THE COMPUTER REVOLUTION

ITS IMPACT AND APPLICATION TO NATIONAL RECONSTRUCTION

K. KORSAH

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THE COMPUTER REVOLUTION
Its Impact and Application to National Reconstruction

by

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An Inter-Faculty Lecture delivered at the University of Ghana on 21st May, 1987

GHANA UNIVERSITIES PRESS
ACCRA
1988

Published for the University of Ghana

by

Ghana Universities Press
P. O. Box 4219
Accra

© K. Korsah, 1988
ISBN: 9964–3–0146–4

Produced in Ghana

Typesetting by MES Equipment Limited, Accra
Printing and Binding by Commercial Associates Ltd., Accra

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INTRODUCTION

The first electronic digital computer was developed in the United States between 1943 and 1946. It contained 18000 vacuum tubes (the same kind of electronic device found in old radio sets of the sixties in Ghana) and occupied several square metres of space.

The first company to get into the commercial production of computers was probably Remington Rand (which later became Sperry Rand). In the early fifties, International Business Machines (IBM) also went into computer manufacture, and the computer industry has continued to expand ever since.

The first generation computers, the computers of the forties and fifties, were huge monsters in comparison to today's computers. Today's fourth and fifth generation technology allows more computing power to be packed into a small space, so that a typical microcomputer has a performance that is several orders of magnitude higher than the first generation computers. Fig. 1 shows a rough comparison of the size of computers of similar power in the fifties through the eighties. One of the reasons for such drastic reduction in size is the rapid developmental changes that have occurred in the building block of the computer. After the vacuum tube, the next major development was the introduction of the transistor. In contrast to the vacuum tube, the transistor was much smaller, generated much less heat and was much more rugged. Still, it required several thousand transistors to be put together to make a computer. Then integrated circuits (Fig. 2) were developed which allowed several thousand tiny

Fig. 1 Approximate physical size of computers from the 1940's through the eighties.

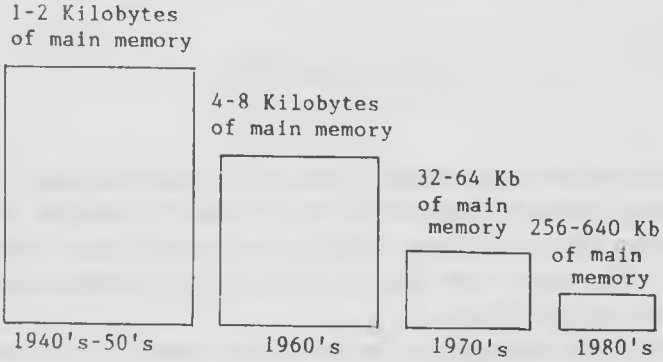
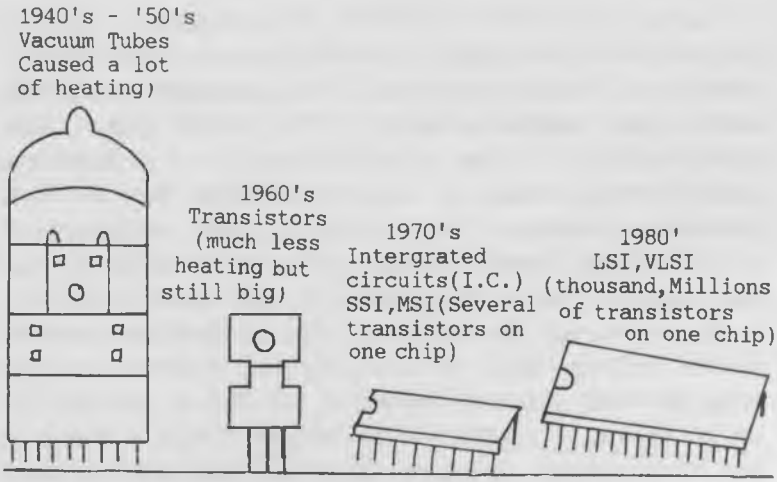


Fig. 2 Major changes in the building block of computers from the 1940's through the eighties



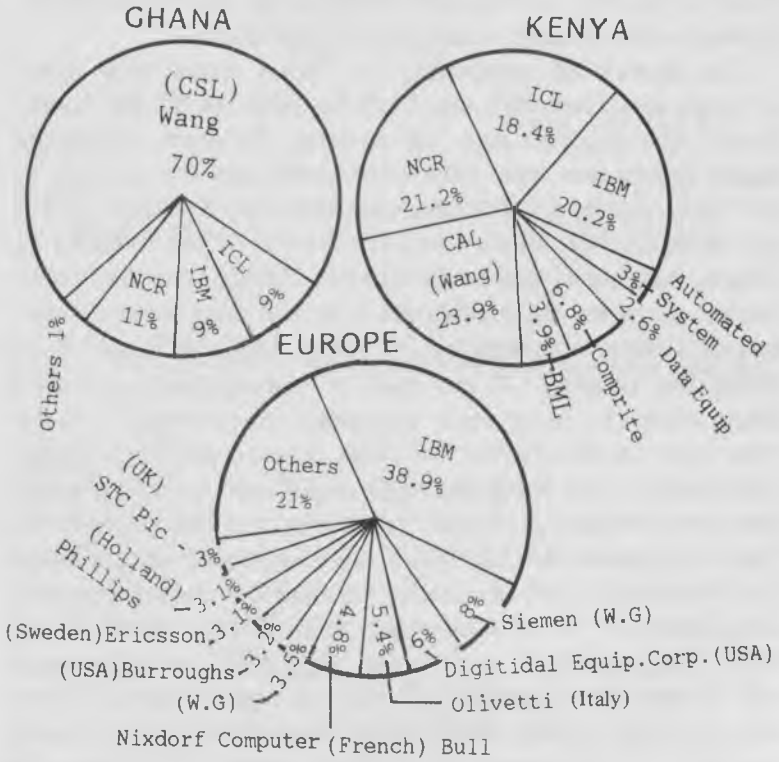
SSI Small Scale Integration
MSI Medium Scale Integration
VLSI Very Large Scale Integration

transistors (barely visible to the naked eye) to be interconnected on the same semiconductor material about 1.3cm x 3.8cm. It is easy to see that now a single chip (as the integrated circuits are called) could do what previously took several thousand individual components to achieve. The result is that the physical size of computers can be drastically reduced while actually increasing its capabilities.

The history of computing in Ghana dates back some 30 years ago when National Cash Register (NCR) first introduced cash registers into the country. However, electronic digital computers were first introduced into the country in the early sixties by International Business Machines (IBM) and later by ICL. Since then, the growth of the industry in Ghana has been rather checquered. Today, the computer market place for the traditional mini and mainframe computers in Ghana is dominated by Wang, IBM, NCR, and ICL. Wang has roughly 70 per cent of the estimated installed base, while the other three companies have roughly 10 per cent each of the market. In other African countries similar trends show that Wang has made significant inroads into the computer market in Africa within the last five years or so. Fig. 3 compares the mini/mainframe estimated installed base in Ghana with that of Kenya, a similar developing country, and Europe.[1,6] It is interesting to note that while Wang, NCR, IBM and ICL rank in the same order in both Ghana and Kenya, the situation in Europe is very different. There, the big name is IBM, while Wang does not even come among the top ten computer vendors (1986 survey). Of course, this could simply mean that Wang's marketing strategy has been concentrated on developing countries, and has nothing to do with the quality of their products.

In the microcomputer area, a number of companies and agencies have sprung up, dealing in a relatively wide variety of microcomputers, notably IBM PC's and IBM Compatibles, NCR, Apple, Amstrade, Wang and Omari Computers.

Fig. 3: Comparison of mini/mainframe computer market shares among computer vendors in Ghana, Kenya[1] and Europe[6]



In all, it is estimated that there are about thirteen or so computer vendors in Ghana, almost all of whom represent at least one overseas supplier. Of the thirteen only four could be said to be in the mini/mainframe business, while the rest are exclusively in the microcomputer sales.

This brief overview suggests that a lot has happened in the computer scene over the past six years or so. For example, six years ago there were virtually no microcomputer vendors in the country; six years ago Computer Services Limited (Wang) was unknown in the country.

The economic problems that continued to plague the country in the early eighties did nothing to increase the growth of the computer industry. Today, all that is changing – there is now a modest base for the computer industry. This, however, is still a far cry from the computer revolution that has, and is continuing to sweep the industrialized world.

In order to appreciate the magnitude of the role computers are playing in the lives of people in the industrialized world, and to form a basis for discussion on how computers can be used in our environment for national reconstruction, some of the applications of computers and computer-based systems are first presented. The paper then looks at the particular areas of application to which computer-based systems have been traditionally applied in Ghana, and suggests ways in which such applications could be improved thereby contributing to Ghana's industrial development. Finally, some of the reasons for the slow growth in the application of computer technology in the country is presented.

COMPUTER APPLICATIONS IN INDUSTRIALIZED COUNTRIES

Rapid technological developments in the industrialized countries have given rise to a computer revolution whose impact has been felt all over the world. In such countries, computers and computer-based electronic devices are used in almost every area one can think of – in the home, in the office, at the bank, at the supermarket, in the school, at the hospital, in industry... the list goes on.

As the rest of the world becomes increasingly automated it is inevitable that developing nations like Ghana will become affected whether we make an attempt to follow suit or not. As the *African Technical Review* puts it[1], "International Commerce is no respector of a country's emerging status and in the harsh climate of transnational trading no quarter is given. African industry has therefore to compete both at home and abroad, often against deep seated but unjustified prejudices agaisnt locally-made goods".

The Auto Industry

Consider the auto industry for example, and the part computers are playing in car manufacture. Today, there are several assembly plants that are about 40 per cent manned by robots. Computerized robots do anything from bolting parts together (such as a flywheel to an engine) to spraying cars with the precise amount of paint material. The advantages of "employing" robots on the factory floor are several:

1. Robots can improve versatility on the assembly floor. For example, a laser scanner fitted to a computer-controlled robot can read a unique bar code lable on an engine and instruct the robot to use a specific painting program according to customer's requirements. Incidentally, robots can achieve a higher quality paint finish than humans, something that is especially important for products made and used in the harsh tropical climates of Africa where the probability of corrosion is highest.

2. Robots make more accurate and economic use of materials (eg. right amount of a paint, optimum use of materials for welding, etc).

3. Robots improve quality control and, because they do

not get tired, they can contribute to increased productivity.

How does robot technolgy, made possible by the computer revolution, affect a developing country such as Ghana? Fig. 4 and Fig. 5 show two possible scenarios. One scenario leads to cheaper cars, which ultimately benefits the Ghanaian consumer. The other, more likely scenario leads to an increase in the capital and/or running cost of cars for the Ghanaian consumer.

Fig. 4 One possible effect on the Ghanaian consumer resulting from the application of robots in the auto industry.

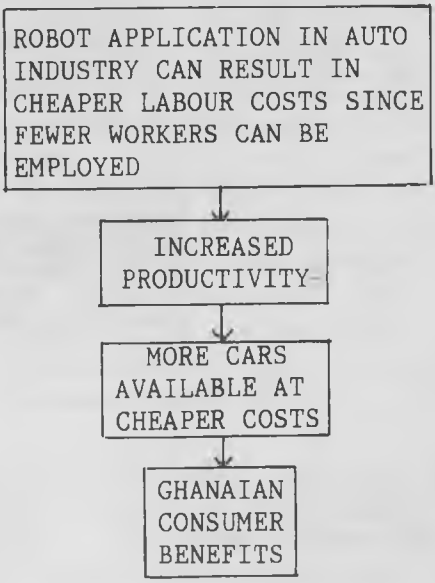
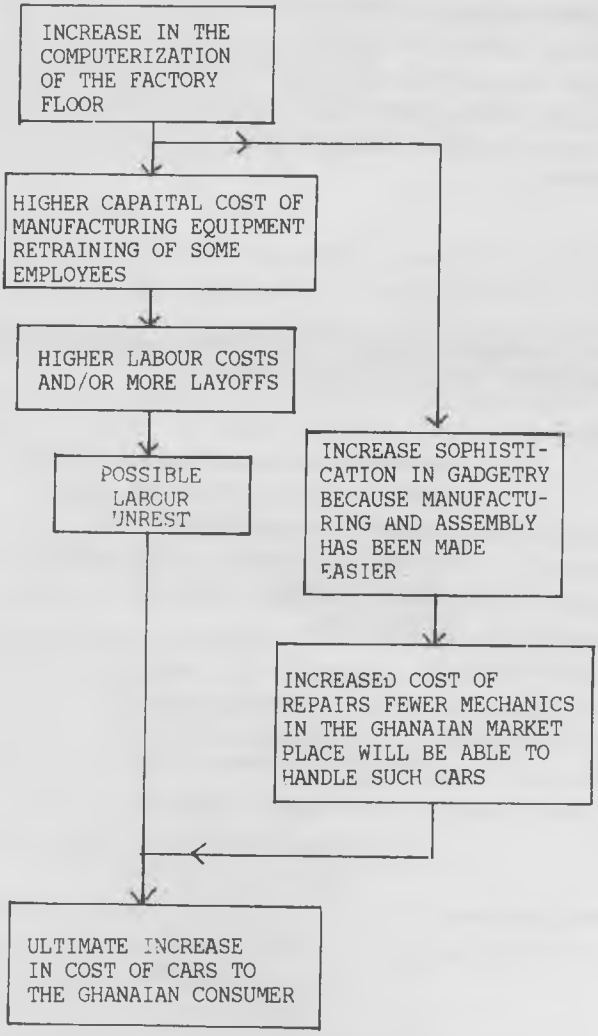


Fig.5 Another (more likely) scenario, resulting from the Application of robots in the auto industry



Either way, it is clear that whatever happens in the auto industry because of the increased use of robots will ultimately affect developing countries also.

Computers in Medicine

Computers have long been used in the medical field in such areas as hospital information systems, diagnosis of illnesses, monitoring of a patient's vital signs, etc. In the latter case, for example, a critically ill patient can be connected to a computer which continuously monitors the vital signs such as pulse rate, blood pressure, temperature, etc. with no supervision. When the computer senses some abnormality it can then alert the appropriate medical personnel.

Another area where computers are contributing to medical science is in the area of three-dimensional imaging with the aid of computer graphics. Traditionally one of the best aids to medical diagnosis has been the ability to look inside the human body. X-rays were one of the first methods that were used. However, one of the major limitations of X-rays is that they show only two-dimensional pictures and only reveal a limited number of hidden ailments. With the aid of computer graphics coupled to computerized tomography scans (which are basically X-ray cross sections), three-dimensional images can be produced, for example, of a patient's skull which can show surgeons what they need to do and what the results of their surgery will be even before they actually carry out the operation. Just by punching a few keys it is even possible to make the three-dimensional picture rotate to reveal features and internal skull structure more vividly.

Microprocessors (often called "computer on a chip") have made possible the design of unique instruments and aids for the handicapped. The technology of the eighties enables people who are suffering from cerebral palsy, epilepsy and other motor disorders of the nervous system to be helped.

For people who are paralyzed in the arm or leg, the technique involves the implantation of tiny platinum electrodes along the spinal cord. The electrodes are then connected by stainless steel wires to a tiny receiver implanted beneath the skin and along one side of the person. The receiver picks up minute radio frequency pulses originating from a microprocessor-based transmitter that is about the size of a cigarette packet worn by the patient on his/her belt. The patient can control the electronic messages reaching the spinal cord by changing switch settings on his small cigarette-sized computer, thereby allowing him to move under his own power.

The use of larger computers and computer networks in medical diagnosis is now common place. By simply dialing a number, a doctor with access to a computer terminal in a hospital can be connected to a medical data bank hundreds of miles away; the host computer's data bank includes thousands of data on phamaceuticals and bodily disorders. By keying in the correct query, a doctor can obtain vital information to help a patient with a serious disorder.

Computers in Military Technology

Although computers have brought several benefits to man, they have also brougbt misery and fear to the world. Computers made sending people to the moon possible, but they have also made the design and deployment of sophisticated weaponry possible.

Once upon a time, people fought with axes, bows and arrows and "horse powered" chariots. Then gunpowder was invented and people began to fight with muskets, shotguns and riffles. Today, computers have made warfare a formidable and sophisticated technological exercise. Nowadays, computerized planes can monitor an air battle from hundreds of kilometres away. Video screens on board the plane show all the enemy and friendly planes engaged in the fight. The

computer shows not only the relative positions of the friendly/enemy jets kilometres away, but also their indentities, where they are coming from or heading towards, altitudes, and even their fuel supplies in some cases.[2] Planes like the hawkeye and the AWACS in the US airforce fall in this category.

In a typical scenario a hawkeye will spot an enemy fighter rising from its home field hundreds of kilometres away, and quickly identify the type (see Fig. 6). As the plane's computer provides the course and speed of the enemy plane, the hawkeye's operator could quickly select a friendly fighter best positioned to deal with the enemy. All the operator has to do is to connect the two planes appearing as spots on his video screen with a light pen and key in a few commands to allow the hawkeye's computer to begin broadcasting data to the interceptor's computer, telling it exactly what course to take to intercept the enemy plane from the most favourable attack angle. If the pilot of the interceptor plane wanted, he could simply allow the computers aboard the two planes to handle the entire attack, until the moment came to press the firing button on his control stick.

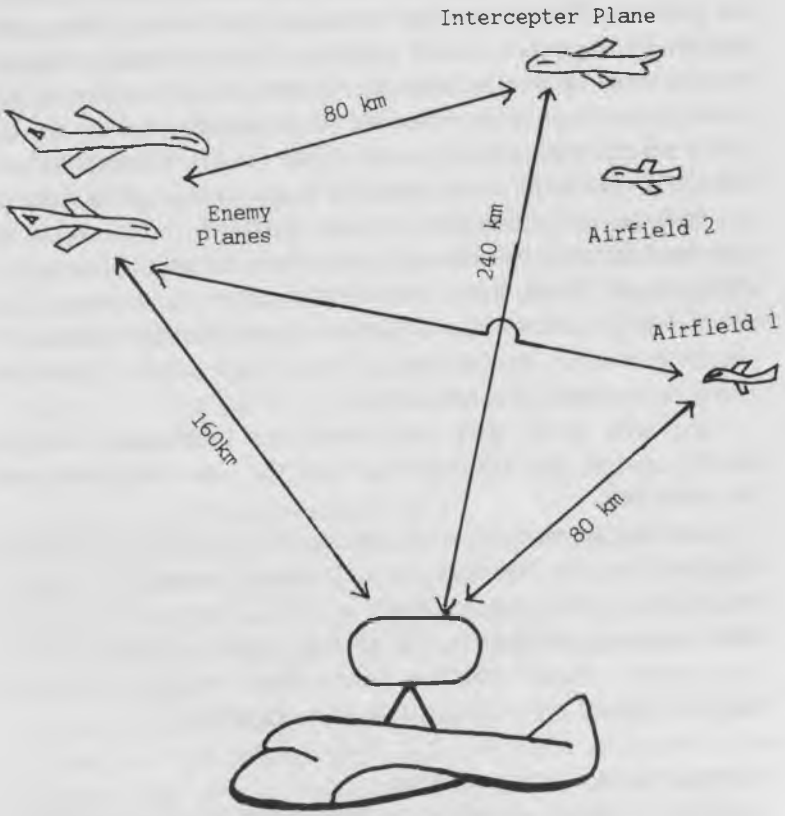
You will agree that such computer technology can be deadly against any adversary lacking the same sophistication in weaponry.

Incidentally, sophisticated planes of this type were probably used for the first time in real warfare during the Syrian – Israeli war in the Bekaa Valley in 1982. During the dog fight that occurred, a total of 79 Syrian planes and come SA–6 anti-aircraft missile battries were alleged to have been destroyed without an apparent loss of an Israeli jet.[2]

Computers in Communication

Computers made possible an improved mobile telephone system, called cellular telephony, at the beginning of the nineteen eighties. The first countries to use cellular telephony were the Scandinavian countries, Japan, and the USA.[3] In

Fig. 6. "COMPUTERIZED WARFARE"— A possible scenario where a hawkkeye controls the action



Hawkeye with computerised
early warning system

ordinary mobile telephony, a person in a moving car can call another person in another car, much like a radio transmitter/receiver (or walkie-talkie) would. Because such systems use dedicated frequency channels and the frequency band allocated is limited, there is considerable limitation on the number subscribers and also susceptibility to noise and interference. In cellular telephony, a city is divided into a number of "cells" or small areas and a computer is used at the central switching office to search and access several two-way channels so that a person who is travelling from one area or cell to another can be assigned another channel (unnoticed by the moving person) to avoid fading or crosstalk. Incidentally, the cellular system is designed to be completely compatible with the regular phone service in the particular country. This means that if a person in a house in Accra is calling another person travelling to Kumasi the result will be exactly the same as if the moving party were answering his phone at home in Accra.

Computers in the Bank

In developed countries, computers have long since eliminated unmanageable queues of the kind those of us who bank at the Legon Commercial Bank encounter. If you go to most banks in an industrialized country to cash a cheque, it is a simple matter of either a teller or a cashier (depending on whether you are an American or an Englishman) verifying your account and how much you have in the bank on a computer, and giving you the money you asked for. In the manual system such as obtains in this country, waiting for verification of your cheque alone could be a very painful experience.

Computerization has even made it possible for one to cash or deposit money after banking hours. Computerized machines – called automatic bank tellers – take the place of human cashiers. To withdraw money you simply insert a card on which is written a code unique to you. The card is

read magnetically and verified that your account number is valid. The computer asks you how much you want to withdraw. After keying in the amount, the computerized machine sends the information back to the bank's central computer which again verifies that you indeed have the amount there. After the go-ahead is given to the machine, your required amount is counted and issued out to you, together with your receipt. The process is completed within about 2 minutes.

Voice Recognition Systems

The ability of computers and robots to execute instructions at the command of the human voice is now a reality. The vast majority of conventional computers today use the keyboard as the major input device. In the next decade, human voice used as input to computers should become almost as commonplace as the keyboard.

Electronic speech (the ability of a computer to put words together to form intelligible speech entirely under the control of a program) has been around for some time although the technology is still not perfect. Earlier applications appeared in educational systems such as "speak and spell" which help children to learn better.

On the other hand, Voice Recognition Systems (the ability of an electronic device to understand human speech) is a more recent technology. VOICE COMMAND, a voice recognition system with a 500 word vocabulary, allows users to verbally operate popular application programs such as Lotus 1–2–3 and Wordstar. The program first appeared in 1983 and allows the computer to recognize the user's voice and accept it as an alternative "input device" to the keyboard.

In terms of the technology involved, voice recognition is more difficult to achieve than electronic speech. One reason is that the computer must be able to recognize the same word spoken by different people, independent of the pitch and timbre of the voice. The other reason is that the compu-

ter should not only recognize words, but also understand what a person is trying to say from the context. "Group the apples in PAIRS is obviously different from "separate the PEARS from the apples". Or consider the following sentences; "Take the MEAT from the fridge" and "I want to MEET Mr. So-and-So". To the human mind, it is easy to decipher the difference in meaning when words that SOUND the same are used in sentences. However, to the computer this problem is not so easy to solve. The third problem is that the "electronic signature" from words spoken with a pause in between words is different from the same words put together in a continuous sentence. Thus voice recognition systems include a matching routine that identifies the spoken word, a grammatical processing routine which figures out how the words are put together, and semantic processing, which extracts meaning from the context.

Traditionally, one of the main obstacles to the wider use of electronic speech systems (not voice recognition systems) has been that it has required large amounts of memory, a high cost item. Already a number of companies have succeeded in reducing the amount of information needed to store and generate high quality speech by as much as 85 per cent.[4]

One of the more recent business applications of voice recognition systems has been the development of a stock Quotation System in the USA which allows callers to enter and retrieve current market information in natural, normally connected speech. A user simply speaks the number codes for any of several thousand stocks stored in the computer, and the service provides current quotes – delivered in computer generated speech. In the very near future it should be possible for one to simply walk to a computer at an airport and ask it when the next Ghana Airways flight from Accra is supposed to arrive in London.

COMPUTER APPLICATION FOR DEVELOPMENT IN GHANA

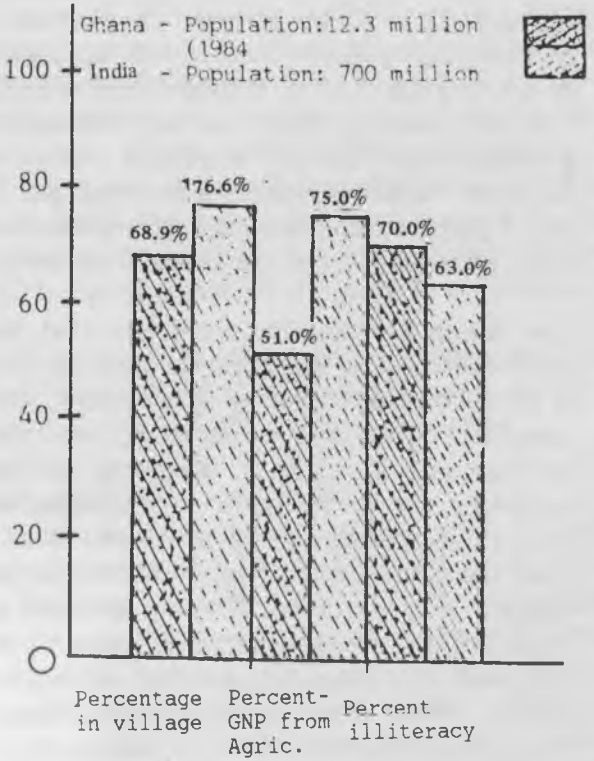
We have discussed at some length some of the various applications of computers and computer-based systems in developed countries. It is not difficult to see how such applications have contributed to improve the standard of living in these countries.

The argument could be raised, however, that the state of Ghana's development at present does not require the use of most of those technologies mentioned above. The question is how can we put computers to greater use for national development?

In Ghana, the application of computers have traditionally been in the area of data processing such as accounting, payroll, etc. Even in such traditional areas the applications are neither widespread nor adequate. In this section it is shown that increased use of computers in data processing and management information can help to improve productivity. To begin with, it is informative to consider what other developing countries are trying to do or have already achieved by applying computers to solve national problems. Notable examples are India, Malaysia, Philippines, Singapore and Sri-Lanka. The case of India is particularly interesting because some of the basic statistics of India are not very different from that of Ghana. This situation is shown in Fig. 7, which shows that in Ghana 68.9 per cent of the population still live in villages while in India the figure is about 76.6 per cent. In Ghana, 51 per cent of our gross national product (GNP) comes from agriculture, while in India the figure is over 60 per cent. It is easy to see that the two countries have a lot in common. However, although the comparison reveals that Ghana is not very different from India except for population, the latter is making a more impressive effort towards its technological advancement than Ghana is. How is informa-

tion technology being used to improve the quality of life of the Indian people? During the past two years, the Indian Government has taken a number of steps with the intention of demonstrating some new and relevant applications of computers – applications through which a citizen can feel

Fig. 7 Comparison of some basic statistics between Ghana and India.



the direct impact of computers on the quality of his or her life. A few of such applications are the following:

1. India is a country where serious seasonal floods can occur, with subsequent loss of lives. Nowadays, computers are being used for flood forecasting and other meteorological applications.[5] In a particular case in which a cyclonic storm devastated a large area of the South Eastern Coast of India, loss of life was minimal because of computer monitoring.

2. India's dense population causes grave problems in the transportation sector. At Delhi for example passengers wanting to reserve seats at a railway station used to stay in a queue for an average of more than 3 hours. Five hour waiting periods were not uncommon. Now, a computerized railway reservation system catering for about 40,000 passengers a day is in use. The system is purported to reduce the waiting time for booking a ticket to an average of about 20 minutes.

3. The Indian Government recognizes that the next generation must be computer literate if they are going to cope with the technology of tomorrow. A vigorous computer education programme is, therefore, being pursued with the aim of supplying computers to secondary schools through the length and breath of India. The programme was only instituted a few years ago, and to date about 1000 schools have been supplied with computers. If the programme becomes successful, the new generation will grow up with the computer technology, so that they will be in a better position to find more ways of using it to benefit their communities, and also to help in advancing the technology itself.

The Indian examples can also be found in other Asian countries such as China, Singapore, Malaysia, Sri-Lanka, etc.

To some people, computers and high-technology information systems may seem one of the least-needed inputs at this stage of our economic recovery programme. However, the above examples from a similar developing country shows that this assumption is not correct at all. Another example from closer home on the African Continent may help to stress the point further.

Zimbabwe is a country of more than eight million people and annual growth rate of about 4 per cent per year. Like Ghana, one of the biggest priorities of the Zimbabwean Government is boosting agricultural production. The country's biggest manufacturer of fertilizers and agrochemicals, Windmill Limited, uses computers to get orders to farmers at the right time. During peaks in business, orders can reach a rate of 1000 a day. Without computers, processing this many orders manually could mean fertilizers reaching their destination long after it was needed, thereby causing significant setbacks in the government efforts towards agricultural production.

In the development of computer technology in Ghana, where are some of the areas that computers can be used to advantage? Let us look at a couple of examples:

An Integrated Agricultural Data Bank

Government considers the agricultural sector a top priority area for development in the Economic Recovery Programme (ERP). However, ensuring complete success in agriculture in the shortest possible time depends on the ready availability of information whenever and wherever it is needed. Most research findings in agriculture will remain on the shelves of institutions to gather dust because there is no centralized and computerized data bank. Vital information such as amount of fertilizer for a particular variety, amount of rainfall to be

expected in any month, weather conditions, etc. cannot be obtained readily.

How can an integrated agricultural data bank be implemented, where any farmer in any region can get valuable information whenever needed? The ideal way would be to install a minicomputer or microcomputer in each region, and interconnect each of them to a mainframe in Accra (Fig. 8). The communication between processors would be by normal telephone lines. Research and other relevant data obtained from the regions would be used to update the database by trained personnel manning the regional centres. Up-to-date reports could then be made available to the farmers on a regular basis.

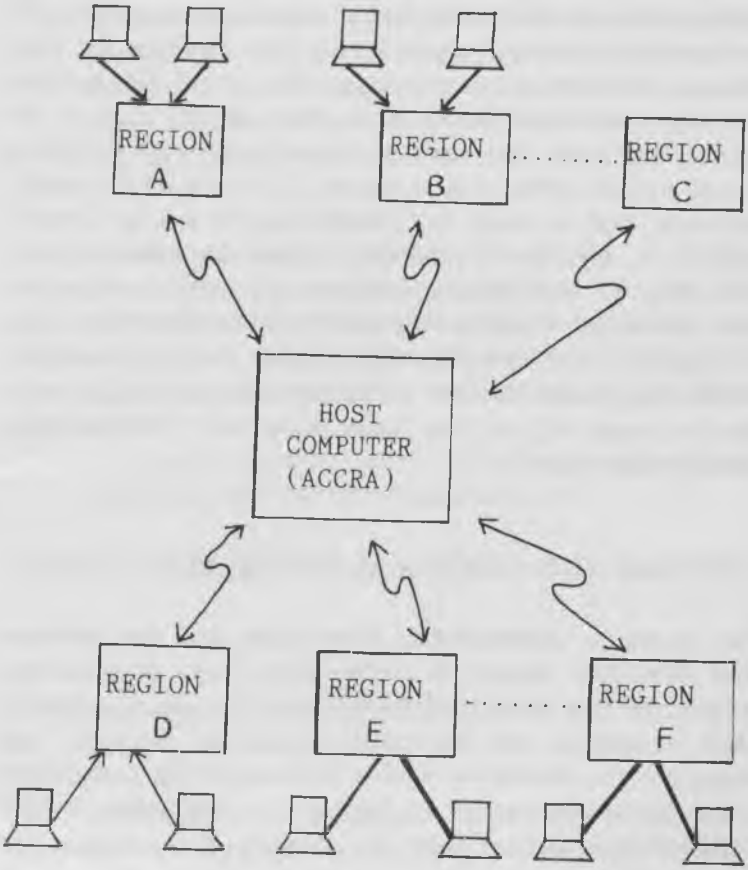
The efficient application of information technology of this nature depends, to a considerable extent, on the country's telephone network infrastructure. At present, this is less than adequate. However, this is not to say that such an important system cannot be developed. If a Government attaches as much importance to its development as it should, dedicated lines could be used with the help of the national Post and Telecommunications Corporation.

The other alternative is for a mainframe to be located in Accra, and for micros or minis to be installed at the various regions. Data could then be acquired on diskettes and brought to Accra on a regular basis for updating the database on the mainframe. Relevant reports could then be copied onto diskettes which will then be sent back to the regions for dissemination to farmers. Such information dissemination could of course be done in conjunction with the existing radio network.

The Banks

Up till now there are few banks in Ghana that are fully computerized in the sense that signatures, account numbers, and

Fig.8 Possible computer network for Agricultural Data Bank



bank balances are automatically and interactively verified when you hand in your cheque to the cashier. This means that even in cases where some computerization exists one can wait for about an hour or more just for signature verification.

Since most government workers are paid through the banks one can imagine how many hours can be lost every month from lack of computerization. During a simple survey made by the author it was found that an average of more than 100 people spent up to 1½ hours at a bank waiting for their cheques to be cashed. If we assume that about 400 workers patronize the bank during peak hours at the end of the month, and that they earn an average salary of ₵5,000 a month (which works out at about ₵ 200 a day) it is easily estimated that as much as ₵15,000 may be lost by Government in a day, just at that bank. Assuming conservatively that about 15 such branches scattered all over Accra face the same problem, a simple calculation shows that more than ₵ 200,000 a day is lost just by people having to wait for hours doing unproductive work. In reality in fact, a more detailed study will put this figure closer to ₵1,000,000 (one million cedis) a day.

THE NEED FOR A NATIONAL INFORMATICS CENTRE

The means to communicate, disseminate, and use information effectively should be at the core of any development programme in a country such as Ghana. A major reason why Asian countries such as India, Sri-Lanka, Malaysia and Singapore are growing at such a fast pace is the recognition of the role of Information Technology in development. India's National Information Centre, for example, is responsible for the dissemination of information technology in government and is already engaged in setting up a major computer network to serve and link government offices. A centre like this is much needed in Ghana. Among other things such a centre should be entrusted with the following:

1. Development of strategies for the application of cur-

rent technologies to information management for administrative and managerial functions.

2. Co-ordination with the nation's universities and other institutions engaged in some aspects of Computer Education in ensuring that a competent and an adequate number of computer professionals are trained for the Ghanaian market.

3. Monitoring and encouraging the growth of indigenous firms in computer technology so that the future expansion and application of the technology to national development will not depend totally on the whims and caprices of multinational corporations.

4. To ensure standardization of hardware and software produced for Government agencies, etc.

SHOULD GHANA MANUFACTURE ITS OWN HARDWARE?

The development of indigenous technology in computer hardware has been attempted by a number of developing countries, notably India and China, and to some extent Singapore and Malaysia. Should Africa in general and Ghana in particular attempt to manufacture its own hardware? It must be noted that central to this question is the development of an electronics infrastructure in the country. Let us briefly discuss what goes into making a computer from scratch (Fig. 9 – Fig. 12).

Source of Electronic Components

The ideal situation will be to have a flourishing semiconductor industry in the country. This ensures that one can get a constant supply of digital electronic components to buy off the shelf. Indeed there seems to be some general agreement that a country which does not have a semiconductor industry should not attempt to manufacture computer hardware.[7] However, it is possible to have a regular and relatively cheap supply of components without having a semiconductor industry in the country. In some cases buying the components elsewhere could be cheaper than having a components manufacturing industry itself. This could be especially true in a situation where the developing country decides to go it alone without support from any of the major transnational corporations.

Fig. 9 Basic steps in the development of an indigenous computer manufacturing industry

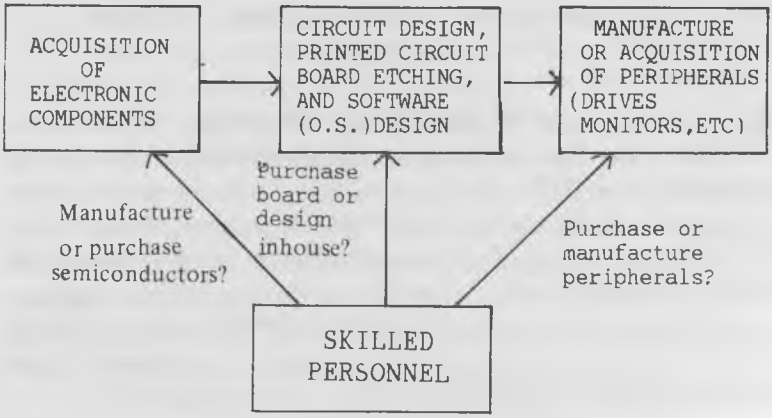


Fig. 10 Steps in translating a circuit diagram into a printed circuit
(Step 1: The circuit design)

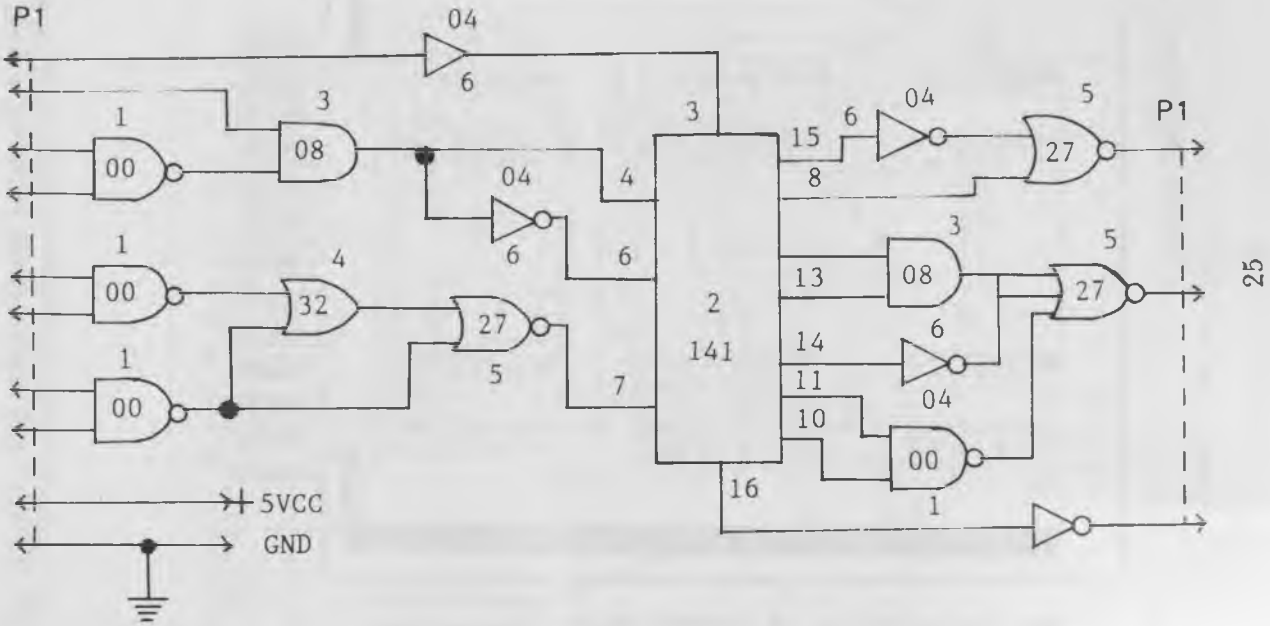


Fig. 11 Steps in translating circuit diagram into a printed circuit (Step 2: the PC Board layout before etching)

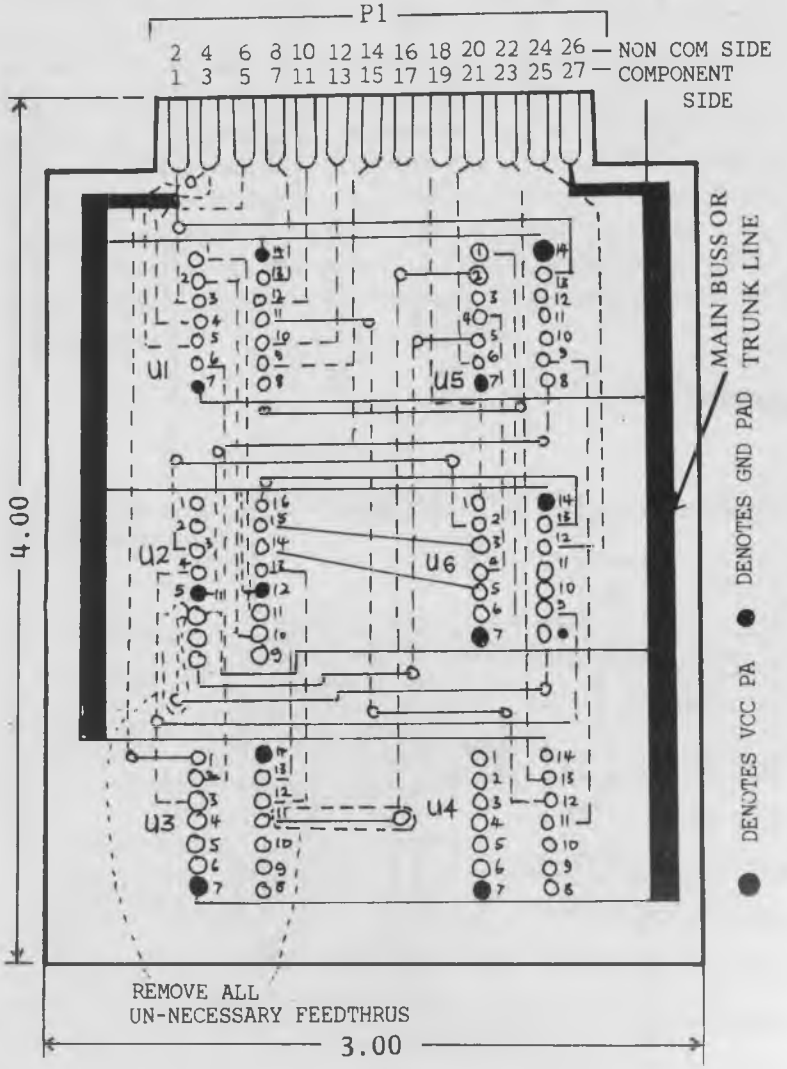
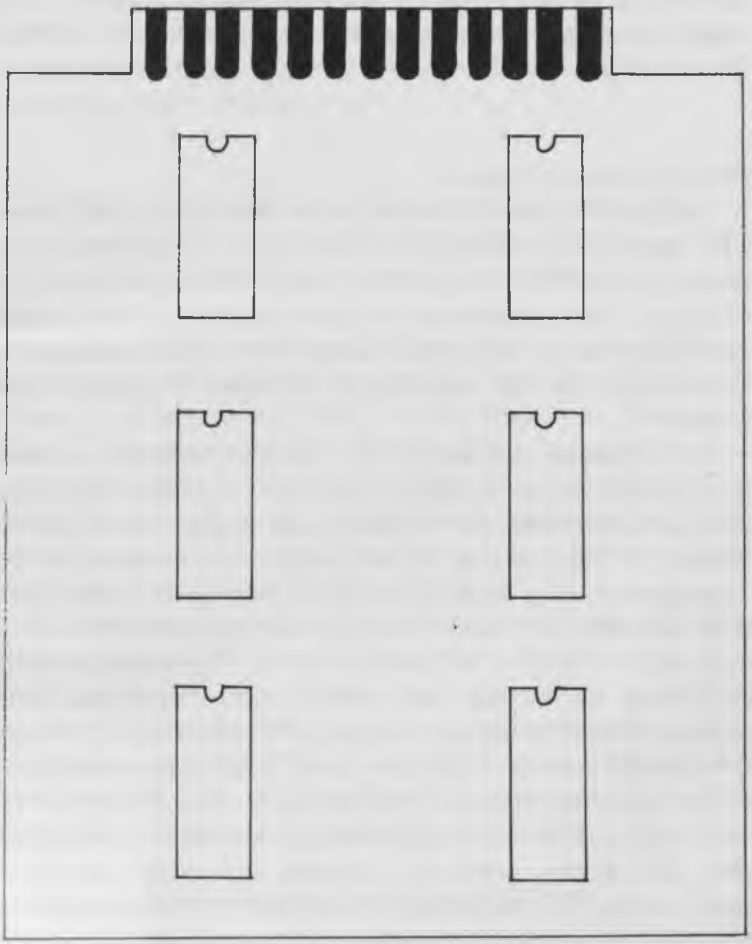


Fig. 12 Steps in translating circuit diagram into a printed circuit (Step 3: The final printed circuit board)



The Hardware/Software Design

Computer design requires personnel skilled in both digital electronics and operating system design. It also requires people experienced in printed circuit board development.

The number of skilled personnel in these areas at present in Ghana is very limited, but that is not to say that they are not around. As far as the electronics design and printed circuit board design are concerned, some expertise can be found in the country.

Other Peripheral Systems

A computer system requires other items like disk drives, CRT screen or monitor, and printer to function properly. At present, apart from the monitor which could conceivably be obtained from Akasanoma or Sanyo and the proper electronics built into it, the infrastructure simply does not exist in the country for the manufacture of these peripheral equipment.

In conclusion, one would add that the situation in Ghana is a peculiar one in the sense that there is neither an electronics infrastructure, nor is there easy access to foreign exchange for the purchase of the required components for the development of a modest, indegenous computer manufacturing industry in Ghana. Granted that the latter were true, however, it would be possible to develop made-in-Ghana computers by buying the needed components and other peripheral equipment and designing the electronics in-house. One should bear in mind that this is what almost everybody in the computer manufacturing industry does. Except for the very large corporations, very few manufacturers design their own disk drives, monitors, printers, and other peripherals that go with the computer. For example, a one-man computer manufacturer or even a reputable company would buy disk drives from Shuggart Associates, and then design his con-

puter input/output electronics to be able to "talk" to the disk drives. "Omari Computers" (an indigenous computer manufacturing company) is probably in this category. It is interesting to note, in passing, that the serious attempts being made in places like China and India to develop indigenous manufacturing of computers is being done in collaboration with major computer vendors. The major reason is probably the fact that most developing countries cannot compete favourably with the major transnational corporations in the manufacture of hardware.

WHAT IS HINDERING THE WIDESPREAD USE AND INCREASED PROFITABILITY OF COMPUTER USAGE IN GHANA

The single most important factor is lack of training and awareness in what computers can do. The typical manager in Ghana is simply scared stiff about computers. Because he thinks, however wrongly, that showing his ignorance of computers might jeopardize his job, he concludes that he better not give an ear to the younger blood agitating for the introduction of PC's into the company to improve management information and decision making.

A recent survey on the campus has shown that only about 40 per cent of the personal computers distributed so far to departments are being utilized, one reason being insufficient training on what to do with them. A comprehensive training programme is, therefore, being developed to improve the situation. Most of the departmental needs can be met by using one of four types of application packages:

1. a spreadsheet package such as LOTUS
2. a data base package such as dBASE III or RBASE 5000
3. a statistical package such as SCSS or SPSS PC^{+}, or

4. a wordprocessor package such as wordstar or wordperfect.

Personnel training will, therefore, also include training in the appropriate package or packages needed.

Training of computer personnel is inadequate, mostly because of lack of proper facilities for practical training. Some so called computer training schools do not even have any computer for training.

Another hindrance to the widespread application of computers in this country is the poor state of our telecommunications infrastructure. If this nation is going to have a greater measure of economic growth, computers must be put to far greater use than has hitherto been done – and improvements in our telecommunications infrastructure is a must in this area.

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