being exceeded, to be easily shed onto the microcomputer. We (Akinde & Kehinde, 1987), in response to the challenging circumstances of inadequate computer facilities in the Department of Computer Science and Engineering at the Obafemi Awolowo University, Ile-Ife, in the 1980s, and with funds from the University Research Committee (URC), designed an interface by employing the simplex current loop method, to link a Data General ECLIPSE C-150 minicomputer to an Apple II microcomputer. It was found that enormous flexibility was conferred on the minicomputer by preprogramming its INPUT/OUTPUT operations.

In another effort, and again with some financial support from the URC, we (Akinde & Ajayi, 1987a) identified the inevitability of the introduction into this University, of an Integrated Information System, preferably in the setting of Local Area Networks, termed the IFEVARSITY Local Area Network (IFEVARSITY LAN). The preliminary investigation conducted was a detailed analysis of the possible connecting media options. This was borne out of a desire to keep the cost of the proposed IFEVARSITY LAN low. The study resulted in highlighting the advantages and drawbacks of each connecting medium considered and making definite recommendation on cost with respect to the implementation of University

LANs.

In (Akinde & Osofisan, 1987) and (Akinde & Osofisan, 1994a), we reported the research findings of the first research studies in respect of the design and specification of a computer-based data handling national network for Nigeria. With the convergence of computers and telecommunications, a revolutionary trend has been set in motion with enormous potentials for tremendous changes in the modes of information and data handling not only on a national scope, but also on an international scope. The current Global Information Society, also known as the Global Knowledge Society, has enhanced the importance of information and knowledge management and dissemination. The lecturer, more than 10 years ago, perceived the need and demand for reliable and efficient national computer networks especially for data handling communication purposes in Nigeria. We (Akinde & Osofisan, 1994a) proposed a methodology for the design of a multi-access computer network whose scope of coverage is Nigeria. A hierarchical method was employed for the control of the network. Specifications of the relevant parameters of the network, christened NIgerian NETwork (NINET), were proposed. A complementary operating system for NINET, designated NIgerian Network Operating System (NINOS), was recommended. The structure and specifications of NINOS have been reported in detail in (Akinde & Adagunodo, 1995c).

INDUSTRIAL AUTOMATION AND ROBOTICS

The capabilities of the computer have been known to hold out enormous potentials for substantially enhancing the productivity of industries, through the solution of a myriad of scientific problems. Even though computer technology acceptance in industries was rather slow, its recognition as a basis for much faster and more dynamic growth in industrial output and safety has made it practically available for every industry. About the middle of the 1980s, I resolved to take a journey into the region of industrial automation for the Nigerian society. My contribution in this sphere of life is in the form of capacity building in order to exploit the potentials of computers to substantially enhance industrial productivity.

In (Ogwu & Akinde, 1994b), (Ogwu & Akinde, 1994c), we gave a detailed treatment of the specification and design of an Adaptive Robot System (ARS). A kinematic model for the trajectory of ARS for a Prismatic Joint type was developed with equations of motion, for both the resolved and

unresolved methods. Simulation studies of the ARS design showed that the Point-To-Point (PTP) technique of tracking ARS is preferred to the Proportional Integral Adaptor (PIA) method, for varying payload mass.

We, (Ogwu & Akinde, 1995a), reported the actual design of a Prismatic Joint Robot System based on the experience and findings of our previous efforts. Robot Systems offer enormous potentials for industrialization, especially in the heavy mechanical production sector. The study gave a systematic treatment of the use of a microprocessor specifically in providing accurate and reliable control for a class of prismatic joint robots. The Newton-Euler and Langrange formulation of equations with respect to the kinematic of the robot for an open-loop chain were developed. A simulation of an Adaptive Robot System trajectory was also undertaken, and it confirmed the reliability and accuracy of our design which is still awaiting appropriate exploitation for development.

INFORMATICS EDUCATION, POLICY AND HEALTH INFORMATICS

Nigeria, with its expanding economy, aggressive business climate, highly active educational stance and a rather delicate political state, has suddenly come to the realization that the COMPUTER is capable of bringing significant benefits to her citizens. At this juncture, permit me to say that the Computer has clearly evolved to be an indispensable tool for information processing. Thus, not only large organizations but virtually every organization now turn increasingly to the computer as the solution to their needs with respect to information collection, processing and communications needs. Even though the computer was initially developed essentially for number crunching, its attributes/potentials as an equipment for data processing, accounting and office automation, principally with respect to wordprocessing and keeping business records, have for sometime now been recognized by several groups. Consequently, computers are now widely installed as standard office equipment not only by large corporations but also in smaller offices and retail establishments.

We live in a world where the knowledge-base and business environment are constantly changing. Furthermore, Information Technology has witnessed such rapid changes that using computer hardware and software effectively now requires considerably less technical knowledge than hitherto was the case. Thus, the major hinarance/drawback to effectively using the computer is not necessarily insufficient knowledge of the fundamentals, but rather the need for greater appreciation and understanding of the role of Information and Communication Technology

(ICT) in business as well as how the Computer can be applied to solve business/administrative/ scientific problems. Suffice it to say that so phenomenal is the rate of computerization in Nigeria that it can rightly be described as experiencing a commendable upsurge in computing activities that are capable of bringing significant benefits to Nigerians, practically in every facet of contemporary life. The main limitations to the sustenance of this trend include:

- lack of a well-articulated material policy on the part of government
- low level computing skills of the people who design surrounding information systems

In the light of the foregoing, a fair proportion of my active professional computing effort, spanning some twenty-seven years or so, was directed at policy issues on:

- informatics education in general, and
- health informatics in particular.

Between 1987 and 1989, on the platform of the Computer Association of Nigeria (COAN), which by divine permission, I have the privilege to serve as the current National President, I made some input into the production of a National Policy on Computer Education. Infact, I served as the Chairman of the Training Committee of the Federal Ministry of Education, in charge of the implementation of certain recommendations of the National Policy. The national service afforded me the opportunity of making contributions to the curriculum for computer education at the secondary education level as well as the writing of the manual used on the Train-the-Trainers Scheme.

For the purposes of emphasis, I must state again that computers have a most pervasive social influence on society in that they are known to change society, jobs, organization, and people. It is therefore important that for Nigeria, her nationals must be given sufficient knowledge to be able to meaningfully enhance their productivity through the use of computers. This conviction is based on the following premise:

- computing should be recognized as a basic skill, just like reading and writing.
- informatics should be recognized as a basic science in its own right.

computer should be recognized as a national resource, just like electricity, oil, etc.

Thus, there must be concerted effort to promote computing at the appropriate level of our educational system, that is, primary or/and secondary school levels, and thereby equip the nation's youths to better face the challenges of living in the twenty first century. To this end, students regardless of age, must be given more computing power; the correct educational level, that is primary or/and secondary, need to be resolved. Ordinarily, I am inclined to support the view to introduce such basic skill as informatics in the primary school level, with the opportunity of correcting any mistakes in the secondary school level, rather than at the secondary school level, with very slim chances of rectifying mistakes. However, the financial implication of introducing informatics education at the primary school level does not make it an attractive option given the continuously dwindling economic fortune of Nigeria, and the reality of the many competing projects for the nation's limited funds. Thus, at least for some time to come, informatics education as far as Nigeria is concerned, should be introduced at the secondary school level, with the major objective of putting more computing power into the hands of students in the classroom. In (Akinde, 1995), I enumerated major factors and issues for an enduring philosophy for informatics education in Nigeria.

Of special note is the enormity of the potentials which the COMPUTER holds out for the health sector especially in developing (or is it science-poor?) countries, given the particularly high medical specialist/patient ratio. Health Informatics, that is, the science of computer application in healthcare delivery, has impacted the health field through TELEHEALTH systems, by employing computer systems and connectivity extensively in the following areas including:

remote medical diagnosis,
tele-nursing,
electronic medical records system,
medical statistics/epidemiological analysis,
pharmacy information system,
medical laboratory services, and
tele-medicine, etc.

In 1989, the Department of Computer Science and Engineering entered into a collaborative research project involving the Obafemi Awolowo

University Teaching Hospitals Complex (OAUTHC), Ile-Ife, Nigeria, and the Computing Centre, University of Kuoppio, Kuoppio, Finland. Towards the close of the 1980s some interest was generated in the use of computer technology in healthcare in Nigeria. The expectation was that computer usage in healthcare delivery would allow for rapid, accurate storage and retrieval of all medical information especially in health institutions. Some apprehension however, was expressed specifically as to the likelihood of the computer taking over people's jobs. Such fears were however relieved early in the decade of the 1990s when a functional Health Information System (HIS) was installed and sustained at the OAUTHC, Ile-Ife. The said HIS which was found to be reliable, efficient and helpful owes its sustenability in the main, to the commendable commitment of the OUATHC Management support for the project. Among the benefits derivable from the HIS are the following:

- improved productivity in the OAUTHC, Ile-Ife
- improved efficiency
- judicious use of the limited available resources
- enhancement of healthcare delivery to PHC Centres in rural areas especially in respect of referrals
- enhancement of the exchange of ideas, knowledge, experience, etc. between OAUTHC, Ile-Ife and other health institutions world-wide.

The Federal Ministry of Health in Nigeria, like many other nations adopted a World Health Organisation (WHO) sponsored global health strategy termed ***Health for All by the Year 2000AD***. To date, the Federal Ministry of Health, even though it has demonstrated some interest in, and support for, Health Informatics, needs to be more aggressive and consistent in her promotion of Health Informatics potentials particularly at the Primary Health Care (PHC) level. In (Soriyan, Akinde, Farewo, Adekunle, Orisatoberu & Korpela, 1996b), we reported our experiences and enumerated future plans in respect of a hospital information system which employed the Mumps Technology (M Technology) for the OAUTHC, Ile-Ife, Nigeria. The Joint Hospital Project, as the collaborative research project was designated, I am pleased to announce, has been a much-needed catalyst for a take-off of health informatics activities in Nigeria and Africa. This project gave birth to a series of National Conferences on ***Computers in Health Care Management***, here in Ile-Ife, in 1992 and 1995. Perhaps its major achievement is the institution of an African regional body of Health Informatics people. In 1993, the first International

Workshop on Health Informatics in Africa (HELINA '93) was inaugurated here at the Conference Centre of Obafemi Awolowo University, Ile-Ife. I had the singular privilege of serving as the Chairman of the Organizing Committee. The second International Workshop in Health Informatics in Africa (HELINA '96) came up in 1996 in Johannesburg, South Africa. In (Akinde, Soriyan & Makanjuola, 1996a) and (Akinde, Soriyan & Adagunodo, 1996b), we discussed issues regarding the funding and sustenance of Health Management Information Systems for African countries and the formulation of a philosophy for Medical Informatics Education in Developing Countries, respectively. We are currently engaged in studies in the participatory method of Information Systems Development as they pertain to healthcare delivery.

In addition, I served as the World Health Organization Consultant for Nigeria and Ghana in respect of Requirements Collection and Analysis (RCA) on the Cooperative Information Network for Professionals in Africa (COPINE Project) in 1996. I also served as a Commonwealth Expert on the Curriculum Development and the commencement of the Commonwealth M.Sc. degree in Computer Science at the National University of Science and Technology, Bulawayo, Zimbabwe, in 1994 and following.

In (Akinde, 1985), (Akinde, 1986a), (Akinde & Adagunodo, 1989b), (Akinde & Njoku, 1990b), (Akinde, 1991b), (Akinde, 1992), (Akinde, 1994d), we offered proposals for policy issues with respect to the use of computer as a modern technique in elections, cultural promotion in the age of computers, computer literacy and awareness as well as computer utilization in teaching, for Local Governments, and in National Agricultural Information Management Systems for the Nigerian society. Thoughts were also given to the general social impacts of computers as well as to ethical, legal and organizational issues in respect of computer abuse and misuse, specifically for the Nigerian society.

CONCLUSION AND RECOMMENDATIONS

As an academic, I believe there is no limit to my scientific responsibility for MAN, ENVIRONMENT and TECHNOLOGY. Thus, in the past twenty-seven years or so since becoming a University graduate, I have always espoused an academic and professional philosophy/credo in respect of solving scientific problems with the COMPUTER. I have adopted a flexible approach which introduces technical and managerial initiatives and techniques with a view to making the knowledge base of mankind in computer engineering in particular, and computer science in general,

available ANYWHERE, ANYTIME, as well as INCREASING THE BENEFITS for all involved. Essentially, my research efforts have contributed to knowledge, playing the role of a catalytic agent, as an initiator of studies in nation-wide computer networks and a stimulator of projects and policies by applying the empowering technologies of digital electronics, telematics and robotics, especially with the ubiquitous computer as a vehicle. Consequently, given the dynamic nature of computer technology, the globalisation/internationalisation of computer applications and uses, as well as the pressure of the high cost of computer systems, I am convinced that there are compelling needs not only to intensify the process chain of RESEARCH ACTIVITIES with respect to computer applications, services and computer personnel training, but also to improve upon the existing levels.

I believe that by the ***magical*** year 2000 there will be some few hundreds of millions of computers in the world more than what obtains today and that there will be more personal computers than television sets. Ladies and gentlemen, it cannot be repeated often enough that mankind will depend more on the COMPUTER in the twenty-first century. It must be noted that human society is changing, such that old jobs are disappearing while new ones are developing/appearing, all through the instrumentality of the computer. Lack of computer skills will certainly constitute illiteracy in the twenty-first century. Therefore, basic computer training is necessary. To live meaningfully in the twenty-first century and beyond, it is crucial to learn how to use information and how to work with it. Yes, the opportunities which the computer offers Nigeria in particular and the world in general are enormous, including:

- geographical proximity, and
- communal commonalities.

But then, the computer does pose some challenges to mankind. For the Nigerian nation-state, especially as we march towards the year 2000, it is imperative for governments at all levels to be honest enough to accept that with respect to computer technology and computing, new communities will emerge and that it is expedient that Nigerian individuals are empowered appropriately. To this end, the powers that be in Nigeria will do well to be determined to face, and squarely too, the computer challenges for the future, which include accepting INFORMATION as a civil right for all. Come the twenty-first century, and it is barely 12 months away, NIGERIA cannot afford a second-class society of ***computer-literate*** and ***computer-illiterate people***.

Mr. Vice-Chancellor sir, it is in the light of the fore-going that, with utmost humility but with profound professional conviction and lacking any iota of doubt, I make the following recommendations:

1. A National Information and Communications Technology Commission be established as a matter of URGENCY and cited in the Presidency. Its membership should include experts from the Government, the Private/Business Sector, Educational Institutions, and relevant professional bodies. Among the objectives that the Commission being proposed will work towards are:

   to develop guidelines on how Information and Communications Technology (ICT) can be employed to achieve and maintain economic, industrial and technological development,

   to identify new applications of ICT and to highlight the benefits that can accrue to Government as well as the private sector too, from the use of ICT,

   to devise, implement and monitor means of promoting greater awareness and literacy in the general public as well as to provide the opportunity for the public to interact directly with new technologies and form a wider appreciation of their capability and benefits.

2. In view of the perceived benefits of, the increasing use of, and dependence on ICT, government is being entreated, as a matter of utmost urgency too, to improve the quality of essential infrastructures, including electricity, telecommunications and to provide a National GATEWAY to the Internet, etc. These are vital for a successful operation of computers and networks.

Undoubtedly, the computer holds much potential for humanity, not only with respect to solving scientific problems but also as a potent, veritable and invaluable tool that is capable of bringing a number of changes with far-reaching consequences, in the structure and process of business, administration, education, engineering, research, entertainment and domestic issues.

REFERENCES

AKINDE, A.D.; GRIMSDALE R.L., HADJIASLANIS A.A., WILLIS P.J., WOOLLONS D.J. (1977): "Use of a surface-oriented colour raster display in computer generation of Images for flight simulators" IEE Publication. No. 150: Display for Man-Machine Systems.

AKINDE, A.D. (1980): "An aspect of a computer-based pilot trainer". Proceedings of the First Annual Conference of Computer Association of Nigeria, April, Lagos, Nigeria.

AKINDE, A.D., (1982): "A fast memory tester". Journal of Computer Science and Its Application, Vol. 2, No. 1, pp. 1-17.

AKINDE, A.D., KEHINDE, L.O.; (1984): "Prospects of microprocessor applications and utilization in a developing country: Journal of Computer Science and Its Application, Vol. 3, December, pp. 53-68.

AKINDE, A.D. (1985): "Application of Information Technology in **Educational Management**". First **NBTE** National Workshop on Management Information System for Nigerian Polytechnics, August 13-16, Kaduna, Nigeria.

AKINDE, A.D. (1986): "Options for Computer Hardware and Software Procurement". Computer Association of Nigeria, SEMINAR on Computer Policy. May, Concord Hotel, Owerri.

AKINDE, A.D.; AJAYI, I.A. (1987a): "Conceptualization of the IFEVARSITY Local Area Network: Analysis of Data Transmission Media". Computer Association of Nigeria, 3rd International Conference, ABUJA '87, April 29th - May 1st.

KEHINDE, L.O., MAKINWA, K.A., **AKINDE, A.D.** (1987b): "A micro-processor-based vector graphic system for microcomputers", International Journal of Electrical Engineering Education, Vol. 24, pp. 131-146.

AKINDE, A.D.; OGWU, F.J. (1987c): "MCS-85 as a front-end controller in a communication system". (Unpublished Technical Report)

AKINDE, A.D. (1988): "Transformation Processor: An alternative design based on bit-slice microprocessor", Journal of Computer Science and

Its Applications, Vol. 5, No. 2, pp. 49-57.

AKINDE, A.D.; KEHINDE, L.O. (1989a): "Interfacing the APPLE II to DATA GENERAL ECLIPSE C-150". Nigerian Journal of Science, pp. 112-115.

AKINDE, A.D.,; ADAGUNODO, E.R. (1989b): "Modern Techniques in Elections: A Conceptual Data Processing Model for Elections in Nigeria". SEMINAR on Computer in Election and Census, N.I.I.A., March, Victoria Island, Lagos.

AKINDE, A.D. (1989c): "Strategies for Computer Literacy and Awareness". 7th National Conference of the Computer Association of Nigeria, May, Ranch Motel, Benin City, Nigeria.

AKINDE, A.D.; UBARU, M.O. (1990a): "Automation in process control: A microprocessor-controlled bubble cap rectification column", Nigerian Journal of Science.

AKINDE, A.D.; NJOKU, S.B.A. (1990b): "Cultural Promotion in the Age of Computers: The Computer as a Tool for the Preservation, Promotion and Presentation of Culture". First National Workshop on National Cultural Parameters in Decision-Making". NIPSS, July 30 - Aug. 3, Kuru, Jos, Nigeria.

AKINDE, A.D.; KEHINDE, L.O.; INYANG, N.O. (1991a): "A multi-purpose digital billing system". Journal of Computer Science and Its Applications, Vol. 5, No. 2, pp. 73-96.

AKINDE, A.D. (1991b): "Computers and Local Governments: Education, Educational Management and Examinations". Computer Association of Nigeria, Lagos Chapter, Seminar for Local Government Officials, Federal Palace Hotel, Lagos, Nigeria.

AKINDE, A.D. (1992): "Funding and Sustenance of National Agricultural Information Management System: Issues and Strategies. Federal Ministry of Agriculture/World Bank, Seminar on Agro-Statistical Data Bank, NTI Conference Centre, Kaduna, Nigeria.

AKINDE, A.D. (1993): "Hardware and software options for the Nigerian Statistical System" Proceedings of National Workshop on Data Banks and Data Production in Nigeria, Lagos, March 3-4, pp. 77-91.

AKINDE, A.D., OSOFISAN, A.O. (1994a): "A Conceptual design and specification of a Data handling Computer Network" Ife Journal of Technology, Vol. 4 No. 1. pp. 49-53.

OGWU, F.J., AKINDE, A.D. (1994b): "A mathematical model for a Prismatic Joint Robot System" Journal of Computer Science and Its Applications (JCSA) Vol. 6, No. 1, pp. 72-92.

OGWU, F.J., AKINDE, A.D. (1994c): "Microprocessor Control System for a Prismatic Joint Robot" Ife Journal of Technology, Vol. 4, No. 2, pp. 41-51.

AKINDE, A.D. (1994d): "Options for Computer Hardware and Software procurement for sustained development in Africa" 2nd Annual African Information Technology Forum, Cambridge, U.K., September 29-30.

OGWU, F.J., AKINDE, A.D. (1995a): "Design of a Prismatic Joint Robot System" Ife Journal of Technology, Vol. 5, No. 1, pp. 1-11.

SORIYAN, H.A.; **AKINDE, A.D.**; FAREWO, F.A.; ADEKUNLE, M.A.; ORISATOBERU, O.A. & KORPELA, M. (1995b): "M and Kernel as Appropriate Technology in Health Care in Africa", M Computing, a Publication of the M Technology Association, March, Vol. 4, No. 1, ISSN 1060-7689, pp. 15-19.

ADAGUNODO, E.R., **AKINDE, A.D.** (1995c): "A Graph-Theoretic Model for Protocol specification and verification in a Distributed Operating System" (Technical Report).

AKINDE, A.D. (1995d): "The Philosophy of Informatics Education in Secondary Schools: The Nigerian Case". An Invited Paper presented at UNESCO/LAUTECH Workshop on Informatics Education Policy for Nigeria, Ogbomoso, Nigeria.

AKINDE, A.D.; SORIYAN, H.A.; MAKANJUOLA, R.O.A. (1996a): "Health Management Information Systems: Issues of Funding and Sustenance", Journal of Methods of Information in Medicine, vol. 36 No. 1, 1997.

AKINDE, A.D.; SORIYAN, H.A.; ADAGUNODO, E.R. (1996b): "Philosophy for Medical Informatics Education in Developing Countries", HELINA '96, Johannesburg, South Africa, April 15-19 (sent for Journal publication).

CAMPBELL-KELLY M., ASPRAY W., (1996b). "Computer: A History of the Information Machine". BasicBooks, New York, Publisher.