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COMPUTERS FOR INDUSTRIAL MANAGEMENT IN AFRICA

The case of Ethiopia

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Preface

The Regional and Country Studies Branch of UNIDO is carrying out a study on the use of computers for industrial management in Africa. It focuses on the present levels of computer usage of this kind, and looks at the obstacles to a wider use. The study is intended to contribute to the development of technical assistance programmes and enhanced international co-operation in this field.

The management use of computers encompasses traditional applications such as payroll, accounts, stock keeping, etc. In other countries the computer has proved a useful tool in increasing the efficiency and accuracy of such tasks and contributing to the effectiveness of the management function. Its role in industry in Africa is potentially very important. However, obstacles to a wider use in Africa are many, and include both economic and technical factors. The study attempts to provide an overview of these.

As part of the whole study, several analyses are being made of individual African countries. The present study examines the case of Ethiopia.

The study has been prepared by Mr. Sentayehu Teferra as consultant to the Regional and Country Studies Branch of UNIDO.

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INTRODUCTION

The purpose of this paper is to explore the use of computer facilities for industrial management in Ethiopia, as a case study to be incorporated in a regional survey project on the subject sponsored by UNIDO. While the focus of the study remains the present state and future prospects of computer use in the office environment of manufacturing establishments, as prescribed in the terms of reference, a few cases from the mining/energy and construction sectors are also reported.

The paper is organized into five parts. The first part briefly highlights the prevailing economic and political background of the country with a view to portraying the subject of inquiry in a broader perspective. In Par II, computer use in the industrial sector of the economy is surveyed with particular reference to existing computer installations. In addition to an overview of the local computer market, Part III covers the profile of computer vendors represented in the country. In the last two parts, existing institutional arrangements for computer education and training as well as the condition of basic infrastructural facilities such as the system of telecommunications for remote computer network are reviewed and those in current use are cited.

Documented reference on computer related subjects concerning Ethiopia in general, and on its role in the industrial sector of the economy in particular, is virtually non-existent. Perhaps, the only item of information available in this regard is computers registered since the policy was introduced two years ago. Hence, virtually all the materials in this report are based on interviews and deliberations conducted with representatives of organizations and individuals directly or indirectly associated with computers including industrial sector users, hardware vendors, educational and training institutions, computer consultants, policy makers, suppliers of utility services such as telecommunication and electricity[1].

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[1] Please refer to Annex 6 for the list of organizations consulted.

I. ECONOMIC AND POLITICAL ENVIRONMENT

The role of computer utilization in a given country for industrial management or other purposes cannot be properly appreciated without the existing socio-economic and political environment as a background to the subject of inquiry. For this reason, discussion of the central theme of this paper is prefaced by an overview of the economic and political setting in Ethiopia.

Ethiopia has a population of about 48 million. In 1988, its GDP per capita was US$ 113 in current dollars. The most important sector is agriculture, although its share of GDP has been falling and was 33 per cent in 1987. Agriculture still accounts for over three quarters of the labour force. Manufacturing value added (MVA) was 9.2 per cent of GDP in 1987. Ethiopia is classified by the United Nations as a Least Developed Country (LDC) and one of the criteria for this is that MVA should be less than 10 per cent of GDP. Although, as can be seen, this criterion is fulfilled in the case of Ethiopia, its manufacturing sector is nevertheless one of the stronger in the LDCs. It is dominated by agro-related industries, especially food, beverages and textiles. In 1987, food processing was 52 per cent of MVA, followed by textiles at 19 per cent. However, there is also a quite strong chemical sector, at 16 per cent of MVA. This includes activities based on Ethiopia's mineral resources, and there are prospects for expansion in the development of natural gas deposits. The textile sector has shown some international success in sub-contracting, and the quality of the leather and leather products industries is high.

In spite of the small size of the manufacturing sector, activities in industry and related services are in some cases of high quality. However, the environment has not been favourable for industrial growth. Combinations of military conflict, drought and famine in the last decade have assumed such proportions that the possibilities for expansion of manufacturing have been very limited. Nor has the external economic environment been favourable. Coffee is a vitally important export for Ethiopia, accounting for over half its export earnings, but world coffee prices have fallen sharply and are likely to remain low for some time.

The central concern of an Ethiopian factory manager today remains obtaining raw materials and spare parts to keep plants running. With an existing general economic crisis and a chronic scarcity in foreign exchange, cost saving investment in computer facilities cannot conceivably be contemplated before these fundamental problems are resolved.

The establishment of a socialist republic in 1974 had brought a radical transformation of ownership and economic organization, with private property and business being nationalized and placed under the control of public corporations. Recent policy statements place new emphasis on the private sector. Both direct foreign investment and new domestic entrepreneurs are to be actively encouraged. State enterprises will be privatized or closed down if they fail to achieve profitability, competition and productivity.[2] Up to now, however, the public sector either dominates or completely controls the different branches of industry. According to a 1986 survey of manufacturing industries, the share of the public sector was more than ninety-five per cent

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[2] Africa Research Bulletin, Vol.27, No.2, 31 March 1990.

of the employment, gross value of production, and value added. Apart from handicraft and small scale processing activities, private local businesses and co-operative organizations do not figure significantly in the manufacturing sector. According to a recent survey conducted by the Joint Economic Commission for Africa/Centre on Transnational Corporations on foreign affiliated firms hosted by Ethiopia, only six cases involving joint ventures between foreign investors and the Ministry of Industry on behalf of the government, were identified.[3]

Virtually all large to medium scale manufacturing is owned and controlled by the government. All manufacturing establishments in the public sector are organized as factories grouped under sectoral corporations accountable to the Ministry of Industry, as set forth in Fig. 1.

In 1989, there were 165 factories within the Ministry of Industry, distributed among nine corporations: Ethiopian Food Corporation (38), Ethiopian Beverages Corporation (26), Ethiopian Sugar Corporation (6), National Tobacco & Matches Corporation (3), National Textile Corporation (20), National Leather and Shoe Corporation (15), National Chemical Corporation (14), Ethiopian Building (Cement) Corporation (6), National Metal Works Corporation (21) Ethiopian Printing Corporation (12), Share companies (4).[4] In 1988, manufacturing establishments under the Ministry of Industry accounted for 2.3 billion birr in manufacturing product value and more than seventy-seven thousand of the industrial employment.

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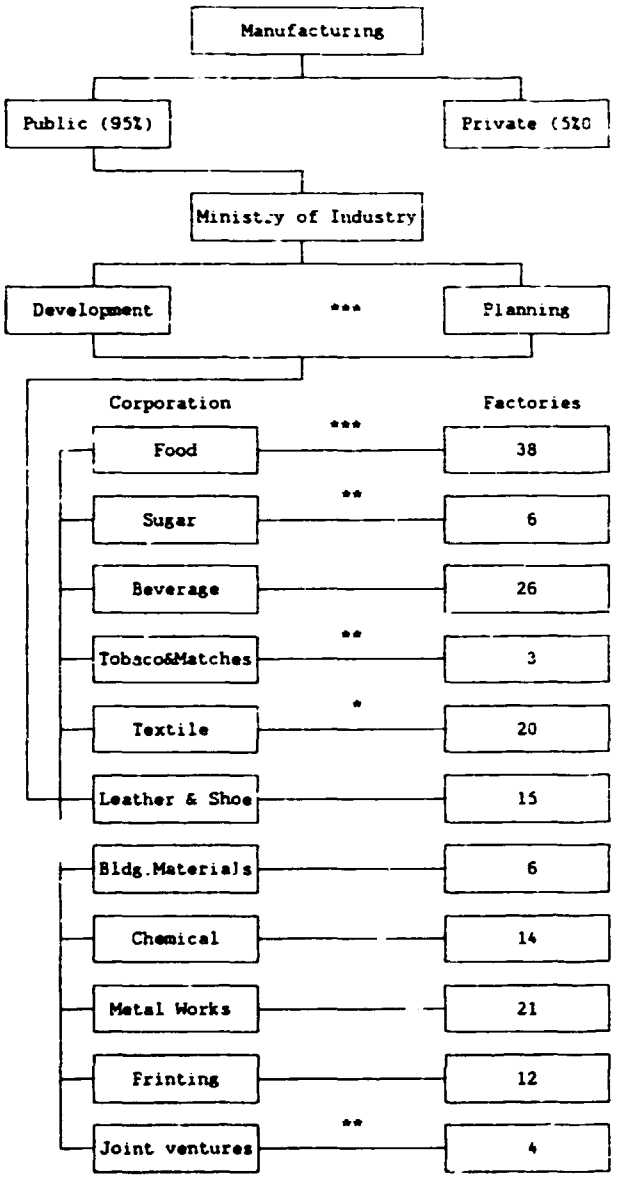
[3] Lubricating Oil Blending Enterprise of Ethiopia (motor oil, lubricants, containers), Addis Tires Company (tires, inner tubes), Ethiopian Pulp and Paper Share Company (paper and corrugated boxes), Automotive Manufacturing Company of Ethiopia (truck assembly), Ethiopian Crown Cork and Can Manufacturing Industries Share Company (crown cork and can), Ethio-Japanese Synthetic Textile Share Company (synthetic textiles).

[4] The figures in parenthesis refer to the number of factories.

Fig. 1 Structure of Manufacturing in Ethiopia



Manufacturing sector computer installations:
* microcomputer
** minicomputer
*** micro/minicomputer

II. COMPUTER USE IN THE INDUSTRIAL SECTOR

Although the introduction of the computer to Ethiopia dates back almost thirty years, the scope of actual computer use in general and in the manufacturing sector in particular remains very limited. On the basis of figures obtained from hardware vendors in the course of a survey for this study, the total number of existing minicomputer and mainframe installations in the country is estimated to be fewer than ten mainframe computers and about sixty minicomputers.[4] From this aggregate, the share of the manufacturing sector is only eight minicomputers, distributed among Ministry of Industry (HP3000/37), truck assembly plant (IBM System 36), petroleum refinery (IBM System 36), food processing (NCR-9010), sugar processing (NCR-9020, 2 of NCR-9010), and tobacco and matches (Burroughs B80).[5]

Reliable estimates on the number of microcomputers entering Ethiopia are very difficult to obtain because most PCs are procured by different groups of users outside existing local distribution channels. But piecing together available scanty data can yield some rough approximation. For example, while only six manufacturers (IBM, HP, NCR, UNiSYS, Wang, Apple) are represented through established local dealers and branch offices, about fifty brands of PCs were identified in a list of 720 microcomputers registered with the National Computer Center of National Science and Technology Commission over two years between November 1987 and 1989.[6] According to figures from authorized local distributors, the total number of PC units sold to date is approximately six hundred.[7] The first figure excludes all computers purchased prior to the introduction of mandatory registration and the second omits computers acquired through external arrangements. If the upper of the two preceding figures is doubled as an allowance for the two elements, the total number of PCs in use in Ethiopia does not exceed 1500 units. Computer registration of about 700 over two years means 350 per year. Under an assumption of personal computers entering the country at such an annual rate over the entire period since the introduction of IBM personal computer in 1981, the population of microcomputers tops three thousand.

Under an alternative assumption of annual sales of 100 PCs by all local vendors over comparable period, approximated as a summation of average annual sales over corresponding period of operation, the number of micro computers installed is estimated at one thousand units. An average of the two approximations yields a rough estimate of two thousand personal computers in current use in Ethiopia.

Regardless of the rough approximation method employed in reaching these figures, the fact remains that the aggregate number of about two thousand computers in use remains exceedingly low by any standard. The near total

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[4] For details on the distribution of existing systems by customer, manufacturer and model, please refer to Annex 1

[5] Please refer to Annex 3 for further details.

[6] Since November 1987, all computers and associated peripherals entering Ethiopia are required to be registered with the National Computer Center of National Science and Technology Commission before commencement of customs clearance procedures

[7] For details on the distribution of PC sales by authorized local distributors, please refer to Annex 2.

absence of personal computers in the manufacturing sector is even more staggering. A survey of manufacturing establishments under the Ministry of Industry shows not more than ten to fifteen personal computers in current use. From just over 700 computers entering the country over two years between November 1987 and 1989, whereas 124 computers were registered to individuals only seven computers were registered in the name of establishments from the manufacturing sector.

Including service extended to sister plants, the scope of computer use in the manufacturing sector is currently limited to about twenty factories under five different corporations and one share company. The remaining 145 factories under nine corporations and three share companies run completely without the benefit of computer facilities. The initiative taken to introduce computer use by the group without such facilities varies from placement of firm order for one or two PCs, application for approval from the Ministry of Industry, systems development study in progress, formation of committees for preliminary studies, to mere expression of desire.[6]

In the first few sections of Part II, the profile of existing computer installations in corporate head offices and manufacturing plants will be reviewed, starting with the Ministry of Industry. In the last portion, pockets of fairly advanced applications such as local area network (LAN), computer aided design (CAD), expert systems, and compute process control will be explored by venturing into the mining/energy and construction sectors. It is interesting to note that the level of computer utilization in the mining and energy sector is much higher than that of manufacturing.

A. Ministry of Industry

The computer was introduced to the Ministry of Industry as recently as three years back and the scope of existing use within corporations and factories under its supervision is very limited. Strategy for the phased development of a management information system for the Ministry of Industry was charted in a study undertaken by Logica of the United Kingdom in late 1985. The document recommended a pilot project to be implemented over fifteen months in three development phases:

Phase	Application
I	Database (production, budget) and wordprocessing
II	Investment database, telecommunications network linking the ministry, corporations, and factories
III	Factory Applications (accounting system, personnel system, payroll system, order processing and sales analysis, purchasing and supplies, inventory control)

The pilot project was budgeted at an estimated cost of US$ 803, distributed among hardware (US$ 242,000), contract for application development

[6] Please refer to Annex 5 for stages of computer use by manufacturing corporations.

and implementation (US$ 525,000), hardware and software maintenance (US$ 36,000).[9]

After a critical review the Logica Plan by a UNIDO consultant, Phase II, involving a communications network system linking the Ministry of Industry, industrial corporations and factories, has been reportedly scrapped in favour of self-contained PC environment at corporate and factory levels.

In implementation of the recommended Phase I, the Ministry of industry acquired its first microcomputer (IBM/PC XT) in 1986 primarily for training and demonstration. The same year, a minicomputer (HP 3000/37, with a main memory of 2 mb, hard disk of 132 mb, 15 terminals) was installed in the head office of the Ministry of Industry. The HP minicomputer was acquired from a dealer in Vienna and through UNIDO with a separate contractual arrangement for maintenance support service with the local representative of HP. The fifteen terminals are distributed among the following departments: planning, finance, production and sales, manpower, Minister's office, library, computer center.

In addition to one minicomputer, there are five personal computer systems in the head office of the Ministry of Industry with these configurations:

Manufacturer	HP 150/1	HP 150/2	IBM PC/XT	IBM PS/2 50
Quantity	1	1	2	1
RAM	640 kb	640 kb	640 kb	1 mb
Hard disk	20 mb	20 mb	10 mb	40 mb
Floppy drive	360 kb	720 kb	360 kb	44 mb
Display	mono	mono	color	mono

Printers: HP Inkjet, Brother X-24 (daisywheel)

The two HP microcomputers are connected to the minicomputer, while the three IBM microcomputers serve as stand alone systems.

All application programmes running on the minicomputer were developed in-house and those implemented to date include databases for production, manpower, project development, raw materials, and the library; and business applications such as payroll system, consolidation of financial statements, and decision support system like financial analysis. While MINISIS is used only for the library system, the other database applications were modified from a dedicated database software bundled with the hardware. All office business applications were written with COBOL.

Application software used in the PC environment include wordprocessors in English (Wordstar, Wordperfect) and Amharic[10], Lotus 1-2-3, dBASE III Plus, and NISP (National Industrial Statistical Package)[11]. The statistics unit of the Planning and Programming Department have just acquired Ventura

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[9] Logica's Final Report, Ethiopian Ministry of Industry Strategy Study for M.I.S. (Volume I), 1986.

[10] The wordprocessing application in Amharic was developed by Ethiopian software engineers living in the United States.

[11] Please refer to Annex 4 for list of applicaton software used in the industrial sector.

desktop publisher to be used in the preparation of a camera ready copy of the annual Statistical Bulletin published by the Ministry. A UNIDO consultant is already on location to assist in the setting up, training and utilization of the software. The unit is eager to use NISE and Venture for the next issue of the Statistical Bulletin, but there is lack of essential peripherals such as a laser printer and scanner.

The data processing unit within the Ministry of Industry is organized as a Computer Center and reports directly to the Minister. The duties of the Computer Center include systems development studies, programming and technical consultancy in a distributed system at the level of the head office, training of Ministry personnel, and technical advice for corporations and factories. The unit is staffed by eight people distributed among one section head, two programmer/analysts, two programmers, a trainee programmer, an operator, a data control clerk, and a librarian. In addition to basic training for members of the professional and secretarial staff in the use of essential application software in the PC environment on a regular basis, the computer unit conducts sessions for COBOL programmers.

There are two committees on computer matters within the Ministry of Industry. As a forum for user feedback, sharing experiences, and user-to-user give and take on practical matters, a regular meeting of a technical group composed of terminal users is held every two weeks. A second interdepartmental committee chaired by the Minister meets regularly to address pertinent issues and formulate strategy and policy at the level of ministry, department, corporation, and factory. The acquisition of a computer facility by a corporation or a factory must obtain the prior approval of the Ministry of Industry before seeking foreign assistance or requesting foreign exchange appropriation.

B. Ethiopian Food Corporation

The Ethiopian Food Corporation is a parent public company for thirty eight food processing factories. It accounts for more than ten percent of the total product value and eight percent of the total permanent employment of public sector manufacturing.[12] At present there are only two computer installations in the food processing sector: one NCR minicomputer and one IBM microcomputer, none of which are at the corporate head office. An IBM PS/2 Model 30 is used by FAFA baby food plant and an NCR 9010 minicomputer is in the service of the Debre Zeit Flour Mills. Existing applications covering general ledger, payroll, stock control and personnel records run on the minicomputer are packages modified by an external consultant to suit the particular requirements of the flour mill. The installation is fully utilized by extending data processing services for the same applications to three other food processing establishments in the area. Software support is provided by the Bureau of Electronic Data Services on a contractual basis. The data processing unit does not possess the manpower capability for the development and maintenance of applications beyond junior operators and clerks, and relies on external contractors for software support.

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[12] Unless stated otherwise, all figures on economic indicators are based on People's Democratic Republic of Ethiopia, Ministry of Industry, Statistical Bulletin, IV (Addis Ababa: June 1989).

C. **Ethiopian Sugar Corporation**

The Ethiopian Sugar Corporation is a state monopoly engaged in the cultivation of cane and sugar production and refining. The labour force employed on estates, factories, and offices exceeds 8300 or ten percent of public sector manufacturing labour, and contributes less than ten percent to the total value of manufacturing.

There are three minicomputer installations in three remote locations within the Ethiopian Sugar Corporation. One NCR-9020 is located in the corporate head office in Addis Ababa, and two NCR-9010 systems are each installed at Wonji and Matahara estates, situated about one hundred kilometers and one hundred fifty kilometers south of Addis Ababa, respectively. The only applications currently in use are general ledger and payroll systems developed in-house with COBOL as the programming language. In spite of the feasibility and desirability of data transmission via telecommunications network for an organization like the sugar corporation, with multiple spatially separated operating plants, data files stored on magnetic medium are presently exchanged between factories and corporate head office by means of courier service.

The Data Processing Section reports to the Finance Department. As the person with overall responsibility for all data processing service including factories, the head of Data Processing supervises a systems analyst and a programmer in the head office, and a data controller and a keypunch operator at each of the two sugar estates. At present there is no in-house training programme, but the corporation has plans to launch a computer literacy campaign as soon as some personal computers are available.

D. **National Textile Corporation**

With a share of twenty percent in the total value of manufactured products, more than thirty-two thousand in the number of employees or more than forty percent of public sector manufacturing employment, and twenty-two factories, the National Textile Corporation is the largest manufacturing company in the country. National Textiles also owns sixty-five percent of Ethio-Japanese Synthetic Textiles Share Company. The six microcomputers owned by the corporation are installed in three different locations. Three of the PCs at the corporate head office have the following configuration:

System Unit	IBM PC/AT	Olivetti B24B	ALTEC
Microprocessor	80286	8086	8086
RAM	640 kb	640 kb	512 kb
Disk Drive			
Hard	20 mb	20 mb	
Floppy	1.2 mb	360 kb	360 kb (2)
Monitor	color	mono	mono
Printer:	IBM Prop.XL	Panasonic Kxp1595	

In addition to standard application software in the office environment such as wordprocessors (Wordstar, Writing Assistant), spreadsheet (Lotus 1-2-3), database (dBASE III Plus), Harvard Total Project Manager is also used for project scheduling. Applications currently in used by the corporate head

office are limited to personnel database, payroll, and project management. The other three personal computers are used by textile factories located in Bahir Dar and Awasa for payroll and budgetary control.

All the personal computers were acquired as equipment components in the development of textile projects. Since computer facilities are mostly used for project planning, the computer unit is part of the Department of Planning and Programming. In addition to running the few existing applications and plans of extension to other functional areas, the two staff members of the computer unit are preparing for in-house training in microcomputer fundamentals to be given soon, in the hope of acquiring more personal computers in the future.

E. National Tobacco and Matches Corporation

The acquisition of a Burroughs B80 by the National Tobacco and Matches Corporation more than ten years ago was the outcome of a study undertaken by a UNIDO consultant. The installation is an early vintage minicomputer with main memory of 64 kb, hard disk of 90 mb, and a single terminal with a console printer and a rudimentary screen display.[13] The whole systems development exercise, including hardware and software support was awarded to the hardware supplier as a turnkey project.

The four applications initially implemented: payroll, general ledger, invoicing, and inventory control were tailored to the needs of the corporation from a manufacturer's package developed by Burroughs.

For lack of software support from the supplier and qualified staff to maintain the computer system, the corporation was for a while forced to switch back to manual systems. The computer system was subsequently reactivated after many years of down time in response to advice sought to bring up to date a five-year arrear in corporate and subsidiary accounts. The strategy adopted was to use an ancient NCR accounting machine for backlog accounts and the minicomputer for current accounts with a contract agreement for software support with the Bureau of Electronic Computer Service[14]. Over and above bringing all books up to date, the compute system is providing service for all corporate and subsidiary payroll and general accounting systems. Under existing arrangements for the distribution of cigarettes through the state-owned Ethiopian Domestic Distribution Corporation as the sole wholesaler, the application for invoicing has been discontinued as needless. The inventory system has been retested, and is awaiting immediate implementation.

The National Tobacco and Matches Corporation shares the same compound with the Addis Cigarette Factory, but the computer unit is organizationally under the direct control of the latter. The unit is currently staffed by three junior operators. The head of the finance unit feels very strongly about the long disruption in the operation of the computer system as a direct consequence of reliance on external software support. This is a compelling

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[13] The computer was acquired for about US$ 75,000 (at official exchange rate) nearly ten years ago

[14] Bureau of Electronic Computer Service (BECS) is a small private local firm engaged in computer consultancy and training. With a recent acquisition of an HP3000/MICRO minicomputer, BECS is poised for further expansion.

reason to develop in-house programming capability as the next phase of development.

F. Ethiopian Petroleum Corporation

Although petroleum refining belongs to the manufacturing branch of the economy, the supervising authority for Ethiopian Petroleum Corporation is the Ministry of Energy and Mines. With a total of 1200 employees, the Ethiopian Petroleum Corporation is a state monopoly engaged in refining imported crude oil The oil refinery located at the port of Assab on the Red Sea and a fifty-one percent equity ownership in the Lubricating Oil Blending Enterprise of Ethiopia, in a joint venture with four oil companies, make up the operating subsidiaries of Ethiopian Petroleum Corporation[15].

An IBM System 36 with a configuration of 1 mb main memory, hard disk of 200 mb, magazine drive backup, tape backup, 15 terminals, one high speed IBM line printer) and two IBM PS/2 model (50 and 60) with two dot matrix IBM Proprinters make up computer facilities found in the corporate head office in Addis Ababa. Applications developed in-house and implemented on the IBM minicomputer include general accounting, payroll, personnel, sales, and inventory systems. COBOL, FORTRAN, and RPG are the preferred languages for the development of application systems. Application programmes have been developed for purchase order follow-up and engineering applications for the repair and maintenance of the process plant, and will be implemented shortly.

The minicomputer was ordered with fifteen terminals for distribution of ten and five terminals between the corporate head office in Addis Ababa and the oil refinery at Assab. The phase of linking the two remote offices by a telecommunications network was delayed by the Telecommunications Authority which questioned the legality of using integrated internal modems in view of monopoly power over the ownership of modems and other telecommunication peripheral devices. Now that replacement external modems have been received, the oil refinery will be connected with the head office by a 2400 baud modem in the immediate future.

The Data Processing Service unit of Ethiopian Petroleum Corporation reports directly to the General Manager. The data processing staff of fifteen people, including both Assab and Addis Ababa offices consist of unit head (1), systems analyst a programmer (1), junior programmer (1), operators (2), I/O control clerks (1), display station operators in Addis Ababa (4), display station operators in Assab (2), operator/clerk supervisor (1). In the sphere of training, the organization estimates a basic computer literacy rate of one-third among members of the professional staff. Training is given in basic data processing concepts and applications in the PC environment such as wordprocessing (Wordperfect 5.0), spreadsheet (Lotus 1-2-3), and database (dBASE III Plus).

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[15] The remaining forty-nine per cent of the shares are equally (12.5 per cent) divided among Agip, Mobil, Shell, and Total.

G. Mineral Resources Development Corporation

The Mineral Resources Development Corporation is a state corporation under the supervision of the Ministry of Energy and Mines, and clearly does not fall within the manufacturing branch of the economy. Attention is drawn here just to note rare instances of applications involving process control and expert systems.

The only cases of computer application for process control in Ethiopia are the Soda Ash Project at Lake Abiata (installed) and the Laga Dembi Gold Production Project (under installation). Both projects are sponsored by the Ethiopian Mineral Resources Development Corporation and are regarded as the first process plants in the country boasting computer application (Programmable Logic Control or PLC). The process control of the Soda Ash Project is less sophisticated than that of the gold production project and was designed to control the drying process in the kiln and ensure quality standards required by glassware factories. The equipment for both installations was acquired from Siemens, and the software was written by a German consultant.

In addition to computerized process control, the Soda Ash Plant also uses two IBM PS/2 30 for other applications. For other office applications, delivery of two IBM PS/2 (Model 30 and 60) is awaited for the Laga Dembi Gold Project.

A few IBM PS/2 systems are presently used in the head office of the Mineral Resources Development Corporation and fourteen units of IBM PS/2 (Model 30 and 60) are under order. The Mineral Resources Development Corporation is also distinguished for being the only organization familiar with software facilities like expert systems. The software library includes operating system (PC-DOS), languages (BASIC, PASCAL) wordprocessor (Word Perfect, Wordstar, Volkswriter), editors (Personal Editor, Professional Editor), spreadsheet (Lotus 1-2-3, Symphony, Smart), database (dBASE III Plus), Graphics (Titles, Printmaster, Diagmaster), Utilities (Norton Commander, Copy II PC, Disk Organizer), Expert Systems (Golden Software, Prospector, Geochem, PPlot).

In spite of the relatively large collection of assorted software, applications are currently limited to wordprocessing, project evaluation, and database. A LOTUS 1-2-3 macro model developed by the U.S. Bureau of Mines is used for project evaluation. Existing database management applications cover addresses, prices, and suppliers.

H. Design Enterprises

The Construction Design Authority of the Ministry of Construction is responsible for the design aspect of all public construction. There are two design centers under the Authority specializing in building and transport: Building Design Enterprise and Transport Construction Design Enterprise.

The Building Design Enterprise has five assorted stand alone personal computers (1 IBM PS/2 60, 2 IBM PS/2 30s, 1 NCR, Olivetti M24), three dotmatrix printers (3 IBM Proprinters, 1 Olivetti), and one laster printer (IBM Pageprinter). The enterprise's library of software consist of operating system (IBM DOS 3.3), wordprocessor (Wordperfect 5.0, Wordstar 2000), desktop

publishing (Ventura), spread sheet (Lotus 1-2-3), database (dBASE III Plus), project management (Harvard Total Project Manager), computer aided design (Auto CAD), structural analysis (SAP), utilities (Sidekick Plus, PC Tools Deluxe, Norton Utilities), languages (Assembler, COBOL, IBM FORTRAN II, Quick/Turbo BASIC, Turbo PASCAL). Current computer applications include project monitoring, project scheduling, frame analysis, statistical analysis, accounting system, and wordprocessing. Some of the engineers are training to use Auto CAD. In the course of this study, the only case of application involving computer-aided design was encountered at the Building Design Enterprise. Although some engineers are diligently engaged in self-training in the use of Auto CAD and some pilot projects have been attempted, it will take some time and effort before the office develops the level of proficiency required to take full advantage of the powerful features of the software.

The computer unit is organized as Data Processing Service and reports to the Manager. With a staff of four people, the unit provides computing service and training to the members of the professional staff. The organization has six hundred employees and ten to fifteen percent of them are considered to be computer literate. The organization has a systematic training programme for its professional staff. The National Computer Center is training about eighty employees for the Building Design Institute in exchange for design of a new office for the former.

The number of full time computer staff exceeds the number of personal computer installations at the Transport Construction Design Enterprise. The Data Processing Center is run by two young graduates in mathematics with the position titles of programmer and one operator. The unit observes that there is a problem of interface between user groups and data processing service. Engineers cannot communicate with computers and programmer/mathematicians cannot communicate with engineers. This is a problem repeatedly mentioned.

The office has two units of IBM PS/2 30 with the configurations of 640 RAM, 20 mb hard disk, 44 mb floppy drive, and a dotmatrix IBM Proprinter XL 24. The list of software consists of DOS 3.3, FORTRAN compiler, Wordperfect 5.0, Wordstar Professional, Lotus 1-2-3, and dBASE III Plus. Applications are presently limited to payroll and very few aspects of engineering. There is no evidence of any graphics software, much less computer-aided-design. All drawings are presently done manually. A preliminary proposal for a LAN network has been submitted to management for consideration. Details of hardware configuration and software requirements will be specified as soon as decisions are taken.

I. Industrial Project Service

The Development Projects Study Agency (DPSA), a government organization responsible for the appraisal of government sponsored investment projects, was the first organization from Africa and probably one of the first in the world to license from UNIDO the earliest release of COMFAR, designed to run on an enhanced version of Apple III with external disk drive. COMFAR was subsequently acquired by the Industrial Projects Service, another government entity organized under the Ministry of Industry to undertake feasibility

studies of industrial projects promoted by the government.[16] The two organizations have kept up with periodic upgrade of COMFAR and the software is actively used for industrial project preparation and appraisal. In 1986, Development Projects Study Agency, Industrial Projects Service, and UNIDO jointly sponsored a COMFAR workshop in Nazareth, Ethiopia.[17] The workshop was attended by training participants from Ethiopia, Ghana, Kenya, Sudan, Tanzania, and Zambia.

[16] Beginning in 1986, Development Projects Study Agency, Industrial Projects Service, and Agricultural Projects Service were consolidated under Development Projects Study Authority with direct accountability to the Deputy Prime Minister for Planning. Responsibility for the appraisal of government sponsored projects, hitherto resting with Development Projects Study Agency has been transferred to the Office of the National Committee for Central Planning.

[17] The author of this paper was privileged to be part of the Nazareth COMFAR workshop as a member of a four-man team of trainers composed of two from Ethiopia and two from UNIDO.

III. LOCAL COMPUTER MARKET

A. Demand market

The only acceptable means of payment for computer facilities acquired from local distributors including maintenance support is foreign currency. Hence, the chronic scarcity of foreign exchange prevalent in the country effectively limits the demand for computers from local dealers. The small amount of foreign exchange allocated for authorized distributors does not even cover the cost of small amounts of supplies and parts, much less cover computer import. The inventory level of all hardware vendors is constantly zero, because none of them buys computers for resale. Computers are shipped to the dealer only after payments are made in foreign currency.

By type of computer systems, computer buyers in Ethiopia can be grouped into sub-markets consisting of government organizations, international organizations, foreign non-governmental organizations, private foreign firms, private local firms, and individuals. More than ninety percent of existing mainframe and minicomputer installations are found in government offices. The remaining portion is distributed between international organizations and foreign affiliated companies.[18] Virtually all mainframe and minicomputer installations were procured through local distributors.

Whereas United Nations and foreign non-governmental organizations account for a major share of personal computers used in the country, they do not contribute to demand for hardware from local dealers because procurement is made externally through head offices of these agencies. Most of the computers installed in government organizations over the last decade were financed through multilateral, bilateral, and non-governmental assistance, and were also bought through external arrangements. Whereas private businesses and individuals are effectively excluded from computer purchase through local dealers, government executed projects through multilateral and bilateral financing constitute the principal source of demand for PCs sold by local dealers.

B. Supply market

Statistical data on computers entering Ethiopia is fragmentary at best. Since the National Computer Center of the Science and Technology Commission began registering all computers entering Ethiopia in November 1987, the tally shows about 720 personal computers distributed among more than 50 brand names.[19] The total number personal computers sold to date by the five authorized distributors, for IBM, HP, NCR, and UNISYS, presently operating in Ethiopia approximates 600, including a few Apple Macintosh, Wang, and earlier IBM incompatible HP units. Whereas the average annual number of registration of was 350 since the policy came into force two years ago, average annual

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[18] Only one private local firm in the whole country, Bureau for Electronic Computer Service, owns a minicomputer.

[19] All computers entering are required to be registered with the National Computer Center beginning in 1987. Customs officials release computers only after receiving evidence of registration. The figures on the number and brand of personal computers was obtained from a print of the registration database.

sales by the five authorized dealers figures to 60 over a period of nearly 10 years since the IBM PC was introduced in August 1981.

In keeping with the steep growth in the sales of computers on the world market during the last decade, the acquisition of personal computers in Ethiopia must have followed a similar pattern of growing at increasing rate to reach an average annual level of about 350 between 1987 and 1989. On the basis of an annual average of 350 units registered between 1987 and 1989, the cumulative number of PCs entering Ethiopia over the decade of 1980s does not exceed 350 x 10 = 3500. Assuming a lower annual average of 200, the cumulative number of installations approximates 2000.

According to the five distributors in Addis Ababa, the combined number of mini and mainframe computers presently installed in Ethiopia numbers less than one hundred, distributed among HP (22), IBM (18), NCR (22), UNiSYS (5), Wang (1), DEC (1). Among about seventy systems reported by the five distributors, over 90 percent of the market for mini and mainframe computers is distributed among HP, IBM, and NCR brands.[20] With approximately one-third of the market share for mini/mainframe computers and an equally significant sales of personal computers in just a decade, HP appears to be the most aggressive of three market leaders.

C. Computer vendors

Six Computer manufacturers represented in Ethiopia are IBM, HP, NCR, UNiSYS, Apple, and Wang. IBM is represented through two organizations: a branch office for mainframe and minicomputers and a sole authorized dealer for personal computers. Apple and Wang are represented by the same local private firm engaged in engineering consultancy. Olivetti, Phillips, and Siemens are hosted by Ethiopia, but their product and service lines do not extend to computers. The few personal computer installations with these brands were all bought outside and brought into the country. The profiles of establishments affiliated to hardware manufacturers hosted by Ethiopia is outlined below.

IBM World Trade Corporation (Ethiopia Branch)

IBM started out in Ethiopia as a computer service bureaux in 1961 and is at present represented by a branch office with nine employees. The authorized local dealer of IBM microcomputers and the branch office of IBM World Trade Corporation are completely independent entities. All sales and contracts for mainframe and minicomputers are transactions between the buyer and the New York office of IBM. The branch office does not operate as a hardware distributor. The role of the branch office in such transactions is confined to simple intermediation. The most important function of the branch office is to provide hardware support service to existing installations. The cost of such support service is payable in foreign currency on monthly or yearly basis.

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[20] Although Olivetti, Phillips, and Siemens have offices in Ethiopia their product and service lines do not include computers. Existing computer installations of these brands were all acquired outside the country. A small office called Protech presently acts as a liaison office for DEC with a view to evolving to sole distributor. Presently support service for a VAX II/130 system owned by the Ethiopian Meteorological Service Agency is provided the DEC office in Nairobi.

Existing mainframe and minicomputer installations consist of IBM System 4361 (Ethiopian Air Lines), IBM System 34 (State Council, Shell Ethiopia, Ethiopian Telecommunications Authority, Ethiopian Air Force, National Urban Planning Institute), IBM System 36 (Ethiopian Electric Light and Power Authority, Ethiopian Import & Export Corporation, Ethiopian Telecommunications Authority, Hilton Hotel, Ethiopian Petroleum Corporation, Ethiopian Road Transport Authority, Automotive Manufacturing Company of Ethiopia/Fiat truck assembly plant, Relief and Rehabilitation Commission), AS/400 (Ethiopian Electric Light and Power Authority, Shell Ethiopia). One installation of IBM System 36 owned by Ethiopian Petroleum Corporation and another belonging to the Automotive Manufacturing Company of Ethiopia make up the share of the manufacturing sector in the preceding list.

Virtually all mainframe and minicomputer installations in Ethiopia have revealed preference for application programmes developed in-house or through external consultants to those application software sold on the market. The policy of IBM branch office in the development of application programmes is to nominate the largest possible number of third party private consultants for the client to choose from and provide all necessary support service throughout the system development cycle.

IBM (AFCOR Pvt. Ltd. Co.)

AFCOR (Ethiopia) Pvt. Ltd. Co. is the authorized dealer of IBM microcomputers in Ethiopia. The company is a subsidiary of African Lakes Corporation, in turn a subsidiary of the London based GILBEX. The other African subsidiaries of African Lakes Corporation are AFCOR Zambia and AFCOR Zimbabwe.

Product and service lines marketed by AFCOR Ethiopia consist of a whole range of IBM personal computers and associated peripherals, peripherals of third party brands, a whole range of third party software, hardware maintenance and repair, and software training. AFCOR is presently staffed by two engineers and a half-time secretary. Although AFCOR was legally established about four years ago, sales activities picked up only over the last two years increasing from only eleven in 1988 to eighty in 1989. Organizations buying IBM personal computers the local dealer include Addis Ababa University, Ethiopian Electric Light and Power Authority, Ethiopian Telecommunications Authority, Ethiopian Petroleum Corporation. Building and Transport Construction Design Authority, Building Design Enterprise, and Transport Construction Design Enterprise. All personal computers sold to date are single-tasking-stand-alone systems.

HP (SERIC Ethiopia)

Hewlett-Packard first entered the Ethiopian computer market with the installation of HP 3000/58 in 1980 at the Economic Commission for Africa. SERIC Ethiopia is the branch office of a French company with exclusive rights over the distribution of HP computers and associated peripherals in Africa. The office also acts as the support base for HP computer installed in Kenya, and the Sudan. Since 1980, twenty-two HP minicomputers have been installed in two international organizations (Economic Commission for Africa, International Livestock Center for Africa), and eighteen different government organizations. The installation of four additional HP minicomputer systems is in progress. Among nineteen HP minicomputers sold to the government, the only installation in the industrial sector is found in the Ministry of

Industry. The total number of HP microcomputers (Vectra, HP/150, HP/125) sold to date by SERIC Ethiopia approximates three hundred. The market share of HP products varies from major for minicomputers, dominant for laser printers, to overwhelming for plotters.

SERIC has a manpower of twelve people, six of which are customer engineers. There are no salesmen; only customer support engineers. As voiced by satisfied customers, the branch enjoys a positive image for support service. In addition to selling hardware, the organization undertakes systems studies for customers with or without HP installations. The scope of its training activities is limited to HP customers.

NCR Corporation (Ethiopia Branch)

With twenty-one employees, NCR ranks as the largest computer company in Ethiopia in terms of employment size. The branch office of NCR Corporation began in Ethiopia as the distributor of cash registers around 1960. The line of trade of the sole local distributor of NCR computers and other office machines cover sales and maintenance of computers (mainframe, minicomputer, personal) and other office machines, sales of computer supplies within the limits of annual foreign currency budget allocation from the National Bank, consultancy in systems development, data processing service, and regular training in programming and application software in the PC environment.

The number of NCR computers installed to date include about 120 PCs, 15 minicomputers, and 6 to 7 mainframe computers including those based on earlier technology vintage. About 65 PC systems haven been installed in banking and insurance organizations. Principal customers of NCR for both mainframes and PCs include the financial sector (National Bank of Ethiopia, Commercial Bank of Ethiopia, National Insurance Corporation, Agricultural and Industrial Development Bank, Housing and Savings Bank) and Addis Ababa University. As a branch office, one of the advantages NCR claims over authorized dealers is its ability to use future foreign currency allocations when the situation arises by obtaining an urgently needed part from one of the sister branch offices in close proximity through a mechanism of reciprocal arrangement.

Data processing service is provided to two types of clients: those customers who do not own computers, and those customers who own computers and seek supplemental service. In both cases, clients are charged on the basis of microprocessor execution time.

The office also develops custom made programs through contractual arrangements. The cost of development is determined by the orientation of the application system as general purpose (payroll application) or special purpose (water utility).

NCR has been giving training services in data processing and programming long before the arrival of the personal computer and enjoys the longest reputation for extending its training services to the general public in Addis Ababa. The training programme currently available is divided into general data processing and programming courses and software for the PC environment as itemized below. The office also administers aptitude tests for a fee of eighty Birr.

Table 1. Training Programme Offered by NCR

Course	Days	Session Hours	Total Hours	Total Fee/Birr
Introductory				
Introduction to Data Processing	10	2.50	25.00	500.00
Basic Systems Analysis Skills	14	2.50	35.00	700.00
Programming				
BASIC	14	2.50	35.00	700.00
PASCAL	14	2.50	35.00	700.00
COBOL, Introductory	14	2.50	35.00	700.00
COBOL, Advanced	14	2.50	35.00	700.00
FORTRAN	14	2.50	35.00	700.00
PC Environment				
MS/DOS	15	3.50	52.50	500.00
Wordprocessors	15	3.50	52.50	500.00
Lotus 1-2-3	12	3.00	36.00	450.00
dBASE III Plus	12	3.00	36.00	450.00
Aptitude Test (half day)				80.00

Source: NCR Corporation (Branch Office), Addis Ababa, Ethiopia, December, 1989.

UNISYS (IZATCO Trading Co, Pvt, Ltd.)

IZATCO Trading Co. (Pvt.) Ltd. is a private local firm with sole rights over the distribution of computer systems and peripherals manufactured by UNISYS. IZATCO added the computer line of products to its dealership of DAF trucks in June 1988 by taking over BURCO Systems, a private local firm acting as the sole local agent for Burroughs computers since early 1980s.

With a staff of 14 employees, IZATCO'S activities in the computer line include sales of computer hardware and peripherals, repair and maintenance service contract, data processing services on customer hardware, system consultancy, training in computer fundamentals. Computer products offered for sale cover mainframe computers, minicomputers, personal computers, peripherals, software, accessories, and supplies. The total number of mainframe computers installed to date consist of five systems: Model A3 (Ministry of Finance, Agricultural Marketing Corporation), Model A4 (Ministry of Finance), Model B80 (Tobacco and Matches Corporation, Agricultural and Industrial Development Bank). No minicomputer has been sold so far. About 20 stand-alone-single-tasking PCs have been sold to Agricultural Marketing Corporation (16), ADN GDR News Agency (1), Addis Tire (1), Gilgel Gibe Hydro Electric Project (1). IZATCO has a data processing service contract with two government organizations: agency responsible for the administration of rented state-owned buildings, Retail Trade Corporation of the Ministry of Domestic Trade. The company is optimistic about growth prospects of the data processing service unit. The only Unisys personal computer sold to the industrial sector, among twenty sold to date, is the acquisition of Addis Tire. IZATCO's hardware and software sales/support extends to third party brands. Most systems sold are configured with monochrome display and dot matrix printer.

Based on trends for computer tenders and demand for training and consultancy services the UNISYS dealers in Addis Ababa are optimistic about the sales outlook of computer products and services in Ethiopia.

D. Software Market

There is neither distribution outlet nor support service for commercial software. Orders for software are usually bundled with hardware through the same supplier. Applications running on minicomputers in most instances are custom developed through external consultants or are modified commercial packages. Among hardware vendors, NCR, HP, and IZATCO provide consultancy services in the development of applications systems. Other local organizations involved in systems development and programming service are the National Computer Center of National Science and Technology Commission and the Bureau of Electronic Computer Services.

IV. COMPUTER EDUCATION AND TRAINING

Before considering the computer content of school curricula at different levels, the alarming condition of the educational system particularly at primary and secondary levels merits a brief statement.

Basic educational infrastructure in Ethiopia today, at the primary and secondary levels especially, is completely overwhelmed by student population in that age group. Facilities in the public education system have been overstreteched to the extent of running three to five daily shifts including evening classes in virtually all primary and secondary schools. Shortage of text books and school stationery are so acute that a book is allocated among half a dozen students in most schools. Similarly, many classes at the university level are conducted in a textless or shared-text environment. In spite of serious deficiency in the language of instruction, students are no longer issued a reference as basic as a dictionary.

In other countries the education sector constitutes a very important market of the computer industry. Apple for example thrived on the educational sector as the primary target market. At present, there is virtually no demand for personal computers among the student population.

A. Primary and secondary levels

It is against such background that a computer component in primary and secondary curricula, at present and in the foreseeable future, does not figure significantly on the priority list according to official sources in the planning unit of the Ministry of Education. Although no position paper on the issue of basic computer literacy at primary and secondary levels of education has been formulated so far, there is genuine concern about the cost of deferred action in a world increasingly driven by information technology.

There is no trace of computer content in the curricula of primary and secondary schools throughout Ethiopia today. Among computers entering the country since registration was introduced two years ago, only one personal computer received by a public high school can be found. Rare exceptions are exclusive private schools such as the U.S. Government supported International Community School and the French Government supported Lycee Gebre-Mariam equiped with desktop computer laboratories for basic computer literacy courses.

B. University level

The government body responsible for about half a dozen educational institutions at the tertiary level is the Commission for Higher Education. Addis Ababa University with its multi-disciplinary programmes in science, technology, medicine, law, social sciences, education, etc. holds a dominant position in higher education--a compelling reason to examine out the course catalogue for computer content[21].

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[21] Addis Ababa University, Undergraduate Catalogue, 1984. Although no catalogue has been published since 1984, no significant change in curriculum has taken place since then, with implications on computer education. Please refer to Annex 7 for computer content in the curricula of Addis Ababa University.

According to the latest course catalogue of Addis Ababa University, virtually none of the programmes of different academic departments offers computers as a core course. Among eight departments in the College of Social Sciences (Accounting, Applied Sociology, Economics, Geography, History, Management and Public Administration, Philosophy, Political Science), only Accounting and Management itemize one computer course of three credit hours in a bachelor's programme of 130-135 credit hours. There is no trace of computer content in the course offerings of the faculties of Education, Law, Language Studies, Pharmacy, Medicine, Veterinary, Technical Teacher Education, and Agriculture. The same lack of computer content characterizes junior agricultural and community development colleges at Debre Zeit and Awasa.

In the Faculty of Technology, electrical engineering is the only department with computer courses in its programme. There is no evidence of computer courses in the curricula of building technology, architecture and town planning, civil, and mechanical engineering. The total number of credit for some of these engineering programmes run as high as 185 hours without a flavour of computer literacy.

In addition to core and elective courses for graduate and undergraduate students of mathematics and technology and a minor programme in computers for majors in statistics, physics, and geology, the Department of Mathematics of the Faculty of Science runs a two-year diploma programme in computer science for adult evening students.[22] The department is also catering for demand from government offices through a users' programme in the micro environment. The training programme covers introduction to computer science, operating system (MS-DOS), wordprocessors (Wordstar, Word 4), spreadsheet (Lotus 1-2-3), and database (dBASE III Plus). The implementation of a new degree (B.Sc.) programme in computer science proposed by the Department of Mathematics is expected to receive the endorsement of the Academic Senate in the immediate future.

Ethiopian Management Institute

The Institute was established with the primary objective of promoting productivity in public and parastatal organizations by undertaking training, consulting, and research functions. The Institute conducts regular training seminars and workshops on topics of general and industrial management designed to enhance the productivity of civil servants and employees of state owned corporations. Whereas the professed mission of the Institute is the promotion of productivity, it has not yet reached the point of offering real productivity tools in the form of microcomputer applications by incorporating such software in the curriculum.

C. National Science and Technology Commission

The principal national institution for the development and promotion of computer and information technology in Ethiopia is the National Science and Technology Commission. The National Computer Center and the National Scientific and Technological Information and Documentation Center are semi autonomous organizational units constituted within the Commission to promote national capability in computer technology and database systems relating to

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[22] Please refer to Annex 7 for programmes in computer science at Addis Ababa University.

science and technology. The recent introducion of computer registration is part of this effort.

The activities of the National Computer Center include microprocessor based hardware projects, development of application software in Amharic and English, consultancy service in systems development studies and implementation, training in software use, and hardware maintenance.

Recent accomplishments of the National Computer Center are initiatives taken to develop PC based software in Amharic essential for modern electronic offices. Different types of software developed for the Amharic language are itemized below:

Amharic Name	Software type
Agafari	Operating system
Tsehuf Makenaja	Wordprocessor
Mereja Atenakari	Database
Digafe	Pop-up utility
Tomar	Editor
Silkegna	Telecommunication
Mereb	Network (LAN)
Maheteme	Desktop publisher

Hardware
- Amharic add-on device
- Printer chips/software

As soon as the Center moves to new premises under construction, it will be renamed the National Computer and Research Center and will be organized into sections for the development of hardware, software, systems, and training. The hardware engineers of the Center are also credited with developing an add-on device and printer chips required to run Amharic software. They are presently working on a microprocessor design and prototyping project to control an elevator system. Similar ideas with potential applications in selected areas such as microprocessors to control crane operation have been identified as pilot projects. The grand strategy of the Commission is to design, build and test microprocessors as pilot projects, collaborate with local firms for mechanical components in the construction of microprocessor controlled devices such as elevator systems, and when such undertakings prove technically and economically feasible spin them off to promote production on commercial scale.

The software team is responsible for the development of different applications systems both in Amharic and English, develop computer models of national significance such as national input-output tables in collaboration with scholars and policy makers. The systems section provides consulting service in systems development to mainly government organizations in the development of computer information systems and applications.

Training is a very important service provided by the National Computer Center. Other than applications systems developed by the Center, regular training is offered in computer fundamentals, different operating systems (DOS, PC MOS, ZENIX, UNIX), programming (introductory, techniques, BASIC, PASCAL, TURBO PROLOG, C), applications (Word Perfect, Wordstar, R:base 5000,

dBASE III Plus, Lotus 1-2-3), professional packages (engineers, architects, economists, statisticians, accountant, publishers), and PC architecture.

The National Computer Committee, an inter-agency body chaired by the Commissioner for Science and Technology, acts as a policy making body on computer related matters in general and government procurement in particular. Purchase of computer facilities by all government organizations must be sanctioned by the Committee in keeping with the objective of economizing on scarce foreign exchange by minimizing waste in the procurement of computer facilities. Under present procedures, a government organization wishing to acquire computer facilities must obtain the sanction of this committee after submitting a formal request with a supporting document. The project document should cover justifications for change over from a manual system to computer system, cost-benefit analysis, and hardware and software requirements to support the proposed system, with being vendor-specific. After approval, a public tender is invited on the basis of hardware and software specifications contained in the project document.

Science and Technology Commission has been acting as a clearing house for all computers entering Ethiopia by requiring mandatory registration with The National Scientific and Technological Information and Documentation Centre, since November 1987. Some of the statistical highlights cited in this paper are based on these registration figures. The Centre uses an HP3000/MICRO and MINISIS for its database system.

V. POWER SUPPLY AND TELECOMMUNICATION SERVICE

A. Power supply

Thanks to the country's modest endowment with water resources, hydro-electricity is the principal source of power supply in Ethiopia. Unlike country's relying on imported oil for generating electricity, a continuous supply of power is available in Ethiopia; but the quality leaves much to be desired. Although blackouts are infrequent, the power lines are noted for wide and recurrent voltage fluctuation. Only an outright risk lover would buy computer devices without the protection of a voltage regulator. Unfortunately such accessories are not locally available.

B. Telecommunication Service

The government exercises monopoly power over the supply of electricity and telecommunication services through two statutory public utilities: Ethiopian Electric Light and Power Authority and Ethiopian Telecommunications Authority. The monopoly power of Ethiopian Telecommunications Authority extends to the ownership and lease of associated peripheral devices such as pbx, telex, modems, fax, and other related equipment. For example, a recent move by the United Nations Economic Commission for Africa to replace existing telephone receivers in its head office with digital sets has been resisted by the Telecommunications Authority by invoking its statutory monopoly power over the ownership of peripheral telecommunications devices. For the same reason, integrated modems are not permitted. A project to connect the head office of Ethiopian Petroleum Corporation in Addis Ababa with the Assab Oil Refinery on the Red Sea was recently held up in the replacement of internal with external modems.

Although the Telecommunications Authority has adopted some standards for the devices it leases out, individuals and organizations pre-emptively buy their preferred brands of FAX machines and modems and apply for subscription to telephone lines.[23] In such cases, the Authority has been accommodating enough, so far, to buy the device from the customer and lease it back to the seller. The value of devices bought from subscribers to modem and FAX lines is determined by the Authority, and has been criticized for falling significantly short of the fair market price.

According to official sources from the Ethiopian Telecommunications Authority, two types of dedicated modem lines are provided: circuit switch for international data transmission via satellite and local and regional transmission on microwave and cable systems. Options available for speed of data transmission are in the range of 1200 and 9600 bauds. Although some organizations such as Reuters and the United Nations use 9600 bauds, the Authority cautions subscribers that at 4800 bauds data are transmitted more slowly but also more surely, whereas 9600 bauds is more susceptible to the risks of moving in the fast lane.

The price structure for modem and fax lines consists of an initial subscription charge and a variable component dependent on use. The higher the

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[23] The standards for FAX machines are Cannon 4-10 and NEFAX-17.

rate of data transmission the higher initial subscription fee: 4800-9600 baud (9264 Birr), 1200-4800 baud (3520 Birr).[24] The payment for a FAX machine alone without including telephone line is 4740 Birr.

There are a number of telecommunication networks connecting offices in Addis Ababa with cities in different parts of the world. The current list of subscribers to modem lines include Economic Commission for Africa, Meteorological Services Agency, Reuters, SITA (World Wide Air Line Communication and Information Services), Petroleum Corporation, Import-Export Corporation, and the Commercial Bank of Ethiopia.

Reuters reportedly subscribes to a dedicated 9600 baud line between Addis Ababa and its office in Nairobi and sub-leases dedicated local lines of 1200 bauds to local data service subscribers.

SITA is connected to reservation database systems in Atlanta through two 9600 baud modem lines to Rome and for a back up to Paris. Information on reservation is transmitted to ticket offices of different air lines by a time division multiplexer.

The Ethiopian Meteorological Services Agency has a 1200 baud dedicated line linking Addis Ababa to Nairobi. Weather related data is transmitted between Nairobi and a VAX II/130 (main memory, 3 mb; disk storage, 456 mb; protocol V.24) in Addis Ababa and multiplexed between three data terminals at the rate of 50 bauds. Apart from occasional interruption in telephone lines and protocol incompatibility between Addis Ababa and Nairobi at the initial phase, no other complaint has been voiced about the reliability of the telecommunications network.

Before moving to a new office, the IBM System 36 of Ethiopian Import and Export Corporation was linked to the Ministry of Foreign Trade through two data terminals. There has been a breakdown in the system of communication since moving to the new cite. Where in the network the problem lies--computer hardware, telecommunications software, configuration, modem, modem line--is not known. A project to connect the 28 city branches of the Commercial Bank of Ethiopia through a telecommunications network has been bogged down by a similar experience.

Data exchange between a distance of one thousand kilometers (Addis Ababa to Asmara) on telecommunications network has been tested by the branch office of IBM without a hitch.

Apart from occasional interruption in telephone lines connected by wire cable during rainy seasons, stiff subscription fee for modem and fax lines, and restrictions on the type and ownership of peripherals, subscribers to telecommunication services are generally content; and the telephone system by and large is adequate for international, regional, and urban computer network. Cable lines connecting a good part of the city remain vulnerable to the combined effects of poor drainage system and heavy rain, pending completion of replacement by more reliable lines such as optical fibre cable, circuit switches, and microwave dishes. The Telecommunications Authority is in the midst of a phased implementation of a project financed with a World Bank credit to replace analog with digital switches.

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[24] The par value of one US$ is 2.07 Birr.

Although a predominantly rural demographic structure provides a great potential for a computer network based on radio frequency, no such mode of communication is in current use for such purpose[25].

C. Local Area Network

Virtually all personal computers in use are of single tasking stand alone variety. The only three cases of local area network in existence, to the best knowledge of this reporter, are the three independent LANs in the three separate offices of the Ethiopian Energy Authority of the Ministry of Energy and Mines.

The network at the head office is configured with an IBM PS/2 80 file server and six IBM PS/2 30 work stations. The file server is configured with 4 mb of RAM, one hard disk of, one internal high density (3.5") and one external high density (5.25") diskette drives, and Token-Ring multi-access-unit. Each of the IBM PS/2 30 workstations has 1 mb of ram, hard disk of 40 mb, and a high density internal micro floppy drive. The three networking systems were installed to enable users share a common database for planning energy projects. There is an intermediate term plan to link up three independent LANS with a telecommunications network and further rationalize the use of common resources. The software list includes DOS 3.3, and PC-LAN 3. Network versions of application software in use are Word Perfect 5.0, Lotus 1-2-3 2.2, and Paradox 3.0.

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[25] It may interest the reader to know that in a recent newsletter of WHO a case of PC communication via radio frequency was reported in the Sudan. To the best of my recollection radio frequency was used to transmit data on Extended Programme of Immunization (EPI) PCs between field offices with concentration points.

SUMMARY AND CONCLUSION

This paper has attempted to survey computer use for industrial management in Ethiopia with particular focus on the state sector of the economy, which accounts for virtually all manufacturing activities in the country. While in the developed world there is hardly an aspect of working and living that is not affected to some degree by the ubiquitous PC, in Ethiopia there reverse is the case: there is hardly any facet of work and life touched to any degree by computer technology. By the most generous estimate the total number of all types of computers in use throughout the country barely tops two thousand units, of which the figure for mainframe and minicomputers is less than one hundred.

The role of manufacturing is very insignificant in the structure of the Ethiopian economy, but the role of computer facilities is even more negligible in manufacturing activities. A head count of all types of computers currently in use in the manufacturing sector of the Ethiopian economy yielded only about twenty installations. The number of minicomputers in the service of manufacturing establishments totals only eight, including earlier generations. Most of the systems running on minicomputer installations consist of financial accounting (general ledger), payroll, personnel, inventory control, invoicing. The only case of engineering application encountered involves maintenance scheduling of the oil refinery, and has not been implemented yet. Except three cases involving local area network, all PC installations in the country are single-tasking-stand-alone systems. Industry standards for wordprocessing, spreadsheet, and database such as Wordperfect, Lotus 1-2-3, and dBASE III plus are the most widely used application software in the PC environment. Apart from one or two instances, more advanced applications like desktop publishing, computer aided design (CAD), expert systems, and process control have not reached the industrial sector.

While six computer manufacturers (IBM, HP, NCR, UNiSYS, Wang, Apple) are represented in the country through branch offices and authorized dealers, the first three brands dominate particularly the minicomputer sub-market with a combined share of more than ninety percent. All computer vendors provide hardware support, and most of them provide training and consulting services in the development of systems and application programmes.

The curricula of the educational system at all levels lack absolutely in computer content. There is little evidence of computers as core, elective, or specialized course in higher educational institutions. Apart from a two-year diploma programme just introduced, there is no institution offering a degree program in computer science.

Other than susceptibility to wide voltage fluctuation in the electricity and frequent interruption in the telephone lines, the country's utility services are generally adequate, and efforts are underway to improve the telecommunication system. In view of the small number of computer facilities and potential damage from voltage fluctuation, policy makers are well advised to allocate some foreign exchange for the import accessories like voltage regulators.

The very limited scope of computer use in industrial management at present and prospects for future expansion in Ethiopia are strictly tied to the country's economic fortune in general, and the chronic shortage of foreign

exchange in particular. Whereas complex issues of economic recovery fall outside the scope of this study and the competence of its writer, resource rationalization of existing computer facilities merits a brief attention.

Over and above being very few by any standard, existing computer installations are also under utilized principally because of low skill level in personnel responsible for computer installations and lack of interface between computer systems and functional systems.[26] Apparently, the problem of interface between user and serving giving groups emanates from the computerization of inferior manual systems without appropriate systems development study. This problem can be addressed by means of schemes for systems development projects, training programmes to upgrade the skill of existing computer staff, and computer appreciation workshops in the PC environment for top and middle level management.

It is also felt that problems associated with foreign exchange notwithstanding, computer illiteracy among top and middle managers at both corporate and plant level contributes to the limited use of microcomputers in the manufacturing sector in no small measure. Most managers running manufacturing establishments come from the pre-PC period and lack the necessary background to acknowledge the microcomputer as a universal productivity tool, without the benefit of some exposure. The extension of computer use in the manufacturing sector must begin with a campaign of computer literacy, supplemented with at least one microcomputer in each corporate office and plant.

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[26] The representative of HP estimates that most of the existing minicomputer installations do not use more than ten of the processing capacity, because organizations lack the in-house capability to develop applications.

Annex 1. Mainframe and minicomputer installations in Ethiopia, 1989

Customer	Model	Operating System	Year Instl'd
Water & Sewerage Authority	HP3000/M3000XE	MPE	1986
ECA	HP3000/III	MPE	1980
ILCA	HP3000/48	MPE	1983
Ministry of Industry	HP3000/37	MPE	1986
Ministry of Mines	HP3000/M3000XE	MPE	1985
Addis Ababa City Council	HP3000/M3000	MPE	1988
Pension & Social Security	HP3000/42	MPE	1987
Coffee Marketing Corp.	HP3000/III	MPE	1988
Maritime & Transit Services	HP3000/39	MPE	1984
Eth. Freight Transport	HP3000/40	MPE	1984
Eth. Shipping Lines	HP3000/40	MPE	1984
Public Transport Corp.	HP3000/37	MPE	1988
Science & Technology Comm.	HP3000/M3000XE	MPE	1987
Ethiopian Air Lines	HP3000/40	MPE	1982
	HP3000/44	MPE	1982
Central Statistical Auth.	HP3000/925	MPE/XL	1989
Ag. Eng. & Tech. Services	HP3000/58	MPE	1986
Addis Ababa University	HP3000/37	MPE	1986
Ministry of Labour	HP3000/M3000	MPE	1988
Ministry of Housing ...	HP3000/M3000	XENIX	1988
Bureau for Electronic & Computer Services	HP3000/M3000	MPE	1989
	22		
Ethiopian Air Lines	IBM System 4361		
Eth. Army	IBM System 5280		
State Council	IBM System 34		
Shell Ethiopia	"		
Eth. Telecom. Authority	"		
Eth. Air Force	"		
Nat'l Urban Planning Inst.	"		
Eth. Elec. Light & Power	IBM System 36		
Eth. Import & Export Corp.	"		
Eth. Telecom. Authority	"		
Hilton Hotel	"		
Eth. Petroleum Corp.	"		
Eth. Road Trans. Authority	"		
AMCE/Fiat truck assembly	"		
Relief and Rehab. Commission	"		
Eth. Elec. Light & Power	AS/400		
Shell Ethiopia	"		
	3 18		

(continued)

Annex 1 (continued)

Customer	Model	Operating System	Year Instl'd
	UNiSYS/mainframe		
Agricultural Marketing Corp.	A3		
Ministry of Finance	"		
Ministry of Finance	A4		
Tobacco & Matches Corporation	B80		
Ag. & Ind. Development Bank	"		
	5		
No. of NCR Installations			
Minicomputer	15		
Debre Zeit Flor Millis			
Ethiopian Sugar Corp.			
Mainframe computer	7		
	22		

Source: Compiled from data provided by computer vendors for HP (SERIC Ethiopia), IBM (Branch office and authorized dealer for micros), NCR (Branch Office), UNiSYS (IZATCO Trading Company), January 1990, Addis Ababa.

Annex 2. Number PC units sold by local distributors upto 1989

Local Firm	Manufacturer	PC Units
AFCOR (Ethiopia) Pvt. Ltd. Co.	IBM	90
SERIC Ethiopia	HP	300
NCR Corporation (Branc Office)	NCR	120
IZATCO Trading Pvt. Ltd. Co.	UNiSYS	20
National Consultants	Apple Macintosh	n.a.
	Wang	n.a.

Source: Compiled from data provided by computer vendors for HP (SERIC Ethiopia), IBM (Branch office and authorized dealer for micros), NCR (Branch Office), UNiSYS (IZATCO Trading Company), January 1990, Addis Ababa.

Annex 3. Hardware installations in the industrial sector, 1990

Organization	Sector	Computer Type	Quantity	Computer Make/Model
Ministry of Industry	manu.	mini	1	HP3000/37
		PC	2	HP150
		PC	1	IBM PC/XT
		PC	1	IBM PS/2 50Z
			5	
Corporation				
Eth. Food				
Debre Zeit Flour Mills		mini	1	NCR-9010
FAFA (baby food)		PC	1	IBM PS/2 30
Eth. Sugar		mini	3	NCR (9010,9020)
National Textile	manu	PC		
Head Office		PC	1	IBM PC/AT
		PC	1	Olivetti M24B
		PC	1	ALTEC
Awasa Factory		PC	1	IBM PC/AT
		PC	1	ALTEC
Bahr Dar Factory		PC	1	IBM PC/AT
			6	
National Tobacco & Match	manu			
A.A. Cigarette Factory	manu	mini	1	Burroughs (B80)
National Metal Works	manu	PC	1	BMC-Star
Ministry Mines & Energy	mining energy	PC	4	IBM PS/2 30
Eth. Petroleum Corp.	energy	mini	1	IBM System 36
		PC	2	IBM PS/2 (50&60)
Eth. Energy Authority	energy	LAN/Server	1	IBM PS/2 80
		LAN/Server	2	IBM PS/2 50
		LAN	18	IBM PS/2 30
			21	
Eth. Geo. Survey Inst	"	mini	1	HP3000/MICRO
		PC	2	IBM PC/XT
Ethio-Libyan Joint Mining	mining	?	1	IBM
Ministry of Construction	constr.			
Building Design Enterprise	"	PC	1	IBM PS/2 60
		PC	2	IBM PS/2 30
		PC	1	NCR 8086
		PC	1	Olivetti M24
			5	

Source: Different organizations in the Industrial Sector.

Annex 4. Application software used in the industrial sector

Organization	Sector	Name	Type
Ministry of Industry	manu.	Wordperfect 5.0	wordprocessor
		Tsehafi (Amharic)	wordprocessor
		Lotus 1-2-3	spread sheet
		dBASE III Plus	database
		NISP	industrial sta..
Corporation			
National Textile	manu.	Wordstar	wordprocessor
		Writing Asst.	wordprocessor
		Lotus 1-2-3	spread sheet
		dBASE III Plus	database
		Harvard...Manager	project mgt.
Ministry of Mines & Energy	mining energy		
Eth. Petroleum Corp.	energy	Lotus 1-2-3	spreadsheet
		dBASE III Plus	database
		(COBOL,FORTRAN,RPG)	mini application
Min.Res.Develop.Corp.	mining	Wordperfect 5.0	wordprocessor
		Wordstar	"
		Volkswriter	"
		Personal editor	editor
		Professional editor	editor
		Lotus 1-2-3	spreadsheet
		Symphony	integrated
		dBASE III Plus	database
		Diagmaster	graphics
		Titles	graphics
		Golden Software	expert systems
		Prospector	expert systems
		Geochem	expert systems
		Pplot	expert systems
Eth. Energy Authority		PC LAN 1.3	local area network
		Wordperfect 5.0	multiuser
		Lotus 1-2-3	multiuser
		Paradox	multiuser
Ministry of Construction	constr.		
Building Design Enterpr.	constr.	Wordperfect 5.0	wordprocessor
		Wordstar 2000	wordprocessor
		Ventura	desktop publisher
		Lotus 1-2-3	spread sheet
		dBASE III Plus	database
		Harvard...TPM	project mgt.
		Auto CAD	design
		SAP	strtural analysis
		(Assembler, COBOL,	language
		Quick/Turbo BASIC,	"
		Turbo Pascal,	"
		IBM FORTRAN II)	"

Source: Different organizations in the Industrial Sector.

Annex 5. Stage of computer use by manufacturing corporations

Corporation	Number of Factories	No. PCs Used	Ordered	Planned	Contemplated
Eth. Food	33	1		T	
Eth. Beverages	17				T
Eth. Sugar	4	?			
Nat'l Tobacco & Matches	3	?			
Nat'l Textile	19	6			
Nat'l Leather and Shoe	15			T	
Nat'l Chemical	14				T
Eth. Cement	8			T	
Nat'l Metal Works	23			T	
Eth. Printing	10				
Auto. Mfg Co. of Eth (AMCE)	1	IBM System 36 2 PCs			
Eth. Petroleum Corporation	1	IBM System 36	Tele. network		

Source: Different organizations in the Industrial Sector.

Annex 6. Organizations consulted

National Science & Technology Commission
    National Computer Center
    National Science & Technology Documentation and Information Center
Ministry of Education
    Planning Department
Ethiopian Management Institute
Addis Ababa University
    Mathematics Department
    Faculty of Science & Technology
Industrial Project Service
Ministry of Industry
    Manufacturing Corporations
     Ethiopian Food
     Ethiopian Sugar
     Ethiopian Beverages
     National Tobacco & Matches
     Ethiopian Cement
     National Textiles
     National Leather & Shoe
     Ethiopian Printing
     National Chemical
     National Metal Works
Ministry of Energy & Mines
   Mineral Resources Development Corporation
   Ethiopian Institute of Geological Survey
   Ethiopian Energy Authority
   Ethiopian Petoroleum Corporation
Ministry of Construction
   Building and Transport Construction Design Authority
     Building Design Enterprise
    Transport Construction Design Enterprise
Ministry of Foreign Trade
   Ethiopian Import Export Corporation
Ethiopian Metreological Services Agency
SITA (World Wide Air Line Communication and Information Services)
Computer Vendors
  AFCOR (Ethiopia) Pvt. Ltd. Co.
   Sole Dealer: IBM PC XT, PS/2
   IBM
   Sole Reprer sentative: IBM mainframe and minicomputer
   IZATCO Trading Co. (Pvt.) Ltd.
   Sole Dealer: UNISYS computer products
   NCR
   Sole Representative: NCR computer products
   National Consultants
   Sole Dealer: APPLE & WANG computer products
   SERIC
   Sole Dealer: HP computer product
United Nations Economic Commission for Africa
International Livestock Center for Africa

Annex 7. Computer content in the curricula of Addis Ababa University

Faculty	Department	Credit hours Computer	Total
Social Science	Applied Soc.	0	130
Economics		0	132
Geography		0	128
History		0	129
Mgt.& PAdm		0	135
Philosophy		0	132
Poli. Sci.		0	132
Library Sci.		0	63
Education	Educ. Adm	0	133
Bus. Ed.		0	66
Ind. Ed.		0	66
Ind. Ed.		0	74
Elec.		0	65
Metal		0	66
Wood		0	67
Law		0	164
Language Inst.	Etla&Lit	0	130
Theatre Arts		0	132
Science	Biology	0	142
Chemistry		0	135
Geology		0	140
Mathematics		minor	131
Physics		0	137
Statistics		0	146
Technology	Bldg. Tech.	0	108
Arch/Town		0	174
Civil		0	184
Electrical		?	185
Mechanical		0	182
Pharmacy	Pharmacology	0	146
Medicine		0	?
Veterinary			219
Agriculture	Ag. Econ	0	132
Animal Sc.		0	135
Plant Sc.		0	135
Awasa Junior	Basic Sc.	0	35
Ag. Eng.		0	72
Animal Sc.		0	72
Home Sc.		0	72
Bahir Dar Textile			
Ped. Sc.		0	132
Adult Ed		0	68
Amharic		0	71
English		0	69
Geography		0	69
Mathematics		0	72
Physics		0	72
Debre Zeit Junior			
Animal Sc.		0	70
Crop Prod.		0	75
Rural Econ.		0	70

Source: Addis Ababa University, Undergraduate Catalogue, 1984

Annex 8. Programmes in computer science at Addis Ababa University

Programme

Mathematics (B.Sc.)
- FORTRAN Programming
- PASCAL Programming
- Applied Linear Algebra
- Numerical Analysis
- Optimization Theory
- Computer Graphics

Statistics/Physics/Geology (B.Sc.)
(Minor in Computer Science)
- Introductin to Computer Science
- Systems Analysis and Design
- BASIC Programming
- FORTRAN Programming
- Numerical Analysis
- Computer Oriented Statistical Methods
- Data and File Management

Technology (M.Sc.)
- Analytical Methods in Engineering
- FORTRAN for Engineers

Diploma (2-year evening)
- Introduction to computer Science
- BASIC Programming
- FORTRAN Programming
- Systems Analysis and Design
- Numerical Methods
- Data and File Management Systems]
- Computer Graphics
- Computer Oriented Statistical Methods
- Computer Project

Users' Course
- Introduction to Computer Science
- MS-DOS
- Wordstar
- Word 4
- dBASE III Plus
- Lotus 1-2-3

Computer Science (B.Sc.,planned)
- Numerical Methods
- PASCAL Programming
- Data Structure and Algorith Analysis
- Modelling and Simulation
- Computer Organization and Assembly Language
- Discrete Mathematics and Combinatorics
- Operating Systems and Computer Arhitecture
- Formal Language Theory
- Comiler Design
- Introduction to Complexity Theory
- Artificial Intelligence
- Probability Theory
- Computer Graphics

Source: Department of Mathematics, Addis Ababa University

Annex 9. Computer facilities in the Dept. of Maths, Addis Ababa University

Computer System	*Quantity*	*Service*	*Status*
NCR PC6 Microprocessor: 8088/8 Mhz RAM: 640 kb Drive: Double 5.25"/360 Monitor: EGA Printer: Dotmatrix	9	student lab.	in use
Apple IIe Microprocessor: 65C02/1 Mhz RAM: 384 kb Drive: Double 5.25"/140 Monitor: monochrome Printer: Imagewriter	9	student lab.	in use
NCR-PC6 Hard disk: 20 mb Drive: single 5.25/360 Monitor: monochrome Otherwise the same config.	2	staff room	in use
Apple IIc Microprocessor: 65C02/1 Mhz RAM: 256 kb Drive: Double 5.25"/140 Monitor: monochrome Printer: Imagewriter	2	staff room	in use
HP Vectra ES/12 Microprocessor: 80286/12 RAM: 1 mb Hard disk: 40 mb Floppy Drive: 1.2"/1.2 mb Printer: HP LaserJet II 2 mb Scanner: ScanJet	1	Desktop pub.	in use
HP 825S minicomputer RAM: 16 mb hard disk: 304 mb terminals 32 printer: 3	1	distributed	planned
HP Vectra ES27 networked with mini Microprocessor: 80286 RAM: 640 kb hard disk: 20 mb floppy drive: 3.5"/1.44; 5.25"/1.2 monitor: VGA Printer: HP DeskJet	11	student lab	planned
HP Vectra RS20 Microprocessor: 80386/20 RAM: 2 mb Hard disk: 40 mb Floppy drive: 3.5"/1.44; 5.25"/1.2 Monitor: VGA Printer: HP DeskJet Plotter: 8 color	1		

Source: Department of Mathematics, Addis Ababa University