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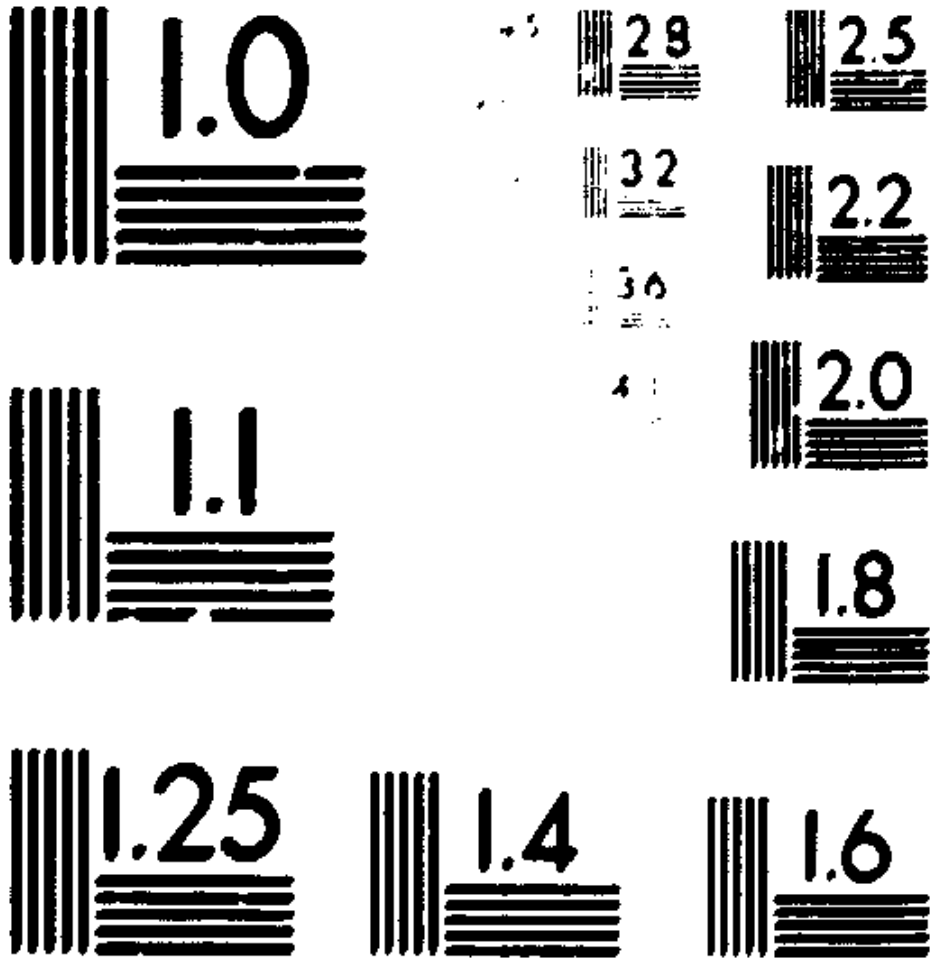

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MICROELECTRONICS AND INFORMATICS POLICY FOR DEVELOPMENT IN KENYA

a note prepared by the UNIDO secretariat*

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1. Microelectronics and industrialization of Africa

Microelectronics is a technology which is already having a major impact on industries and service sectors in developed countries and is gradually flowing into the developing countries in view of their dependence on the developed countries for most manufactured goods. But its adoption in the African countries cannot be left to chance. The potential is considerable but possible adverse results could also be serious, if care is not taken.

A large number of the products and processes used in Africa will contain more and more microelectronic products in the future, requiring, on the part of Africa, the capability to use and maintain them in appropriate systems. In addition, recent advances in microelectronics have given microprocessors and microcomputers precisely those advantages that make them appropriate for use, customization, development and manufacture in developing countries. It is important, therefore, that African countries and regions should make efforts to enter this technology in time in order to cope with the inevitable involvement which is sure to result. This is a matter of great urgency. Given the explosive revolution already underway in terms of complexity and variety of available microelectronics components and systems, those who fail to enter the technology at the early stages will face a much more difficult challenge in the future and, consequently, a much greater likelihood of finding themselves locked into a condition of dependency. The implication for Africa is that steps should be taken expeditiously to prepare for this new technology and to ensure the proper role for African nations in microelectronics as an element in their strategies for technological development. This should take cognizance of the negative effects microelectronics can have and the need for seeking ways of avoiding them.

Microelectronics could play a significant role in the industrialization of Africa, with applications which can contribute to virtually every field such basic needs as food production and distribution, health, education, industry, services, etc. In most sectors of industry as well as in some of agriculture, effective progress and competitiveness are not achievable without appropriate microelectronics applications. The most important advantages seem to be the decreased need for middle level technicians and workers, (which is a

bottleneck in most African countries), energy savings in all productive sectors, and the design and production of new products with versatility not achievable without utilization of information technology.

The economic and social conditions should be considered, including possible adverse implications, extending mostly to employment. Besides that, utilization of products based on microelectronics should be considered only where they provide real advantages to the producer or user. The transfer of the right technologies matching the needs and aspirations of African countries should be a crucial element in the technology policies. With limited financial resources only those technologies should be transferred, which allow the building of local capabilities and increase existing and future production quality and volume of products. More detailed discussions can be found in several UNIDO publications, such as "Prospects of Microelectronics Application in Process and Product Development in Africa", (UNIDO/IS.331) by M. Radnor, and "Microprocessor Applications for Developing Countries" (UNIDO/IS.351) by J. Oliphant.

Strengthening of research, development and manufacturing capabilities in the field of microelectronics requires suitable institutional infrastructure, a certain level of relevant expertise and some capital investment. The present reality is that none of these is available in most African countries. The prime requirement is building up the necessary human resource capacity.

A major problem, which has to be dealt with at the national level, is the integration of informatics technology in the mainstream of production. International and regional action may be, however, essential in providing models for such integration, as well as promoting, developing and demonstrating specific technologies, products and processes. As microelectronics-based information control products can be made cheaply from standard, off-the-shelves components, which can be customized by the user, training of the skilled staff, which may adapt products to African countries environment, is one of the most important factors of informatics development. The developed products can be very reliable, less sensitive to changes in environment and hard use, easier to develop and expand modularly, and better to withstand inadequacies in other systems, skills and materials. The

development of products and their applications should not be viewed as an isolated problem, but the appropriate governmental policies should integrate them especially in the priority sectors of national economy.

It is now broadly recognized in developing countries that, while the capacity to develop and utilize applications is an important step in the introduction of microelectronics for socio-economic development, attempts to develop application should be accompanied by efforts to develop design and manufacturing capabilities according to needs and ultimately the development strategies of each country.

The Expert Group Meeting on the Implications of New Technologies in the Implementation of the Lagos Plan of Action and the Programme for the Industrial Development Decade for Africa, held at Mbabane, Swaziland, from 22 to 26 October 1984 (Report UNIDO/OED.137), underlined the importance of African countries acquiring a capability in the field of micro-electronics.

2. Policy framework for national action

A microelectronics policy framework in a developing country may involve the following components, the sequence depending on the situation of each country and fitting into its specific socio-cultural context:

Monitoring and awareness:

(a) Monitoring on a continuous basis, through a multidisciplinary national team, the developments in microelectronics technology and its impact on priority areas in industry and other sectors, in particular in terms of skill and infrastructure requirements and comparative advantage in international trade;

(b) An awareness campaign directed to a target audience of decision-makers and end-users.

Endogenous capacities and applications:

(c) Promotion and establishment of a microelectronics industry, ranging from assembly to design and manufacture of chips and instrumentation on the one hand, and the manufacture of components on the other, the actual feasibility being dependent on local requirements and applications, comparative advantage, technological capabilities and other relevant factors;

(d) Promoting applications, based on identified national tasks, in priority areas in industry and other sectors, including the accessing, handling, processing and use of information;

(e) Short term and long-term programmes of education and training in hardware and software, to meet local requirements and, where possible, for exports; existing programmes and institutions should be kept under review and reoriented as appropriate;

(f) Setting up or encouraging applied R and D, particularly in the fields of special applications on importance, including the training and sensitization of R and D personnel in those fields; special attention should be paid to the possible applications of microelectronics for the development of rural areas, the satisfaction of basic needs and for finding solutions to other particular concerns of developing countries;

(g) Setting up and/or linking national institutions to develop endogenous capacities and applications mentioned above;

(h) Reviewing or formulating appropriate policies for transfer of technology and investment and the encouragement of endogenous capacities and applications;

Review:

(i) Keeping under review the implementation of the several elements of the strategy and ensuring coherence and consistency of the strategy with overall development aims and other sectoral strategies, in particular a telecommunications strategy.

The above framework should be characterized by a systems approach and long-term planning and should, to be effective, incorporate appropriate co-ordination mechanisms.

Each of the elements of the framework have to be elaborated into a series of measures depending on each country's conditions. To illustrate, hardware development may require government financing of the development; bank loans for software industry; tax concessions; compilation of a programme

register to avoid duplication and promote distribution of available programmes; protection of software. Promotion of applications may require identification of priority applications; applications in small enterprises; and applications in central and local government offices. Improving human resource environment may include training informatics specialists; computer-aided learning; awareness programmes for the general public.

The actual operation of the policy framework would depend for its success on continuous monitoring and review. Within the framework certain key issues will have to be decided upon. There are referred to below.

One major issue would be whether to enter into manufacture in addition to applications. Arguments have been advanced that manufacture will be skill- and capital-intensive and not possible for developing countries. While the point of entry should be decided by each country keeping in mind the feasibilities in terms of investment, skills and infrastructure requirements, there are countries whose manufacturing efforts would extend to the production of chips, instruments and related equipment and yet others whose efforts might have to be limited to assembly-type activities and/or manufacture of peripherals. Attempts to develop applications, it is pointed out, should not be at the expense of efforts to develop, design and manufacture components; without these efforts mastery of the technology is not possible. This has become all the more necessary due to technological trends which increasingly incorporate added value in the components and erase the traditional distinction between hardware and software.

Efforts to develop applications would create a demand base for manufacture and also obviate imports of applications from abroad. Though application areas are known to some extent, setting up of criteria for applications by each country may be necessary to focus efforts. Broadly, these criteria would relate to (a) areas that would enable the country to maintain, improve or create competitiveness in the international markets; and (b) critical areas of internal demand including those which will improve the quality of life in areas such as transportation, health, education etc. In this sense, the criteria for applications should be derived from a diagnosis of the needs and ultimately from the development strategy of each country. The public sector and public services are areas which hold out potentials for

applications. The operations in public services (for example, wagon turn-round in railways, berthing of ships in ports) could be considerably improved through microelectronics applications, but some systems may not be transferable to developing countries.

Any programme on applications has to be based at the country level on a detailed survey of the potentialities in several sectors of the economy. Such surveys should take into account the socio-economic aspects and problems of acceptance by producers and users. A close interaction between electronics professionals and users will be necessary to ensure successful application.

Building up of technological capabilities should occupy a central place in any policy framework. The concept of technological capability may have to be looked at de novo in the context of microelectronics. The developing countries will, among others, require capabilities in the field of electronics manufacture and assembly; while such capabilities are not totally different from manufacturing skills in general, the capabilities required for applications of microelectronics are non-existent in most developing countries and are lagging behind hardware development even in the developed countries. Software capabilities will be critical. The manpower required will include programme designers, systems analysts, data-base designers, programmers, controllers and managers, in addition to the more basic specialists in operations research, mathematical logic and scientific management. The objective in the development and use of software should not be only to meet routine requirements but to promote the design of applications for local problems and also to serve an export market where possible. In the final analysis, the actual impact of microelectronics on developing countries will be largely determined by their capacity to develop and apply software.

Software should be looked at in the broader sense of the requisite technological capabilities and should not be confined to select groups of programmers, systems engineers and operators. These specialized skills are crucial, of course, but it is equally important for developing countries to try to develop a software/microelectronics consciousness among as many people as possible. Persons working in all fields must be trained and encouraged to think about the potentialities of microelectronics for their own activities and to recognize that pre-packaged technology could be unpackaged to serve

local needs as perceived by themselves. Much of the software ought to be developed in the culture in which it is to be applied. Innovative training programmes starting from familiarization with computers at the school-level would be needed in addition to learning kits, micro-informatics clubs etc. Several developed countries and some developing countries, like Singapore, have initiated such programmes. Investment in human resources will be the most important key to realizing the benefits of microelectronics. If the infrastructure for application of microelectronics is created the benefits could be expected to come sooner. The term 'infrastructure' should be looked at in broad sense, including repairs, maintenance and service facilities and, above all, an industrial milieu which permits and provides microelectronics applications.

Education and training are therefore the key areas to which policy action should address itself. This would require not only an inter-ministerial effort but also interactions with the academic community. Given the socio-economic nature of education, innovative but carefully formulated policy directives from the highest levels in government will be needed to initiate the necessary changes and allocate the requisite resources.

It is possible to organize a centre for microelectronics application. A centre like that should conduct its activities in such areas as:

- Research and development including the elaboration of the mechanism of implementation of results in industry;
- Training and upgrading the professional skills of manpower;
- Collecting and dissemination of information from the field;
- Maintaining the connections with the relevant research institutions in the region and internationally.

If the local conditions and constraints are not favourable enough to create a centre for microelectronics applications, then a core-group model on selective applications may be more appropriate. A group may consolidate

around the the existing institutions, e.g. a university, concentrating its activity on the selected problem or set of problems and in this way solving tasks which are important for the country's economy. An approach like that is more elaborated in "Microprocessor Applications for Developing Countries" (UNIDO/IS.351) by J. Oliphant.

While human resource development would belong to one of the longer term measures, certain short-term measures would also need attention. One key area in this respect is the policy for public purchases. The purchase policies for computers, telecommunications and microelectronic equipment in several developing countries would at present appear to be uncoordinated. Apart from avoiding possible distortions, the purchasing power of the government could be considered as an important tool and utilized for the development of national industries and technological capabilities.

3. Requirements and policy measures for Kenya

There is a need for short- and long-term measures. Short-term measures include monitoring policies for acquisition of technology and for public purchases. The most important requirement in the long term is that for skills. Four types of skills are required. The first is the type of skills required for identifying and specifying applications of microelectronics. The second type of skill, and the predominant one for development, is for software identification, adaptation and development. The third type of skill is for promoting wide adoption of microelectronic systems among local users. The final type is for service and maintenance of microelectronic systems.

In designing policy measures aimed at implementing programmes to stimulate and facilitate appropriate use of microelectronic systems in Kenya, the following general principles must be borne in mind:

(a) Application approach should begin by being practice-up. Applications should begin with well-identified microelectronic candidate user needs and current practices, or with such products, processes or services that are already in use or being locally produced, and could be performed by a core production group identified through the needs.

(b) It is essential to develop methodologies for optimally promoting and disseminating the programme structurally as well as operationally. A linked regional structure plus a "learning and improving by doing" strategy (that moves through a use, make, improve and innovate cycle) should be considered.

(c) Every effort should be made to harness and exploit any appropriate sources of technology assistance from other developing countries (in a TCDC mode) as well as from developed nations.

(d) The programme must build up a self-sustaining capacity through lagged but concurrent efforts utilizing training (in Africa and elsewhere) as well as the build-up of experience and confidence among users as well as producers.

Having regard to the foregoing considerations and the possible components of a framework for national action indicated in chapter two, the meeting may consider identifying the content and modalities of a possible framework for national action in Kenya in the field of microelectronics. Within that framework there could be:

(a) A set of government policies to monitor acquisition of technology and public purchases as well as for the development of an endogenous capability in this field;

(b) Specific programmes of action, such as in the field of human resources development and other relevant areas, preferably in the form of a plan of action to be implemented by the concerned agencies and institutions;

(c) Possible institutional arrangements for developing endogenous capability such as interdisciplinary core groups or a centre for microelectronics application.

As already emphasized, the elements of action to be finally undertaken should be closely related to the development objectives of Kenya and its present socio-economic conditions.

4. International co-operation and role of UNIDO

International and regional co-operation should result in the establishment of a mechanism to continue the exchange of information, consultation, advice, etc. In several regions UNIDO assists in the promotion of regional co-operation in microelectronics and informatics. As a result of the UNIDO/ECLAC activities, the Latin American Microelectronics Network (REMLAC) is being created. Also as a result of the co-operation between UNIDO and ECWA, a microelectronics meeting was organized in Kuwait, and co-operation among the countries of the ECWA Region was sensitized. A network is being established in that region also. In November 1984, an Expert Group Meeting on the Implications of New Technologies in the Implementation of the Lagos Plan of Action and the Programme for the Industrial Development Decade for Africa took place in Swaziland, and special attention was given to microelectronics applications. UNIDO prepared several studies to assist developing countries in establishing indigenous capabilities in the field of informatics. The "Guidelines for Software Development in Developing Countries" (UNIDO/IS.439) by R. Narasimhan, give an outlook on policy preparation in the field of informatics. The studies "Software Engineering: A Survey" (UNIDO/IS.446) by W. Turski, and "Guidelines for Software Production in Developing Countries" (UNIDO/IS.440) by H. Kopetz, as well as "Problems of Software Development in Developing Countries" (UNIDO/IS.383), prepared by the UNIDO Secretariat, present the software possibilities for developing countries.

In the scope of international co-operation, UNIDO may provide technical assistance and advisory services, as required by African countries, for the establishment of microelectronics assembly/manufacture and the development of human and institutional capabilities, in particular software and the basic design. The concepts such as microprocessor applications centres and core groups for software and design may be particularly relevant for implementation in the African context UNIDO may also promote co-operation among African countries. Applied research and development of hardware and software related to microelectronics and its applications may be the subject of co-operation. In the field of public purchases of equipment and components as well as acquisition of technology, UNIDO may promote exchange of information among African countries and provide advisory services as required. UNIDO may also provide advisory services for policy formulation, if requested, including the preparation of programmes and plans.