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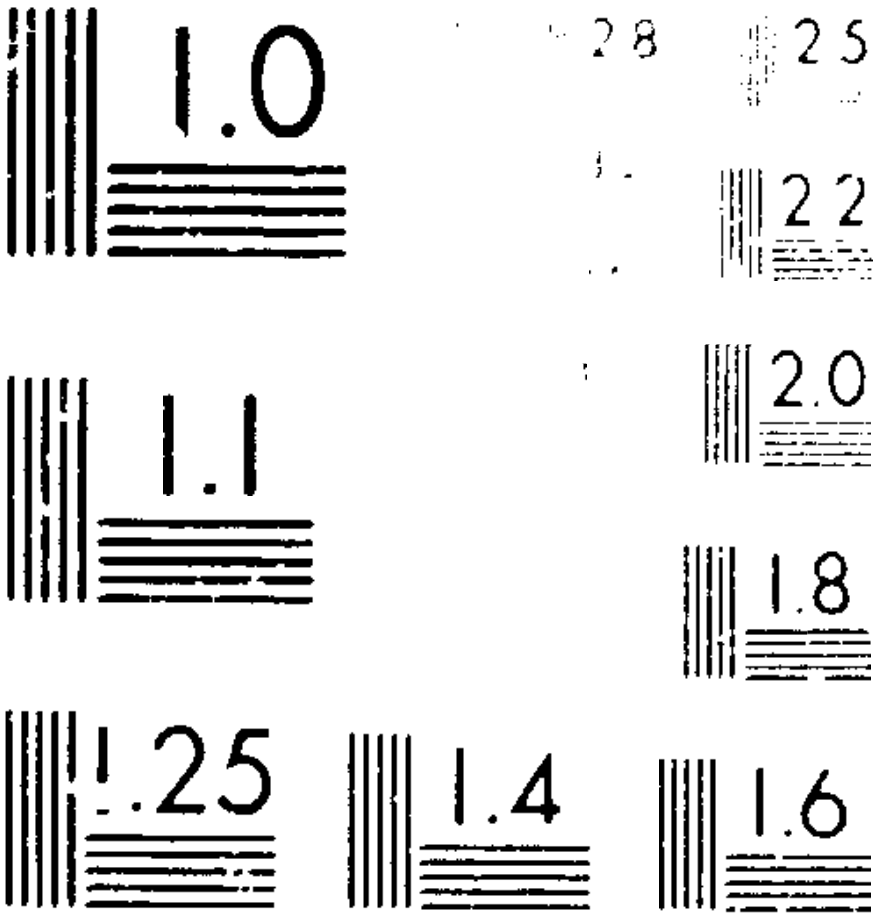
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org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INDUSTRIAL TECHNOLOGY IN AFRICA*

A PRELIMINARY VIEW

Report and documents of the
Joint OAU/UNIDO Symposium,
Khartoum, November 1980

TECHNOLOGY PROGRAMME
UNIDO

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FOREWORD

In April 1980 the Heads of State and Government of the Organization of African Unity (OAU) adopted the Lagos Plan of Action for the Economic Development of Africa. To assist African countries to operationalize the Plan in the field of technology, the UNIDO Secretariat, in co-operation with the OAU, organized a Symposium on Industrial Technology in Khartoum, Sudan, 5 - 11 November 1980. The UN Economic Commission for Africa (ECA) and the African Regional Centre for Technology (ARCT) also collaborated with UNIDO in organizing the Symposium. The objective of the Symposium was to enable each African country to identify its starting point for action, with reference to its specific requirements and conditions. Principal emphasis was given to the overall policy framework, infrastructural arrangements and linkages, development of manpower capabilities, technological information and intra-African co-operation.

The Symposium, which was attended by representatives of 35 African countries, made a number of important recommendations and emphasized in particular the need for each African country to formulate and implement a minimum programme of action in industrial technology within a basic policy framework. In co-operation with the OAU, ECA and ARCT the UNIDO Secretariat is currently seeking to translate the recommendations into specific projects and activities to be undertaken at the regional and national levels. It is also proposed to monitor the progress achieved in this field, in co-operation with the OAU and ECA.

The Symposium specifically requested OAU and UNIDO to widely circulate its report and documentation among all African countries as a means of promoting action by them. In response to that request the UNIDO Secretariat has prepared this document. It is hoped that the document, combined with other UNIDO efforts, will assist the African countries in adopting measures in the field of industrial technology to achieve the goals of the Industrial Development Decade for Africa.

Abd-El Rahman Khane
Executive Director

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PART ONE

REPORT

I. INTRODUCTION

Background

1. The Governments of Africa, through the Organization of African Unity (OAU), have consistently declared their faith in industrialization as a strategic element in the structural transformation of the African economies. This faith, clearly stated in the Addis Ababa Declaration on Industrial Development in Africa, as adopted by the First Conference of African Ministers of Industry (1971) and reaffirmed in various summit meetings of the OAU as well as subsequent meetings of African Ministers of Industry, also aknowledges the role of technology as an inalienable factor in the attainment of Africa's industrialization goals and in achieving collective self-reliance.

2. The Heads of State and Government of the OAU adopted the Monrovia Declaration on Economic Development in Africa (1979) in which they commit themselves to, inter alia, "the development of indigenous entrepreneurial, technological manpower as well as the technological capacities that will enable the African peoples assume greater responsibility in the attainment of rapid industrialization". The Lagos Declaration and Plan of Action (1980) went further by adopting a comprehensive set of recommendations in the field of industrial technology, identifying a number of key or priority industrial sectors for concentrated action, and reiterating their support for the resolution adopted at the Third General Conference of the United Nations Industrial Development Organization (UNIDO) recommending that the United Nations General Assembly should proclaim the 1980s as the African Industrial Development Decade. Such a proclamation was proposed in order to create a greater awareness among the African countries on the need to accelerate the industrialization process on the continent; to facilitate the full participation of their entire population in the industrialization process; and to obtain greater technical and financial support from the international community towards the industrial development efforts of the African countries. The resolution also calls upon UNIDO and the ECA to co-operate with the OAU in preparing a draft programme of action for the decade.

3. As a follow-up, the OAU and UNIDO, in co-operation with the ECA and the ARCT, organized a Joint OAU/UNIDO Symposium on Industrial Technology for Africa in Khartoum, Democratic Republic of the Sudan, from 5th to 11th November 1980. The objective of the Symposium was to discuss and evolve practical measures of action in the field of industrial technology based on alternative models and experiences, taking into account the need to initiate action for achieving the objectives of the African Industrial Development Decade and for operationalizing the relevant recommendations of the Monrovia Declaration 1/ and the Lagos Plan of Action 2/.

Participants

4. Delegates from 35 African countries participated in the Symposium, as well as representatives from various subregional, regional and international bodies, including the UNDP, UNCTAD, WIPO, the African Regional Centre for Technology (ARCT) and the Arab Bank for Economic Development in Africa (BADEA). The list of participants and observers is in Annex I.

Opening of the Symposium

5. The Symposium was inaugurated by His Excellency Izzeldin Hamid, Minister of Industry of the Democratic Republic of the Sudan. In his address, Mr. Izzeldin Hamid pointed out that the third world constituted 75 per cent of the world population, but hardly contributed 20 per cent of the world income and only 10 per cent of the world industrial output. The African region was the least developed

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1/ Monrovia Declaration of Commitment of the Heads of State and Government of the Organization of African Unity on Guidelines and Measures for National and Collective Self-reliance in Social and Economic Development for the Establishment of a New International Economic Order (AHG/ST.3 (XVI) Rev. 1).

2/ ECM/ECO/9(XIV) Rev. 1

region in the third world, containing the largest number of the least developed countries as well as being the least physically integrated in terms of transportation, communication and energy. The African countries insisted on industrial development, knowing that it constituted an important factor in achieving a balanced international economic order. The present world industrial structure, however, represented a mismatching of endowment of resources and productive capacities. The achievement of the Lima target involved a combination of policy issues, including the development and transfer of industrial technology. The objectives of the Symposium, Mr. Hamid noted, were closely consistent with the Monrovia Declaration and the Lagos Plan of Action. He called for the enhancement of collective self-reliance through the promotion and strengthening of technological capabilities in the field of industrial technology.

Mr. Hamid emphasized the importance of the creation of an industrial infrastructure at national levels within the framework of an integrated economy; thus promoting inter-dependence among all sectors and sub-sectors of the economy and achieving harmonized industrialization within the overall economic development. In regard to strengthening technological capabilities,he referred to the experience of Sudan which included the establishment of specialized research centres and institutes; review of the curricula of educational institutions so as to expand technical education to suit the country's potentials and future requirements; and the involvement of universities, research centres and technical institutes in the preparation of the Six Year Plan for economic and social development

6. Speaking on behalf of the Executive Director of UNIDO, Mr.G.S.Couri,Senior Technical Adviser in Charge of the Technology Programme, conveyed the best wishes of Dr. Khane, the Executive Director, for the success of the Symposium. Recalling the recommendation of the Third General Conference of UNIDO that the 1980's be proclaimed as the Industrial Development Decade for Africa, he pointed out that at the beginning of the Decade, the African Continent found itself in a difficult economic situation which was compounded by problems such as inflation and growing unemployment in the developed world, diminution in the scope and volume of external aid, the energy situation, and lack of progress in the North-South Dialogue. As part of their efforts in achieving the Lima target of industrialization,

African countries should press vigorously to increase their share of 0.9 per cent in world industrial production to at least 2 per cent by the year 2000 as called for in the Lima Declaration and Plan of Action on Industrial Development.

7. The Symposium was the first of a series of meetings, reviews and dialogues that were necessary in this context. It was based on the realization that unless Africa came to grips with both technology and self-reliance, it could not come to grips with development. Industry was related to other African priorities such as food and energy, and equally with technology. This complex relationship had to be activated. There was a need to build structures and policies to handle technology, just as many countries had done to handle investment. The primary emphasis was at the national level and countries would have to choose from various options, models and experiences. Intra-African co-operation needed to be promoted, with OAU, ARCT and ECA playing a vital role. Mr. Gouri pointed out that the Executive Director of UNIDO had, inter-alia, set up a Secretariat Task Force to co-ordinate and accelerate the Secretariat's activities in regard to the African Industrial Development Decade, and re-iterated, on behalf of the Executive Director, UNIDO's commitment to continue to assist the African countries in all aspects of industrialization.

8. Speaking on behalf of the Secretary-General of the Organization of African Unity, Mr. P.O. Etiang, Assistant Secretary-General (EDECO), referred to the slow technological progress of Africa in comparison with other developing regions and its own vast technological needs and potentials. The subject of industrial and technological progress was given special emphasis in the Lagos Plan of Action, which is now regarded as Africa's economic blue print up to the turn of the century. The biennial Conference of African Ministers of Industry and its follow-up Committee on Industrialization in Africa had expressed the aspirations of OAU Member-States for technological development of Africa. To this end, UNIDO, ECA and the OAU had been active in creating various specialized institutions for technological development in line with the decisions of the Member-States. Relevant in this connexion were the African Regional Centre for Technology, the African Regional Centre for Engineering, Design and Manufacturing, and the Association of African Industrial Technology Organizations.

9. Emphasizing the importance of technological co-operation in Africa, Mr. Etiang referred to the role assigned to the OAU in this regard, which included identification and encouragement of joint projects, establishment of regional and sub-regional institutions and monitoring developments and activities in Africa which are related to the specific decisions of the African Heads of State and Government.

Election of Officers

10. The Symposium unanimously elected the following as officers:

Mr. Abdel Rahman Ahmed El Agib (Sudan)	Chairman
Mr. Sidi Lamine Ba (Senegal)	Vice-Chairman
Mr. R.D. Arunga (Kenya)	Vice-Chairman
Mr. Joseph Rakabane Monametsi (Botswana)	Rapporteur

Organization of Work

11. The Symposium unanimously adopted its agenda and programme of work. All discussions were held in plenary, and were based on background documents prepared and introduced by UNIDO, the OAU and ARCT.

Transmission of Report of the Symposium

12. The Symposium decided that its Report should be forwarded by the Chairman to the Secretary General of the OAU and the Executive Director of UNIDO for appropriate and necessary follow-up action by the two Organizations. In compliance with the Symposium's decision, a letter of transmittal was prepared by the Chairman and forwarded to both the OAU and UNIDO.

II. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

13. The Symposium welcomed the OAU/UNIDO initiative in holding one of the first meetings at an operational level for the implementation of the Monrovia Strategy and the Lagos Plan of Action at the beginning of the African Industrial Development Decade. This initiative would also constitute the first in a series of meaningful actions in Africa to bring about the implementation of the Vienna Programme of Action adopted by the United Nations Conference on Science and Technology for Development and the New Delhi Declaration and Plan of Action adopted by the Third General Conference of UNIDO. It was therefore important that programmes in the field of industrial technology should be formulated and initiated without loss of time as a means of achieving self-reliant and self-sustaining economic, social and cultural development. The actions proposed in the Symposium would be consistent with the Lagos Plan of Action and contributary to, and integrated with, its other essential elements.

14. The immensity of the task and its diversity are further heightened by the urgent need for prompt action. The development of industrial technological capabilities in Africa will reflect in the development of priority sectors such as food and energy. Not many African countries are yet committed to particular technologies and courses of action. This is an advantage as well as a potential point of vulnerability, if the right courses are not adopted.

15. The task is basically multi-disciplinary, integrated and holistic, yet actions have to be conceived and implemented in specific areas and sectors, without being fragmented, unco-ordinated or discontinuous. There is no substitute for actions at the national level. Yet, regional action and technological co-operation are not only desirable for effective utilization of complementarities, but is highly essential in view of the existence of small, least developed and landlocked countries which could only participate in and benefit from development activity in a broader framework. Internal and external inputs have to be blended and a strategy for maximising the benefits of external assistance be formulated and implemented.

B. Recommendations

Action at the National Level

16. In recognition of the prime importance of action at the national level, the Symposium recommends that each African country should review the Lagos Plan of Action in the light of the discussions in the Symposium, also taking into account other relevant action programmes such as the New Delhi Declaration and Plan of Action and the Vienna Programme on Science and Technology. On the basis of this review, a basic national programme in technology should be formulated and implemented, as a matter of priority and urgency which should consist, as a minimum, of:

1) a framework of guidelines for action for the development of national technological capabilities;

2) a set of minimum programmes in accordance with national priorities in specific industrial sectors and areas including information, institutional infrastructure, manpower and development of indigenous technologies;

3) a "kit of policy tool" based on an assessment of national requirements and availabilities as well as of policies relevant to industrial technology, especially in the areas of finance, trade, etc.;

4) a monitoring and regulatory machanism for the inflow of foreign technology and equipment.

17. UNIDO in co-operation with UNDP is called upon to continue to assist African countries in industrial technology development and transfer, including:

i) preparing technology policies, plans and programmes and establishing the appropriate institutional structures for this purpose;

ii) strengthening and/or establishing industrial technological information systems and linking them with regional and international systems;

iii) collecting and disseminating information on technologies in the informal sector;

iv) developing more pilot projects of adapted technologies and their widespread use;

v) developing programmes for training technology manpower, including non-formal training.

Action at the Regional Level

18. The Symposium calls for an intensification of intra-African technological co-operation activities for strengthening institutional arrangements at the regional level and for inter-related action in the various activities related to industrial technology.

19. The OAU is urged to intensify its activities in this regard, as required by the OAU Heads of State and Government, inter alia, in the Lagos Plan of Action. To this end, the OAU and UNIDO with the assistance and co-operation of the UNDP, ECA, ARCT and other relevant international and African regional organizations are called upon to:

i) carry out a cross-country analysis of African technological experience in technology policy and planning as a prerequisite for meaningful action in this area, and dissemination of information and experiences;

ii) organize a symposium on industrial and technological information exchange systems in Africa;

iii) prepare a directory of African industrial technology experts and institutions;

iv) carry out an appraisal of existing regional industrial technology centres and suggest actions for full utilization of their potential;

v) organize more regional training programmes in industrial technology skills on a regular basis in African centres of excellence;

vi) promote the establishment of mechanisms for joint acquisition of technology by groups of African States;

vii) analyse African experience with external assistance in technological fields and propose the implementation of the recommendations of the Symposium, and to bring the results to the notice of African

Governments for review and initiation of further meaningful actions;

viii) assist in the preparation of African participation in the UNIDO system of industrial consultations.

20. The actions to be taken by the OAU need to be re-inforced by other collective actions by the African countries and international organizations. The African countries are thus called upon to intensify their support to and co-operate with relevant African regional centres and other institutions. The UNDP, UNIDO, ECA and other relevant international organizations are also called upon to expand the scope and increase the magnitude of their technical assistance to African regional organizations including the ARCT and the Regional Centre for Engineering Design and Manufacturing and to co-operate with them in the development and implementation of joint programmes.

21. African countries are collectively called upon, and through national, regional and international centres and organizations, to:

i) intensify the development and widespread use of appropriate indigenous technologies;

ii) promote the strengthening and conversion of existing national centres into regional centres of excellence, particularly in the fields of industrial technology, manpower and information;

iii) encourage more widespread involvement of African experts and consultants in UN activities and to formulate and participate in programmes for reversing the brain drain.

C. General Recommendations

22. In view of the value of the Symposium to the efforts of the African countries in the development of their technological capabilities and in order to maintain the momentum generated, the Symposium recommends that the OAU and UNIDO, in co-operation with the ECA, ARCT and other relevant international and African regional organizations should formulate concrete projects based on the deliberations of the Symposium for possible financing by the UNDP, IFSTD, and other sources, for implementing specific activities arising from the recommendations of the Symposium. The OAU and

UNIDO are called upon to print and to widely disseminate the report and recommendations of the Symposium among all African countries and organizations and to bring them to the attention of their governing bodies with a view to ensuring their consideration in the formulation of their future activities in the field of industrial technology. Finally, UNIDO and the UNDP are called upon to intensify their assistance to the OAU in planning effective mechanism and modalities for co-ordinating and monitoring the implementation of regional activities in the field of industrial technology in Africa.

23. The Symposium also recommended that the OAU and UNIDO should organize, in co-operation with the UNDP, ECA and ARCT, a follow-up meeting to this Symposium in 1982 in order to examine the progress achieved in Africa in the implementation of the industrial technology programmes adopted at this Symposium, the Lagos Economic Summit and other relevant fora. The Symposium urged that the follow-up meeting should exchange relevant information and experience on the steps taken, models adopted, constraints experienced and results achieved. The Symposium suggested that for the preparation of the follow-up meeting, it would be desirable to call a preparatory group in the nature of a Steering Committee, consisting of representatives of OAU, UNIDO, UNDP, ECA and ARCT as well as the chairman of the Symposium. The Executive Director of the ARCT announced his invitation to host the meeting of such a preparatory group in Dakar.

D. Concluding Session

24. The Symposium adopted the draft report, decided that its report should be forwarded by the chairman to the Secretary General of the OAU and the Executive Director of UNIDO with an appropriate letter of transmittal and authorized the chairman accordingly. The OAU/UNIDO Secretariats were authorized to edit, reproduce and circulate the final report of the Symposium to all participants and African countries and organizations.

25. The Symposium unanimously resolved to place on record its high appreciation of the hospitality and the excellent arrangements made by the Government of the Sudan and the Sudan EXPO for the conduct of the Symposium.

26 The chairman of the Symposium and representatives of UNIDO and OAU thanked all concerned for the successful manner in which the Symposium was conducted and the constructive results achieved by it.

III. SUMMARY OF DISCUSSIONS

A. Industrial Technology in Africa: Towards an Integrated Approach

27. Introducing the UNIDO Secretariat paper,[3] the Secretariat stated that while the Lagos Plan of Action contained detailed and wide-ranging recommendations in the field of technology, and had also listed the priority sectors of industry,[4] there was a need to convert the political commitment reflected in the Plan, to a set of practical measures. Each African country would need to identify its starting point and its options for action in the light of its specific requirements and its existing level of industrial and technological development. Notwithstanding variations in country conditions and levels of development, the overall African industrial scene presented a challenging picture. Increasing Africa's share in world industrial production up to the 2 per cent of the Lima target required the growth of the manufacturing sector at 11.3 per cent per annum as against an average growth of 7.3 per cent achieved between 1955 and 1975. Yet such an increase was required not only for its own sake but for its contribution to other sectors such as food and agriculture, transport and energy. Some features of the African industrial scene included: predominance of food, beverage and textiles in the industrial structure; low contribution of industrializing industries such as engineering industries, an apparent emphasis on equipment and hardware rather than on people and software. Arising from these features, a low level of technological development was achieved.

28. In such a context, a careful approach to technological development was called for, to avoid limited or lop-sided actions. The perceptions of developing countries concerning technology had evolved considerably from concerns limited to contractual conditions of technology transfer to appropriate choice of technology, strengthening technological capabilities, endogenous technology development and finally questions of overall development itself. This necessitated

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3/ Industrial Technology in Africa; Towards an Integrated Approach.

4/ viz. Food and agricultural industries, building materials and construction industries, engineering industries, metal industry, chemical industry, forest-based industries, energy industries.

integrating actions in the field of technology to development goals and their attainment and to the productive sectors which contributed to such development. The field of technology development and transfer was itself a wide one and needed closely inter-related actions for effective results within a consciously designed national framework for action.

29. During the discussion that followed, it was noted by several participants that the subject of technology had come to the forefront in Africa. The importance of industry and industrial technology as leading factors in development was recognized. Reference was made to shortcomings in the international comparisons of production, some of which stemmed from the concept of development itself. It would be necessary to make a careful examination of the objectives of development, leading to a clarification of that concept, and thence to the role of industrial technology in fulfilling the objectives. In this context, one of the essential considerations would be the fulfilment of basic needs of the majority of the population in the struggle against poverty. It was noted that the priority industries identified in the Lagos Plan of Action would contribute, inter alia, to the satisfaction of basic needs.

30. It was pointed out that the Monrovia Declaration and the Lagos Plan of Action had stressed the strategy of collective self-reliance. Self-reliance, it was urged, should be a cardinal criterion in the design of action programmes. Self-reliance was not autarchy, but rather the ability to take autonomous decisions, to control a country's relationship to others and to ensure that African outputs outweighed the inputs. The pursuit of self-reliance involved control over the development process which in turn required control over technology. Such control was not always in evidence in several African countries due to a number of internal and external constraints. In this connexion, the importance of the political will, the need for creating awareness of the issues involved, and avoidance of discontinuities in technological inputs and actions were stressed.

31. Technology and its development and transfer involved a mass of heterogenous elements which had to be mastered by African countries and utilized effectively in achieving development objectives. There was a continuous need to develop within Africa, technologies of its

own, such that people could live and work with. The role of technology transfer from abroad, which would be the main source for some time to come, cannot be ignored and should be given due consideration. Measures relating to transfer of technology included choice of technology; the terms and conditions of its acquisition; its diffusion throughout the society and closer South-South co-operation ensuring exchange of studies, information on projects and experiences as well as of semi-finished products and manufactures between complementary economies. Attention should be given, inter alia, to organizing and regulating transfer of technology, sensitising decision-makers, enterprises and the public at a variety of levels, as well as developing R and D capabilities and engineering services.

32. Reference was made to the problems facing African technological development, some of which were of a structural nature. The limited market size of many African countries and the problems in creating an export market, including those of communication and transport, underlined the need for an appropriate mix of technologies. It was therefore necessary to co-ordinate the technological development of large, medium and small-scale industry, bearing in mind, on the one hand, the important role the individual entrepreneur could play, and on the other, the consideration that small-scale industry alone could not build a strong economy. The differences in sizes and resource endowments of African countries and the scale limitations in certain industrial technologies called for regional development of certain industries.

33. The foregoing considerations underlined the need for each African country to evolve a framework for national action, based on a diagnosis of the existing situation and aimed at the achievement of development objectives and self-reliance.

B. Action in the Field of Technology Policy and Planning in Africa 5/

34. Introducing the subject, the UNIDO Secretariat pointed out that technology was a commodity with a price and that it now came to be

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5/ The papers discussed were: Action in the field of technology policy and planning in Africa, and The role of external assistance in African Technological Development: Potential and Limitation.

recognized as a fundamental factor in socio-economic development. Technology policy was part of overall development policy. The life style chosen dictated the product mix in a society, and consequently, the technology needed for production.

35. Technology policy and plans dealt with the two streams of technology, namely: the "flow" stream of imported technologies and the "stock" stream of endogenous technology. The former would be predominant for some time to come; but the latter could provide useful inputs to meet requirements that could not be appropriately satisfied by imported technologies. Experience in other regions confirmed that the building-up of indigenous technological capability in handling both streams was a requirement for sound development, regardless of the political orientation or development strategy of a country.

36. While comprehensive technology policies and plans might be difficult and might have to be worked out over a period of time, at least a framework of guidelines and a minimum set of programmes for specific sectors, as well as the mechanism for implementing and monitoring implementations were badly needed. This was essentially a multi-disciplinary exercise that called for maximum participation at many levels and in many walks of life.

37. A framework would establish a concensus on product and technology mix, an assessment of existing capabilities and a strategy for filling in the gaps and overcoming deficiencies on the basis of optimum utilization of resources and the mobilization of desirable demand within clear time horizons. Specific programmes in key sectors were outlined and a kit of basic tools in technology policy and planning was suggested.

38. As regards the role of external aid on African technological development, no clear-cut strategy for optimising the benefits of external aid was in evidence. In some cases, external aid was not based on a well-defined set of national priorities, nor was its full cost to the recipient fully appreciated.

39. While some donor countries regularly analysed their experiences, very few African countries did the same or participated in joint evaluation exercises. Adequate information on the motives and capabilities of prospective donors would improve the recipient country's capacity in negotiating mutually beneficial terms and conditions.

40. The importance of transferring skills, "know-how" and "software", as against the acquisition of "hardware" had not always been reflected in external aid programmes. The possibilities of co-operation between third world countries were increasing and could contribute significantly to the benefits of external aid.

41. Various participants underscored a number of the points presented. The following points received special emphasis.

42. It was noted that although most African countries have development plans, very few of these are based on science and technology policies, linked to technological practices at the grass-root level. It was noted further that policy instruments specifically designed to encourage the development and use of national technological capabilities were rare. Policies were often not backed by meaningful policy instruments.

43. Though technology might be difficult to plan, it was possible and necessary to control and monitor it. It was important to select specific priority sectors and to concentrate the action within the framework of clearly defined objectives. Maximum possible participation of all individuals and institutions involved in implementing technology policies and plans would guarantee their success.

44. It was felt that there was a pressing need for establishing control on the "flow" stream of technology without delay, including the selection and procurement of equipment. A number of developing countries in other regions had adopted such policies; different models were available and their experience had been documented.

45. Technology policy should encourage development of indigenous technology, particularly for rural societies and of an income-generating nature. Such a policy, however, should not be unduly restrictive, but should be based on a sound assessment of the potential of such technologies. In addition to technology generation, the standardization of technologies and products within a country, as well as between countries in Africa, was considered an effective means of the rapid development of technological and productive capacities in Africa. Examples from South-East Asia were cited in support of this point.

46. There was a pressing need for analysing and disseminating information and experiences on the methodologies of drafting and monitoring the implementation of technology plans. It was also important to develop a 'technological intelligence' capacity in the choice, acquisition and implementation, as well as for monitoring technological advances and assessing their possible impact on African societies.

47. One of the fundamental tasks identified was the need to carry out a cross-country analysis of the African technological scene today as a prerequisite for identifying actions in technology policy and planning. UNIDO, in co-operation with the OAU and ARCT, was called upon to field, with the possible assistance of UNDP, a multidisciplinary team to study and analyse African experience in formulating and implementing technology policies and plans. UNIDO was called upon to intensify and expand its activities in this area. An approach to formulating technology policies and plans would be that such teams would associate national counterparts in identifying elements of such policies and plans for specific sectors, ·rg into consideration the present state of industrial technology and the existing policy instruments in the country. The draft technology plan or programmes would be submitted to the broadest possible section of the community that was concerned either in implementation or as beneficiaries before the Plan was adopted. Effective implementation, monitoring and follow-up mechanisms should be established.

48. As regards external assistance various participants noted that, even after years of sustained external assistance, most projects failed to flourish independently. This was attributed to the failure to develop local skills required for operation of the projects. The measure of success of aid programmes would be the speed with which they could operate without foreign experts.

49. A call was made for comprehensive analysis of the social impact of external assistance programmes. Experts from the third world have shown understanding of the problems facing recipients and have been more sympathetic and effective.

50. In view of the paucity of studies on the impact of external assistance on technological development, it was felt that in-depth investigations in this regard were necessary. It was suggested that provision for development of relevant local technological capabilities should invariably be insisted upon in aid packages; perhaps, by common agreement, a fixed percentage of an external aid package could be devoted to local R and D and the development of local capabilities.

C. Industrial Technological Information in Africa

51. Presenting the subject,[6/] the UNIDO Secretariat underlined the variety of end users of industrial technological information and consequently the diversity of such information, varying from socio-economic data and statistics at one end, through financial, legislative, market, technological and management information. An effective industrial and technological information system thus had to combine technical and socio-economic orientation; identify sources of information and communicate with them; analyse, assess and organize storage and retrieval, and thus provide end users with the right information in the right form at the right time. This was a prerequisite for inspiring confidence and generating demand for the services of any industrial and technological information system.

52. Information relating to the selection and acquisition of technology is particularly important if we want effective results from the "flow stream". Details were given of the operation of the Industrial Technological Information Bank (INTIB) which is specifically concerned with technology choice, and the Technology Information Exchange System (TIES) for the exchange of information on technology contracts between participating countries, as well as UNIDO's long-standing Industrial Inquiry Service. Participants were urged to establish and maintain closer links between institutions in their countries and UNIDO's information systems and services.

6/ Action in the field of Industrial and Technological Information in Africa

53. The necessity of establishing a focal point, no matter how small, close to potential users of information was underlined, together with the pressing need to build a technological intelligence capacity and a cadre of effective industrial information officers.

54. During the discussion, several participants stressed the importance of coordinating the systematic handling and flow of information within the African countries. This was considered to be a basic requirement for exchanging information within Africa on past experience, both positive and negative, for better development of technological capabilities and sound industrial planning and project formulation.

55. The need for regional co-operation in industrial and technological information and the possible role of the OAU and the ARCT was stressed.

56. Examples of successful national information systems, particularly for investment promotion, were cited, as well as cases where a law obliges nationals to provide the required information at the national level. The practice was cited of three African countries whereby, at the time of formulation of a project, information and experience was exchanged with countries where similar projects had already been initiated.

57. The problem of the rather low social standing of information officers was cited as a serious constraint in developing effective information systems. A call was made for upgrading their social status and career development opportunities, and interesting engineers and economists in the information function.

58. Information should be seen as an integral function of each activity and as an essential tool of management. It was important to ensure the flow of information within the system of activities pertaining to industrial and technological development. Attention was drawn to the need for close links with user groups and for training them in the handling and use of information.

59. A plea was also made for the setting-up of national focal points in order for INTIB to increase its activity in the exchange of experience within Africa on experience in the choice of technology. There was a need for collecting and disseminating information on technologies available in the informal sector and on appropriate technologies in developing countries in general. UNIDO was requested to disseminate such information among the African countries.

60. Special attention was drawn to the requirements of the small industrial entrepreneur and to the need of winning his confidence as well as assisting him so as to minimise the danger of his taking wrong decisions on technological matters.

61. While noting that UNIDO activities in information were helpful in many African countries, it was proposed that UNIDO in co-operation with CAU should organize a symposium on industrial and technological information exchange systems in Africa, and further that UNIDO should continue to assist the African countries in setting up information systems at the national level and to harmonize these at the regional level.

D. Industrial Technology Institutions

62. Introducing the subject,[7] the UNIDO Secretariat pointed out the value of institutions in implementing policies, plans and programmes as they ensure continuity and become depositories of technological capabilities. A detailed accounting was given of the possible contributions of technological institutions along the spectrum of industrial technological activities. The patterns of institutions, their functions and possible modalities of operation were analysed and experiences from various parts of the world presented.

63. It was noted that while Africa was not acutely short of institutions for policy-making or industrial research, their effectiveness has not been clearly demonstrated. There was a clear shortage in institutions concerned with the monitoring and regulation of imported technologies, a fact that had resulted in inappropriate choices and unfavourable contractual arrangements.

64. It was suggested that a diagnostic matrix[8] could help identify shortcomings and gaps as a prelude to appropriate action in the priority industrial sectors within the framework of an integrated systems approach. It was proposed that emphasis be placed on identifying

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7/ Industrial Technology Institutions.

8/ ibid, pp. 23-24

functions to be preformed rather than on institutions per se. The strengthening of existing institutions; their involvement in performing new functions with the help of extra inputs; the sharing of programmes and networking of institutions with a centre of excellence as the focal point; and the organization of joint training programmes were cited as possible modalities for obtaining desirable outputs from existing institutions.

65. In establishing new institutions, the time horizon for the function needed, its potential for development and the interim measures necessary during the process of building up the capabilities of the new institution should be integrated in a detailed feasibility study, with well defined phases and detailing of resources needed.

66. In the discussion, the lack of information on existing institutions and their work was referred to, and it was suggested that UNIDO should prepare in co-operation with the OAU, ARCT and ECA, a directory of national industrial technology institutions and promote exchange of information on their work. The twinning and/or linking of institutions was cited as a means of avoiding repetition of mistakes and benefiting from successful experiences. It was noted that after the colonial period no established relations were formed to replace those that existed with institutions in the colonizing countries. Several participants referred to the need to avoid building new institutions until the full potential of the existing institutions was realized. The importance of selective and sustained action in this field was emphasized. The representative of UNCTAD reviewed some examples of the work of UNCTAD in Africa in the institutional field.

67. On the problems of existing institutions, participants referred to inadequate co-ordination between institutions within the same country, the lack of well-defined modalities for co-operation, shortage, as well as the frequent movement of personnel resulting in the lack of continuity in programmes and their implementation, the inadequacy of specialised training opportunities and the absence of close links with end users, particularly in the private sector. There was also a need to establish better co-ordination between organizations and institutions working on similar activities.

68. Suggestions were made for the transformation of some national centres into African centres, the propagation of successful experiences in co-ordinating institutions within a country and linking up the efforts of industrial technology institutions with those in other sectors in view of the basic unity of development effort. Multi-disciplinary was emphasized, as was also the development of vertical and horizontal linkages by institutions. The need for multidiciplinary training and for structures for exchange of institutional experience was underlined. Attention was also drawn to the need for institutional systems and services for small scale industry. It was suggested that once an institution was established with clearly defined functions, it should be enabled to discharge those functions with adequate resources and manpower, without multiplying institutional arrangements for the same purpose, resulting in dispersion of effort.

69. A reference was made to a possible model of a National Science and Technology Council being developed in an African country with assistance from UNIDO; and it was suggested that UNIDO should assist other African countries in establishing similar institutional arrangements. The model, now being subjected to critical evaluation and inspection, will be made available as soon as detailed necessary feed-back has been obtained.

70. It was recommended that UNIDO, OAU, ARCT and the ECA carry out a programme involving:

- an appraisal of the present effectiveness of industrial technology institutions at various levels of functions;
- a similar exercise for African regional industrial technology institutions;
- Specific joint co-operative programmes; and
- monitoring and follow-up of the recommendations of the Symposium.

E. Industrial Technology Manpower in Africa

71. The document presented by the UNIDO Secretariat 9/ dealt specifically with industrial technology manpower development, which is part of the wider issue of manpower development in general. The main characteristics of the specific situation in Africa, e.g.

9/ Industrial Technology Manpower in Africa.

underpopulation, limited educational facilities in colonial times, continued reliance on substantial numbers of expatriates, the social bias towards white collar and clerical jobs and away from science and technology in higher education, have resulted in Africa lagging considerably behind other regions in its stock of scientists, engineers and technicians.

72. Actions in developing industrial technology manpower have to be carried out both at the long-term and short-term levels. The former would be part of the exercise of preparing national manpower development plans, a task that is rather difficult and for which there are, as yet, no generally accepted methodologies in developing countries. It was pointed out that manpower development plans should not be strictly tailored to the manpower needs of development plans and projects, since upgrading of the skills of the population is a good investment leading to self-employment and the spread of entrepreneurial spirit.

73. The immediate needs of the present and immediate future can best be met by flexible modes and ad hoc measures in existing educational, training and production facilities to satisfy specific needs without waiting for the establishment of new institutions. Examples of such actions in a variety of institutions were presented. One of these involved the need for up-grading the capabilities of professionals responsible for training (possibly through the establishment of associations for training and manpower development) who would then develop new and appropriate methodologies and organize group training programmes; special training for multi-disciplinary teams in the skills of technology selection, acquisition and adaptation was suggested; and the importance of inter-institutional linkages in technological manpower development emphasised.

74. During the discussion, the need for fundamental changes in educational systems to suit the African technological environment and to harmonize with development objectives was stressed. One participant pointed out the need to view technological manpower development as being closely related to the general enlightenment of society, since the masses should be the end users of technology.

The significant role that functional literacy could play in this respect was also pointed out.

75. The seriousness of the brain-drain of high level manpower in Africa was discussed and the need for continued political and developmental actions to alleviate this problem emphasized. Attention was drawn to UNDP's TOKTEN Programme and also to UNIDO's programme in Turkey aimed at reversing the brain-drain; African countries were advised to examine the possibility of pursuing similar actions.

76. It was pointed out that developing industrial technology manpower did not only refer to high-level manpower (scientists, engineers, economists, legislators, etc.) but also to middle level para-professionals and technicians of whom there is great shortage in Africa. In view of the high cost of technician training and the large numbers needed, a proposal was made for non-formal training of technicians in production enterprises, and UNIDO was called upon to take appropriate action, in co-operation with other concerned organizations, to develop modalities for this type of training, and to work out, with reference to Africa, the criteria and norms for the required numbers of technicians in certain industrial sectors.

77. Finally, it was pointed out that regional training programmes for helping small African countries to develop their human resources at all levels is of crucial importance.

78. The attention of the Symposium was drawn to UNIDO's efforts to prepare a directory of African experts and organizations involved in industrial technology and also to a draft OAU/UNIDO study on the development of industrial and technological manpower in Africa. The Manpower study would be widely circulated to all African countries and was intended to form the basis for a meeting of inter-governmental group of experts, which would be partly in preparation for African participation in UNIDO's Global Consultation Meeting on Industrial Training, as well as for identifying action to be undertaken by African countries, individually and collectively. The need for continuation of these efforts, leading to sustained and meaningful action, was stressed.

F. Intra-African Co-operation in Industrial Technology

79. Three documents were presented. The first,[10] prepared by the UNIDO Secretariat reviewed the antecedents and present situation in Intra-African technical co-operation up to the Nairobi meeting earlier this year.[11] It pointed out the inter-relation between self-reliance and co-operative efforts in promoting industrial technology in Africa and summarized the outcome of UNIDO organized meetings in New Delhi (1977),[12] Vienna [13] and New Delhi [14] in 1978, relating to the promotion of technological co-operation among developing countries. Noting that technical co-operation among developing countries is more advanced at the conceptual, philosophical and political levels than in operational terms, and taking into consideration the importance of political will, it pointed out the range of activities in which the African countries could co-operate, extending from the less committed exchange of personnel, through joint meetings, training courses and co-operative research programmes all the way up to jointly-owned production facilities. Specific action programmes based on the functions of industrial technology, the priority sectors of industry and instruments of implementation were proposed. It was pointed out that the starting point for the formulation of feasible programmes would be a thorough identification of the potentialities and complementarities of existing institutions and resources.

80. The second document, [15] presented by OAU, pointed out that the crucial role of industrial technology had been underscored in several African fora, citing as examples the "Addis Ababa Declaration on Industrial Development" and the "Cairo Declaration on Industrialization in Africa": "Principles and Guidelines for Co-operation and Development",

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10/ Inter-African Co-operation in Industrial Technology.

11/ UNDP Conference of Governmental Experts on Technical Co-operation Among African Countries, Nairobi, May, 1980.

12/ Round-Table Ministerial Meeting on Industrial and Technological Co-operation, New Delhi, January, 1977

13/ Meeting of Senior Officials and Heads of National Technology Registries in Developing Countries, Vienna, March, 1978

14/ International Forum on Appropriate Industrial Technology, New Delhi, 1978

15/ Intra-African Co-operation on Technology and the Role of the OAU.

the "Monrovia Strategy", and the "Lagos Plan of Action" adopted in April 1980, in which two chapters are devoted to the role of science and technology in development. Mention was made of co-operation with UN agencies in establishing regional technology centres and associations in Africa. Proposals for further action in promoting intra-African co-operation in the fields of technology were presented and the role of OAU in co-ordinating this co-operation and the initiatives taken by OAU outlined (see following section).

81. The Executive Director of the African Regional Centre for Technology presented the third document [16] dealing with Mobilization for Intra-African Technical Co-operation for Self-Reliance. He pointed out that the Symposium was unique in being one of the first gatherings after the Monrovia Strategy and the Lagos Plan of Action based on "collective solidarity for self-reliant development". This should make the deliberations more novel, concrete and action-oriented. He next cited the formidable impediments facing implementation and created by Africa's continued dependence, even after independence. Costly foreign life-styles that are consumption-oriented have not been matched by production skills and technological capabilities. Removing these endemic impediments called for continent-wide mobilization of mass awareness, based on self-confidence, knowledge of the great technological achievements of part African civilizations, as well as a true appreciation of Africa's immense reserves of natural resources. Awareness should be disseminated upwards to the political leaders, and downwards to the grass roots. He went on to identify two priority areas for co-operation, for example, energy and food. Statistical information on the contemporary African situation in food and energy production and mineral resources were presented and analysed. Particular emphasis was placed on the great potentialities of technological breakthroughs, particularly the role that technology in solar energy and microbiology could play in technological development in Africa. The programmes of ARCT were reviewed as also were

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15/ Intra-African Co-operation on Technology and the Role of the OAU.

16/ Mobilization for Intra-African Technical Co-operation for Self-Reliance.

the co-operation with other UN agencies in developing and implementing these programmes.

82. Several speakers underlined the great potential of industrial technological development in Africa and contrasted this with the lack of support to existing regional institutions. Various reasons, e.g. nationalistic considerations and economic pressures, were cited as causes for lack of sustained support.

83. Against examples of unsustained co-operation (e.g. East African Community), examples of meaningful and expanding co-operation (e.g. in Morocco and Tunisia; and Ghana, Ivory Coast, Togo and Upper Volta) were described. A call was made for further expanding such co-operation and for setting up systems for the joint acquisition of technology. Against the apparent lack of political will in some cases, the importance of linking up technological decisions with political will was emphasised. It was felt that the Monrovia Strategy and the Lagos Plan of Action present a new challenge to the technological community which needs new sustained political support and stability.

84. It was recommended that future co-operative programmes be based on positive national experiences, and that this called for substantial improvements in the flow of technological information of all types within a country and between countries, inspite of difficulties due to differences in language, poor communication facilities and the long distances involved.

85. The representative of the UNDP pointed out that Nairobi Recommendations 33 to 36 suggesting allocating 5-10 per cent of UNDP resources in Africa, both at the national and international levels, to financing of specific TCDC activities. He further indicated that UNDP was agreeable in principle to these recommendations.

86. There was concensus on the imperative need for monitoring the performance of mechanisms and modalities for translating good intentions into practical activities and analyzing successes and failures. UNIDO was called upon to undertake suitable action in co-operation with governmental and other UN agencies, particularly OAU, ARCT and UNDP to perform this function and to bring the results for discussion and initiation of effective remedial action.

G. Intra-African Co-operation and the Role of the OAU

87. The role of the OAU in promoting intra-African co-operation in the field of industrial technology received considerable emphasis from participants. The Symposium noted that despite the large number of Declarations by member-states concerning joint action programmes in the field of industrial development, in general, and industrial technology, in particular, very little concrete action was indeed taking place - a fact which is confirmed by Africa's share of world industrial output of only 0.9 per cent.

88. Referring to the document presented by the OAU Secretariat,[17] the Symposium picked out some of the more obvious factors which have combined to retard intra-African co-operation in the development of industrial technology. The Symposium noted that African Governments have on occasions not been fully aware of, or have preferred to ignore, the benefits of co-operating with one another in the establishment of joint industrial and technological institutions. Secondly, even in the extremely few cases where such multinational institutions have been established, they have not usually been provided with enough financial and other resources necessary to make their impact felt. The Symposium also took note of the large number of unnecessary barriers between countries and their negative impact on the free-flow of products, ideas and know-how, which effectively prevent the diffusion of technological knowledge already available to some member states.

89. In examining the various measures to be taken for promoting intra-African co-operation in the area of industrial technology, the Symposium was unanimous in its belief that the Secretariat of the OAU would have to take a leading role in promoting such co-operation. This, participants indicated, was very much within the scope of responsibility of the OAU, as contained in its Charter which includes, inter alia, co-ordination and harmonization of the policies and programmes of member states; mobilization of political will of member states for the carrying out of joint and common activities; taking initiative in promoting the collective undertaking of development projects involving more than one state; etc. The Charter thus gives

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17/ Intra-African Co-operation on Technology and the Role of the OAU.

the OAU Secretariat the mandate to undertake the promotion of concrete action programmes in the field of industrial technology as well as in the transfer of technology.

90. The Symposium felt that, while it was now up to each country to draw up national level plans and action programmes for promoting the development of industrial technology, the OAU Secretariat should monitor, co-ordinate and harmonize these national level policies and programmes for the benefit of the region as a whole, and called on member states to exercise the political will necessary for the realization of the objectives of technological progress.

91. The Symposium noted that a determined and united effort by the African countries, through the OAU, had already brought significant results in the struggle to achieve political independence for the African people. This same unity and determination must now also be channelled towards bringing technological self-reliance to the continent. The OAU Secretariat was requested to intensify its co-ordinating efforts to bring about this technological self-reliance. Such efforts should include co-ordinating all scientific and technological activities at the sub-regional, regional and international levels; organization of conferences, seminars and workshops in the field of industrial technology; monitoring and promoting the establishment of more training institutions and centres of excellence for industrial manpower development; supporting and strengthening regional institutions and centres already established to make them more responsive to Africa's needs. The OAU Secretariat was called upon to seek the support and co-operation of international organizations such as ECA, UNDP and UNIDO in carrying out these tasks.

92. The Symposium called on member states to strengthen the OAU Secretariat in order to enable it carry out the task of co-ordinating the promotion of industrial and technological development in the African region, and carrying out the various responsibilities relating to industrial technology assigned to it within the context of the Lagos Plan of Action.

H. The Role of UNIDO

93. Introducing the two documents on the role of UNIDO, 18,19/ the objectives, functions and organizational set-up of UNIDO were explained, with special emphasis on its promotional activities in the field of industrial technology. It was pointed out that UNIDO has been co-operating with ECA and OAU and has provided expert assistane in preparation of the programmes of ARCT.

94. UNIDO's technical assistance to developing countries was of the order of $70 million in 1979 of which some $17 million had been spent in Africa. Technical assistance was rendered, inter alia, to strengthening institutional infrastructure including technological institutions, manpower development, the development and transfer of technology in specific industrial sectors, and the formulation of national policies in the field of technology. The field experience acquired through technical assistance activities invested UNIDO's promotional activities with a strong bias towards practical actions in line with the field conditions.

95. UNIDO's activities in the development and transfer of technology have endeavoured to maintain a balanced approach that combines concerns of the productive sector and autonomous actions dealing with technology as an all-pervasive factor. It has also endeavoured to keep in close touch with field experience at the national and regional levels and to link up with other aspects of industrialization (such as investment, training, feasibility studies, etc.) as well as with overall development.

96. As examples of programmes in the field of policy and planning, the cases of Cameroon, Egypt, Ghana and Tanzania were mentioned. In technology transfer, UNIDO has been mobilizing national effort and sensitising decision-makers and specialists by demonstrating new ways for effective and fair transfer. Programmes for reviewing cost and conditions of acquisition were carried out in, among other countries,

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18/ The Role of UNIDO in Industrial Technology.

19/ Strengthening of Technological Capabilities of Developing Countries : The Role of UNIDO, ID/CONF. 4/7

Algeria and Egypt. The last meeting of TIES members was attended by five African countries. Training workshops for strengthening negotiating capabilities have been conducted in a number of countries including a recent one in Cameroon and publications in this regard brought out.

97. As a follow-up to the International Forum on Appropriate Industrial Technology, UNIDO has undertaken a publications programme which has included technical memoranda and manuals on the identification and evaluationof alternative technologies. Promotion of R and D projects included one on a prototype for a small scale rice bran stabilizer and a pilot plant production of ethanol from cellulose by enzymatic action. The impact of technological advances on developing countries is being studied and feasible programmes for effective actions in preparing for such advances are being formulated. An inventory of R and D institutions in Africa involved in adaptive research is under preparation.

98. Within the scope of strengthening technological capabilities, mention was made of the Technology Services Delivery System (TSDS) in the Philippines, the plant-level co-operation programme between small and medium size industrial enterprises in developed and developing countries (in which Kenya and Egypt would participate), the scaling down of metal production units to suit conditions in least developed countries of Africa, and the development and use of mini hydro-generating units.

99. UNIDO's on-going advisory services, particularly in negotiating technology contracts, and its industrial information services were also reviewed briefly.

100. During the discussion, the cellulose project was commended as a good example of a practical demonstration of the value of new technologies to developing countries.

101. Participants expressed the wish that more African experts be involved in UNIDO field activities in Africa, particularly for short-term consultations and that the joint UNIDO/UNDP/OAU/ARCT directory of African technology experts and institutions be completed and published as soon as possible.

The meeting was informed that it had always been UNIDO's policy to encourage the use of experts from the developing countries whenever possible. Participants were urged to submit names of qualified Africans for consideration for assignment as UNIDO experts or consultants, and to recommend the approval of African experts by their governments.

102. One participant felt that some African countries do not benefit to the same extent from UNIDO's activities as some others do and a call was made for widespread UNIDO activity in Africa during the African Industrial Development Decade. Special emphasis was recommended in the following areas:

- manpower development through regional training courses offered regularly in African centres of excellence;
- a massive effort in the field of industrial and technological information in the form of a long-term carefully structured set of programmes;
- a joint UNIDO/UNDP exercise in studying and evaluating the situation in regional industrial technology institutions in the African region as a follow-up to the joint study of national industrial research institutions;
- the development of appropriate technologies through pilot plants and demonstration projects, and the upgradation of indigenous technologies and the dissemination of results.

PART TWO

INDUSTRIAL TECHNOLOGY IN AFRICA: TOWARDS AN INTEGRATED APPROACH

INTRODUCTION

Industrial Development in the Context of the Monrovia Declaration

1. The role of industry as a dynamic instrument of socio-economic development has always been prominent in the thinking of African decision-makers. As far back as 1971, the Addis Ababa Declaration on Industrial Development in Africa adopted by the First Conference of African Ministers of Industry expressed its faith in industrialization as a strategic element in the structural transformation of African economies.

2. The guiding principles of the strategy for the African Region in the Third United Nations Development Decade, as enunciated in the Monrovia Declaration (1979) give second priority, after self-sufficiency in food, to "the establishment of a sound industrial base with special emphasis on the development of the requisite national industrial and technological policies, capabilities and institutional infrastructure, as well as intra-African co-operation in order to permit the industrial take-off of Africa".[1/]

3. The Heads of State and Government of the Organization of African Unity (OAU) committed themselves in the Monrovia Declaration to, inter alia, "the development of indigenous entrepreneurial, technical manpower and technological capacities" to enable the African peoples to assume greater responsibility in achieving rapid industrialization.

UNIDO III and the African Industrial Development Decade

4. In response to the decision of the African Heads of State and Government, the Third General Conference of UNIDO (1980) recommended to the UN General Assembly that the 1980s be declared as the African Industrial Development Decade.[2/] This would enhance awareness among the African countries of the need to accelerate the industrialization process; mobilise the entire African population to participate fully in the industrialization effort and ensure greater technical and financial support from the international community for industrial development in Africa.

1/ Monrovia Declaration of Commitment of the Heads of State and Government of the Organization of African Unity on Guidelines and Measures for National and Collective Self-reliance in Social and Economic Development for the Establishment of a New International Economic Order (AHG/ST.3(XVI)Rev.1).

2/ ID/CONF.4/22, pp. 59-60.

Plans and Programmes for Action:

5. The Council of Ministers of OAU in its Fourteenth Extraordinary Session in Lagos. 21-25 April 1980, formulated a Framework for A Programme of Action for the African Industrial Development Decade (1980-1990).[3] The programme of action deals, inter alia, with industrial strategies, policies and plans; industrial and technological manpower; development and transfer of industrial technology and industrial co-operation among African countries.

6. The Plan of Action for the Implementation of the Monrovia Strategy for the Economic Development of Africa adopted by the Heads of State and Government in their Second Extraordinary Session held in Lagos, 28-29 April 1980, calls, amongst many other things,"for the Establishment or Strengthening of national machinery for the establishment of industrial policies and instruments",[4] "a consulting engineering and management institution" as well as "a standards and quality control institution".[5]

7. The Lagos Plan of Action also contains detailed and wide-ranging recommendations in the field of technology. What is important now is to operationalize those recommendations, keeping in mind their dynamic interrelation to the productive sectors and using the cause and effect relationship between industry and technology in a manner that will accelerate the growth of both.

8. There is a close interrelationship between industry and technology in general. Perhaps no other single branch of economic activity influences or gets influenced by technology more than industry. Industrial development often paves the way for the initial technological development of the country and thus contributes to the development of skills. Further the application of technology in other sectors often requires the manufacture of products on an industrial scale and may determine the technology to be adopted for such manufacture. Nowhere are the ramifications of technology transfer and development more apparent than in the field of industry.[6]

3/ Organization of African Unity, ECM/ECO/6 (XIV).

4/ ECM/ECO/9(XIV) Rev.1, p.71, "Programme Element 6.2"

5/ Ibid., p.72, "Programme Element 6.2(ii)"

6/ ECM/ECO.9(XIV) Rev. 1, p. 58, Programme Element 3.

The Joint OAU/UNIDO Symposium on Industrial Technology for Africa

9. It is in this context that UNIDO, in co-operation with the Organization of African Unity (OAU), is organizing the Symposium on Industrial Technology for Africa with the aim of developing operational measures for implementing the decisions, recommendations and action programmes embodied in the Lagos Plan of Action in the field of industrial technology. The Economic Commission for Africa (ECA) and the African Regional Centre for Technology (ARCT) are also collaborating with UNIDO in organizing this Symposium.

10. The three key areas of technological development that have a marked impact on the building of a sound industrial base are:

(a) Technology policy and planning;
(b) Technological infrastructure;
(c) Technological co-operation.

Among them, they cover the critical aspects of the industry technology nexus leading to action across all sectors of priority. They are the major instruments for the development of national technological capabilities. Identifying feasible and effective operational measures in these areas will be a positive contribution towards fulfilling the programmes for African technological development.

11. The Symposium will thus examine and discuss in specific terms a variety of actions and propose those most effective, within the realities and constraints of the African industrial scene, in moving towards the full implementation of the tasks ahead. The Symposium will propose methods for integrating them into individual national technology development policies and plans, thus enabling African countries to identify the most suitable starting points for action and to select the most appropriate actions for attaining their objectives in the context of their own particular situation.

12. In examining ways and means suggested for operationalizing the decisions, recommendations and programmes of action in the field of technology, consideration has to be given to the main elements of a technology development and transfer programme as well as the policy elements that need to be adopted at the national level in order to accelerate the process of endogenous technological development in African countries. Particular emphasis will need to be placed on the overall policy framework, infrastructural arrangements and linkages, and development of manpower capabilities. The documents for the Symposium present some illustrative models or options for action

in respect of each of the other agenda items. It is hoped that other examples and illustrations presented by the participants during the discussions could lead each country, in keeping with its level and path of development, to adopt the approach most suited for effective implementation of action programmes. Measures for promoting collective self-reliance in the field of industrial technology through the strengthening of technological capabilities and ensuring they are utilized to the maximum extent possible in the development effort could then have a more concrete basis. The promotion of further co-operation among the African countries in the field of industrial technology in fulfillment of the recommendations of the Lagos Declaration and Plan of Action will be discussed and appropriate measures identified, including the role of the OAU, UNIDO and external assistance and taking into account the variations of conditions in African countries.

13. It is hoped that on the basis of the material provided, the discussions and recommendations of the Symposium will be oriented towards enabling each African country and the region as a whole to arrive at the broad approach and the substantive content for an action programme most suited to local requirements and the development objectives in view.

THE AFRICAN INDUSTRIAL SCENE

Some basic facts

14. Africa's share in world industrial production now is a mere 0.9 per cent. Its share of the Lima target amounts to only 2 per cent. Although this figure is extremely modest for a region endowed with enormous natural resources and potentially large markets, the value added in the manufacturing sector in the African region would have to grow at the rate of 11.3 per cent per annum in order to meet the Lima target. Yet, during the 20 years between 1955 and 1975, the manufacturing value added in the African region grew only at the average rate of 7.3 per cent per year and the overall average economic growth rate of GDP achieved during the same period was just 4.9 per cent. Thus for each individual country and all African countries collectively the effort required to reach the 11.3 per cent minimum rate of growth is immense. Very few African countries have been able to achieve such a high rate of growth over the past years.

15. Sixty to 90 per cent of the labour force and around half of the national output in Africa is in agriculture; yet Africa's self-sufficiency ratio in food production and local processing and preservation of agricultural produce declined from 98 per cent in 1962-1964 to 90 per cent between 1972-1974. Moreover the average annual rate of food production per capita which had been approximately stable, fell by 1.4 per cent a year between 1970-1977. This draws attention to the complementarity between industrialization and the development of agriculture in Africa, which has to be borne in mind in planning industrial development.

16. Africa's share in world output in the leading sectors of metal and engineering products remained unchanged at 0.2 per cent between 1955-1970. The share of metals and engineering products in total industrial production seems to have declined. Africa has the lowest ratio of engineering production to engineering imports of all developing regions. Yet the growth rate of heavy industry has risen by 9.3 per cent yearly while that of light industries has increased by a mere 4.1 per cent yearly.

17. Employment in manufacturing has also grown more slowly than manufacturing value added because of the manufacturing industry becoming more capital intensive. Africa's trade in manufactures continues to be characterized by a large and increasing imbalance of imports over exports.

18. If these trends continue, per capita GDP in Africa will be considerably below that of South and East Asia while the region's per capita manufacturing output will be less than one half that of other regions.

19. There are considerable differences in the state of industrialization in Africa. Table 1 gives some industrialization indicators for individual African countries. Twenty-two, out of a world total of about 30, are classified as non-industrialized countries in which manufacturing is concentrated in a handful of factories producing mainly construction materials, textiles, footwear and processed food. Another 19 fall in the middle bracket of industrializing countries. They also show marked differences in the level of industrial activity.

20. The value added in manufacturing (MVA) varies from more than three billion dollars to a few millions, even though some figures include the elements of the extractive and service sectors for a number of countries. Only in six countries does contribution of MVA to GNP exceed 20 per cent.

In seven others, the contribution of MVA is less than 8 per cent of GNP. During the period 1970-1976, MVA grew at widely varying rates from country to country. In Africa, negative rates of MVA growth co-exist in some countries together with rather high positive rates in others.

21. These wide differences can be related to historical antecedents and time horizons in overall development, and in industrial development in particular. Yet, they also reflect the considerable variations in endowments of material and manpower resources. Populations vary from just over half a million in one country to close to eighty million in another. Coupled with this, discrepances in natural resources account for the variation in per capita GNP, from around US$2,500 to as little as US$100.

22. The sectoral composition of African industry is reflected in table 2, which lists the major industrial sectors in 22 African countries, as well as their share in total MVA. Food, beverages and textiles predominate.[1/] The low contribution of the industrializing industries is particularly striking and significant in the context of self-reliance in industrial technology.

23. Until quite recently, the involvement of Africa in industrial development has been marginal. It was left mainly to foreign capital and to expatriates to staff industrial enterprises. It was based on importation of plant, equipment and even skilled manpower. It catered mainly for urban populations and seldom for the rural and less affluent sectors of society. African governments had little control on the flow of capital or equipment or the choice of product.

Constraints and problems

24. While it may be claimed that this unsatisfactory level of industrial development is largely due to inappropriate actions in the past based on certain conceptions and approaches that have now come to be recognized as inadequate, other constraints too have played a role in limiting the nature and magnitude of industrial development in Africa. Those imposed by the existing international economic order as well as geopolitical and global problems are being addressed by the Heads of State and Government and do not fall immediately within the scope of the deliberations of the Symposium, even though they will always influence them, particularly in connexion with the flow of external assistance. But, constraints within the national and regional frameworks must be taken into consideration.

1/ It is worth noting here that some of the products in these industries, for example soft drinks with brand names, do not seem to reflect a high priority need in African development today.

Table 1: Industrialisation Indicators for Individual African Countries, by Stage of Industrialization, 1976

Country or area	Population (millions)	GNP: Per capita (dollars)	GNP: Average annual growth rate, 1960-1975 (%)	Value added in manufacturing: Total (millions of dollars)	Value added in manufacturing: Per capita (dollars)	Value added in manufacturing: Average annual growth rate (constant prices), 1960-1976 (%)	Value added in manufacturing: As percentage of value added in commodity production	Percentage of GDP: 1960	Percentage of GDP: 1976	Manufacturing exports as percentage of total exports (%)
A. Industrialized countries and areas										
Developed										
None in Africa										
Transitional										
Africa (south of Sahara)										
Zimbabwe	6.53	550	2.4	851[a/]	135[a]	-	44.2[a/]	16.7	24.8[a/]	
B. Semi-industrialized countries										
None in Africa										

continued ...

Table 1 (contd.) **Industrialization indicators 1976** *(continued)*

Country or area	Population (millions)	GNP: Per capita (dollars)	GNP: Average annual growth rate, 1960-1975 (%)	Value added in manufacturing: Total (millions of dollars)	Value added in manufacturing: Per capita (dollars)	Value added in manufacturing: Average annual growth rate (constant prices), 1960-1976 (%)	Value added in manufacturing: As percentage of value added in commodity production	Value added in manufacturing: Percentage of GDP: 1960	Value added in manufacturing: Percentage of GDP: 1976	Manufacturing exports as percentage of total exports (%)
C. Industrializing countries										
Northern Africa										
Algeria	16.23	990	1.8	2 027	125	9.1	20.4	10.4	13.0	-
Egypt	38.07	280	1.5	3 329	87	5.1	40.9	20.1	23.9	24.5
Morocco	17.20	540	1.9	1 021	59	4.8	23.7	12.1	12.4	12.5
Tunisia	5.73	840	4.1	431	75	9.8	21.5	-	10.8	25.6[d]
Africa (south of Sahara)										
Central African Empire	1.83	230	0.4	89	49	5.8	31.1	5.7	22.9	23.7[a/g]
Congo	1.36	520	2.9	93	68	8.7	46.3	8.2	13.0	8.0[e]
Ghana	10.14	580	-0.2	1 973	195	3.0	33.5	9.8	24.8	1.4[e]
Ivory Coast	7.03	610	3.5	551	78	9.9	26.3	7.1	11.8	7.0
Kenya	13.80	240	3.2	362	26	9.7	22.1	9.4	12.1	12.8[e]
Madagascar	9.11	200	0.1	341	37	3.0	37.5	4.1	18.5	9.2[e]
Malawi	5.17	140	4.1	105	20	12.4	23.0	5.8	13.5	3.9[e]
Mali	5.84	100	0.9	66	11	6.4	19.9	4.7	10.9	11.1[e]
Mauritius	0.89	680	0.8	99	111	2.8	33.2	13.1	19.1	11.0[a]
Nigeria	77.05	380	3.4	2 395	31	10.4	11.0	4.8	7.9	0.2[a]
Senegal	5.13	390	-0.7	491	96	5.1	46.3	12.4	23.8	21.5[a]
Swaziland	0.51	470	6.8	52	103	15.0	36.4	5.3	24.1	-[h]
United Rep. of Cameroon	7.07	290	3.0	324	46	8.0	25.9	-	13.5	10.5[a]
Upper Volta	6.17	110	0.7	82	13	5.6	27.1	7.9	13.8	6.0[a]
Zambia	5.06	440	2.0	413	82	8.0	32.8	4.0	17.8	0.4[a]

Table 1 (contd.) Industrialization indicators 1976 *(continued)*

Country or area	Population (millions)	GNP: Per capita (dollars)	GNP: Average annual growth rate, 1960-1975 (%)	Value added in manufacturing: Total (millions of dollars)	Value added in manufacturing: Per capita (dollars)	Value added in manufacturing: Average annual growth rate (constant prices), 1960-1976 (%)	Value added in manufacturing: As percentage of value added in commodity production	Value added in manufacturing: Percentage of GDP: 1960	Value added in manufacturing: Percentage of GDP: 1976	Manufacturing exports as percentage of total exports (%)
D. Non-industrialized countries										
Africa (south of Sahara)										
Angola •	5.47	330	3.6	168[a]	31[a]	7.6	9.4[a]	4.3	5.3[a]	9.4[d]
Benin	3.20	130	-0.3	51	16	6.0[c]	19.1	-	10.1	17.9[d]
Botswana	0.68	410	6.0	16	23	5.5	13.6	8.1	5.4	-[h]
Burundi	3.81	120	2.7	26	7	12.7	13.1	-	10.1	1.2[d]
Chad	4.12	120	-1.1	45	11	2.3	14.6	4.5	9.6	3.2[d]
Ethiopia	28.68	100	2.0	275	10	7.6	15.8	6.1	10.3	1.3[a]
Equat.Guinea	0.32	330	-0.9	-	-	8.5	-	-	-	-
Gabon	0.54	2 590	5.0	105	194	-	14.9	6.1	7.4	4.8[f]
Guinea	5.69	150	0.2	-	-	17.8	-	-	-	-[h]
Lesotho	1.24	170	4.6	2	2	17.8	5.4	-	2.4	1.0[d]
Liberia	1.60	450	1.8	36	22	12.2	7.6	-	5.3	3.3[d]
Mozambique	9.46	170	2.0	314[a]	34[a]	8.5[c]	20.1[a]	7.7	12.0[a]	8.4[a]
Niger	4.73	160	-1.3	99[a]	23[a]	12.5[c]	25.8[a]	4.4	16.4[a]	14.6
Reunion	0.50	1 920	3.9	-	-	-	-	-	-	-
Rwanda	4.21	110	0.5	29[d]	7[d]	7.0	13.5[d]	0.7	10.0[d]	62.8[g]
Sierra Leone	3.05	200	1.5	30	10	2.3	13.8	-	-	0.6[d]
Somalia	3.25	110	-0.3	25[a]	8[a]	16.8[c]	20.9[a]	2.4	8.3[a]	0.1[a]
Sudan	15.88	290	0.1	397[a]	26[a]	1.9[c]	17.0[a]	4.7	9.7[a]	3.2[d]
Togo	2.28	260	1.4	63	28	6.7	30.0	7.7	10.6	3.6[a]
Uganda	11.94	240	1.0	176	15	1.9	10.7	8.8	6.7	11.9[a]
United Rep. of Tanzania	15.13	180	3.0	244[a]	16[a]	8.5[c]	17.0[a]	5.1	10.3[a]	2.0[a]
Zaire	25.39	140	1.6	210[a]	9[a]	8.0[c]	21.5[a]	13.2	10.0[a]	

a/ 1975; b/ including Botswana, Lesotho, Swaziland and Namibia; c/ 1960-1975; d/ 1974; e/ including mining, electricity and construction; f/ 1973; g/ mostly diamonds; h/ included in South Africa

Source: Helen Hughes, "Industrialization and development: a stock-taking, Industry and Development, No. 2, 1978.

Table 2: Major industrial sectors in 22 African countries 1970, with shares in total manufacturing value added (percentages)[a/]

Country	Major sectors (with shares in MVA)[b/]
Burundi[c/]	Beverages (46), clothing (16), metal products except machinery (15), food (14)
United Rep. of Cameroon[c/]	Food (30), non-ferrous basic metals (17), beverages (12)
Congo	Beverages and tobacco (20), petroleum refining and products (18), food (16)
Egypt	Textiles (32), food (10)
Ethiopia	Textiles (28), food (27), beverages (16)
Ghana	Petroleum refining (15), textiles (11), food (11), non-ferrous basic metals (11), beverages (10)
Kenya	Food (19), transport equipment (11)
Libya	Tobacco products (44), food (14), other chemical products (11)
Madagascar	Food (29), textiles (20)
Malawi	Food (22), beverages (17), tobacco products (12), textiles (11)
Mauritius	Food (61)
Mozambique	Food (36), textiles (11)
Nigeria	Textiles (24), beverages (15), food (12)
Rwanda	Food and beverages (89)
Somalia	Food (89)
Zimbabwe	Food (12)
Sudan	Textiles and clothing (27), food (21), beverages (14)
Swaziland	Wood, wood products and furniture (57), food and beverages (37)
United Rep. of Tanzania	Textiles (22), food (21)
Togo	Textiles (37), beverages (33), food (20)
Tunisia	Food (19), industrial and other chemical products (13)
Zambia	Beverages and tobacco products (41), food (14)

a/ Major sectors defined as accounting for at least 10 per cent of total MVA (1970).

b/ Precise sector definitions are based on the ISIC classification.

c/ Refers to shares of output.

Source: UNIDO, Recent Industrial Development in Africa, (UNIDO/ICIS.117), 6 August 1979.

25. In general, like all developing countries the major problems of African countries mainly relate to:

(a) Lack of a well-developed industrial environment. In most African countries, industrial technology is still part of an imported culture. Industrial development is generally at an embryonic stage. It lacks sufficient basic facilities such as fiscal and tax incentives on the one hand, and the energy and infrastructural services to encourage investment by entrepreneurs on the other. No substantial sector of the community has a vested interest in industry. The establishment of industries has largely been in the hands of foreign elements using their technologies and personnel.

(b) Inadequate industrial planning, programming and evaluation. In most African countries, local technological institutions, where they exist, are generally not called upon, nor do they succeed in seeking to play a significant role in development. There is, nowadays, an increasing movement in Africa towards establishing national technological institutions and developing various indigenous technological expertise for initiating industrial projects and programmes. Yet, there is nevertheless a lack of evaluation systems for assessing on-going production, market and technological trends; identifying changes arising from revised national and sectoral plans; and providing technical information and data required for assessing short- and long-range industrial and economic trends of the country and the changing needs of industry. There is little systematic effort to analyse past successes and failures in depth and to learn from them.

(c) Lack of well-defined national technology policies and plans. Only very little attention has so far been given to preparing technology plans and programmes as well as determining the technological manpower required to implement the industrial and economic plans at the overall, sectoral, and even sub-sectoral levels. This is directly related to the fundamental issue of development strategy of the country and its efforts to seat new development alternatives.8/

8/ See document Action in the Field of Technology Policy and Planning in Africa prepared for this Symposium.

(d) Underdeveloped national machineries and institutions for industrial and technological research and development. Also related to this problem is the lack of a national system in most African countries capable of the economic exploitation of industrial and technological research and development results. According to "Science and Technology in African Development", there are 355 industrial research institutions in Africa. 9/ While in some countries, some of these institutions fulfil important functions, in most countries where they exist, their role is still limited, excluding especially such areas as technological planning and forecasting, project identification and evaluation and project and engineering design, and implementation. It is in these stages that the basic decisions concerning design, development or selection of appropriate technologies are made.

(e) Underdeveloped national machineries and institutions for the selection, evaluation, acquisition and transfer of industrial technology. In their efforts to industrialize, African countries have been relying heavily on imports of technology, almost wholly, from developed countries. In spite of this dependence, African countries, on the whole, lack the machinery and institutions for the selection, evaluation, acquisition and transfer of industrial technology. They are therefore in a weak negotiating position due mainly to their lack of sufficient and precise information on various aspects of technology transfer. Africa still lacks machinery for developing capacities and capabilities for absorbing and upgrading technology. It consequently has to resort to massive imports of equipment connected to large turnkey projects which essentially involve the purchase of the products of off-the-shelf technology and know-how with little or no involvement of national elements and no acquisition of technological know-how or accumulation of experience.

9/ UNESCO document SC/CASTAFRICA/3, para 62.

(f) Inadequate allocation of funds. While African countries have invested significant funds, both from local and external sources, in establishing industries, an almost insignificant amount has been allocated for developing the necessary technological capacities, manpower and institutions to ensure not only a smooth operation of these industries but also their integration in economic development. The importance of long-term investment required for acquiring the software of technological activities and institutions has not been recognised by decision-makers in most African countries. Funding has been mainly allocated for hardware and materials.

(g) Shortage of technological manpower. The shortage of skilled technological manpower has placed serious constraints on development. There is a general lack of correlation between skill requirements and the training provided. The present educational system does not permit an appropriate development for technologists. Universities need to take practical measures to diversify their course options so as to reflect the actual needs of the economy. Many African countries do not have adequate training facilities to train technicians. This has resulted in shortages of, for instance, fitters, machinists, welders, electricians, carpenters and pattern-makers, required especially for industrial production, quality control and for the installation, smooth operation and maintenance of industrial machinery and equipment. The limited number of technological personnel, especially high-level personnel, continues to migrate internally to the commercial and business communities or, worse still, to other countries, particularly industrialized ones where better conditions exist. In terms of the number of scientists, engineers and technicians, a majority of African countries possess only about a half to one third of the corresponding numbers (per size of population) in Asia and only one thirtieth of those in Europe. Further, only a few African countries have so far achieved the target laid down for the Second United Nations Development Decade in the World Plan of Action (200 research workers per 1 million inhabitants by 1980).[10/]

10/ See tables in document on Industrial Technology Manpower in Africa prepared for this Symposium.

(h) Lack of suitable industrial and technological information systems. In most African countries, there is a general lack of industrial and technological information, data and statistics, without which planning and forecasting the development of relevant sectoral and national targets is impossible. To a great extent the weakness in most African countries in the area of technology policy formulation, planning, programming and institutional development is a reflection of the weakness of the industrial and technological information structure and expertise. The problem is particularly acute with regard to knowledge and information on alternative sources of technology and the existence of alternative technologies in various fields. At the national level, there is little information on the existing technological capability of the country, in terms of both manpower and institutions. At the subregional and regional levels there is a lack of information channels for the dissemination of the achievements in various technological activities; although there have been some attempts to communicate with similar regional institutions at the sectoral level.

The need for co-ordinated and effective external assistance

26. Although the external assistance for Africa in technological development falls far short of her needs and what is her due, it is even doubtful whether whatever assistance that has been accepted has been given to the right project or has produced optimal results. More often than not, the assistance has been proposed by the donor, rather than given in response to a well-defined need by the recipient. The institutions administering aid do not always succeed in making the best use out of it. A well-defined national policy for development would contribute greatly to improving the benefits from external aid and would, in all probability, generate more assistance. While the disadvantages and inequities of foreign technology (and capital) transactions have now come to be analysed and generally appreciated, little systematic attention has been paid in Africa, or indeed elsewhere, to optimizing the benefits of external assistance and minimizing whatever adverse effects it may have. Generally speaking, Africa needs a clear strategy in accepting and administering external aid. Since this will probably continue to play a prominent role in development and in industrial technology in particular, the subject is dealt with in a separate document.[11/]

11/ See document The Role of External Assistance in African Technological Development: Potential and Limitations prepared for this Symposium.

GENERAL CONSIDERATIONS

27. The application of science and technology for development is a means to an end, the end being the development goals of each country.[12] To achieve these goals the pattern of industrial development, as outlined above, would need to combine a rapidly growing modern industrial sector, side by side with a sound and efficient decentralized industrial sector. Concomitantly, the pattern of industrial technologies to be applied should combine the access to, and the application of, modern and large-scale technologies, with the use (after upgrading, if need be) of technologies more suited to the requirements of the decentralized industrial sector. Only such a reoriented pattern of application of science and technology can enable accelerated industrial growth of a nature consistent with over-all development goals and the achievement of the Lima target.

28. Thus the vital need for integrating science and technology in economic and social development through linkages with development goals is, in a sense, more important and fundamental than the mere consideration of mechanisms to be employed to promote transfer of technology and technological development. A key element in the process of integrating industrial technology with industrial development is the stimulation of interest and the sensitization of all partners and decision-makers in the process of industrial development. It is largely through such integration, both conceptually and in practical terms, that the application of industrial technology can make the most effective contribution to industrial and economic development.

29. It is largely within the framework of such basic considerations that science and technology can be applied realistically and effectively. To promote such application of technology, three major elements have been identified for the purpose of national and international action. First, the linkage of technology to industrial development, and through industrial development to overall development goals, will be successful only in the context of the formulation of relevant policy measures by the national governments; technology policy and planning therefore become important elements. Second, the development of technological capabilities in each country is a prerequisite for the selection, acquisition, adaptation, absorption or development of industrial technology. This involves, among other things, access to relevant information, the building up of technological

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12/ See the document Action in the Field of Technology Policy and Planning in Africa prepared for this Symposium.

institutions and the training of industrial and technological power. Another element is the appropriate choice of technology, since inappropriate choice will not only be expensive but will also distort the pattern of development.

30. In fact, it is in the area of policy and planning, manpower and institutions for industrial technology that the core of the discussions of the symposium lies. Each of these key areas is dealt with in separate documents.

31. With the wealth of conceptual studies of the problems in hand and with a target clearly defined by the Monrovia and Lagos Declarations, what is needed now is action. The discussion will no doubt help to identify possible alternatives for feasible and meaningful actions that could be started now, within a well-defined framework of what should follow. Many promising initiatives have failed in the past because interest has waned too quickly and the quest for quick results has overshadowed the imperatives of long-term action based on a solid foundation. There is an obvious need for planned and integrated action within the limits of the availability of resources, the time span envisaged and the degree of political support.

32. Furthermore action must not be spread too thinly across the board. There is no choice but to be selective and to set priorities; what those priorities are will be the choice of each country. This is the most crucial part of the exercise and it merits the maximum possible attention and careful consideration.

33. Finally, it is important to make a distinction between science and technology. Science is the "know-why" and technology is the "know-how". Over the last few centuries industrialized countries have achieved a very close and fruitful link between the two. This is not yet the case in Africa. In fact, the establishment of this effective twinning will be one of the hallmarks of development.

34. The working documents of the symposium present each of the topics to be considered; but they offer no ready-made solutions. They simply describe the problem in what is hopefully a meaningful way, relevant to action. They indicate points for discussion and outline some options. The wealth of experience of the participants will clarify what each of them entails, its prerequisites, and its chances of success or failure in Africa today. Other options for action will no doubt also be proposed

and reviewed. It is felt that this will help each African state to decide, in the light of the discussion and its specific conditions on the course of action to take at the national, subregional, regional and international levels in achieving the aims of developing industrial technology. The African and international agencies will, by the same token, be better placed to structure and implement actions in support of African national and regional programmes in developing industrial technology capabilities in the continent.

AN APPROACH TO ACTION-ORIENTED PROGRAMMES

35. The wide-ranging actions recognized by African governments to be necessary in the field of technology call for a systematic approach which should correspond as closely as possible to the specific African conditions and the priorities arising therefrom. The major elements of such an approach could be identified through a broad exercise in matching the demand for industrial technology in Africa with the available supply, in order to locate those key areas of action which will have a maximum impact.

36. The demand for industrial technology and technological products is ultimately decided by the development goals of the country. Technology policy is a derivative of the industrial development strategy, which itself has to be derived from the overall development goals of the country.[13/]

37. The priorities of industrial development in Africa have been identified and approved in Monrovia and Lagos. In almost every one of the sectors identified,[14/] the range of technological options, in

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13/ A/CONF.81/BP/UNIDO

14/ viz. Food and agricultural industries, building materials and construction industries, engineering industries, metal industry, chemical industry, forest-based industries, energy industries.

products or technologies is remarkably wide in Africa today. Not many African countries are historically committed to particular technologies. This is an advantage as well as a potential point of vulnerability.

38. It is necessary for the African governments to take note of the technological options available in the priority sectors. Some illustrations are provided here in this regard. In the food industry sector, a number of options are available in the areas of preservation, processing and packaging including several technologies available in the African region itself in the form of traditional methods which could be upgraded and provide more viable alternatives in terms of local consumer preferences than those imported from abroad incorporating different life-styles. In the agro-industries sector, wide choices are possible in the field of agricultural implements and machinery and in the processing of agricultural products as well as of livestock and fisheries. In the case of pesticides, while formulation of technical ingredients could be undertaken, the feasibility of using local materials, such as pyrethrum, could be explored simultaneously. In regard to fertilizers, while the manufacture of synthetic fertilizers would call for large-scale plants and correspondingly large-scale markets, the manufacture of fertilizer mixtures could be undertaken locally and the use of natural fertilizers, such as biomass, could be increased. While a number of traditional technologies in the field of agro-industries could be improved, export-oriented technologies may have to be adopted for the processing of export crops, such as cocoa and palm. In regard to engineering industries, the areas of concern in the beginning are more likely to be maintenance, repair, metalworking and manufacture of tools, implements and spare parts. Here again, there is ample scope for technological choices and these have to be exercised in such a manner that the engineering industries provide the skills necessary for technological development and also enable the gradual disaggregation of technology or equipment packages. In the field of small-scale industries, the size of the markets for certain products in several African countries is such that small-scale units will be the only viable option and the question of choosing between large and small-scale industry units may not arise. Such "non-competing" groups of small-scale industries can be identified and promoted. In the field of energy, in view of the distances and terrain

to be covered and the limited demand for electrical energy in the initial years of development, mini hydro generating units may present a viable alternative and sometimes the only method of providing electrical energy in certain areas.

39. While the demand for technology is identified for each of the priority sectors within the development strategy of the country and the product mix derived from the desired life-style and consumption pattern, investigation on the supply would need to cover the country's stock of institutions, manpower, information, experience, know-how and infrastructural facilities that together form the capacity of the country to select products, technology and equipment wisely, to control effectively their inflow and to stimulate the widest possible utilization of endogenous creativity and traditional technology. The above is essentially a transdisciplinary task which calls for an integrated systems approach involving all institutions and individuals taking part in implementation. Isolated, unco-ordinated action, as well as action without at least a framework of basic guidelines, if not a plan, would not lead to the desired goals. It is realized that the pattern of joint multidisciplinary action is without strong historical roots in developing countries. It will call for patient determination and mutual understanding and respect on the part of all involved.

40. With this approach in mind, the documents presented for discussion of each item of the agenda have attempted a rough diagnosis of the common features of the African industrial technology scene, looked into past experience and present problems and sketched some models and options for action in enhancing indigenous capabilities in industrial technology, both in the long- and short term perspectives. The main ideas for immediate action which emerge are briefly summarized here.

41. In the field of industrial technology policy and planning it is realized that it may not be possible to embark immediately on the drafting and implementation of comprehensive technology plans. Yet, every country should have a basic "tool box" of policy guidelines and ongoing programmes in industrial technology matters.

42. By way of immediate tasks, the initial step in technology planning cannot avoid being one of collecting and bringing together an aggregate of relevant programmes in specific sectors. In regard to technology policy the first priority would be to integrate such a policy with the basic development strategy and the monitoring of action at the national level in close association with development policy-making. In addition an assessment of both the existing technological policies and the ostensibly non-technical or implicit policies, such as the relevant fiscal, monetary, trade and industrial policies should be made in order to see how far they are consistent with the objective of technological development and the overall development objectives. The field of technology imports may require special watch in regard to both technologies and equipment in order to see that such imports contribute to the growth of production and the fulfilment of development objectives. Since, as of now, most industrialization programmes in Africa are based on import of technology or equipment, the need for monitoring this activity cannot be overemphasized. At the same time formulation or review of policies for promoting endogenous technological development and the use of endogenous technological services should be initiated. Several African countries still have a fairly wide margin of choice in their strategy for industrial and technological development and this choice should be exercised effectively to avoid the pitfalls that other developing countries have faced in the past.

43. A good deal of the national and regional information resources for industrial technology are as yet unidentified, their stores and data bases need to be upgraded, access to them made easier and their linkages strengthened. The nucleus of an industrial technology information system, no matter how small or unsophisticated, is needed in every country to cater for the very specific needs of technological development. It has to be manned by professionally-qualified information officers with an enterprising approach in contacting end users and encouraging them, by successful performance, to seek information and to use it in decision-making. Some effort towards building a technological intelligence capability in the country is also needed. Both long and short-term action are required including a clear definition of needs, strong and effective relations with

users of information and developing a capacity for handling and processing technological information. The immediate demands for information in the fields of industrial and technological development are such that the first priority has to go to mission-oriented information tasks to help policy-makers, enterprises and research institutions particularly in the field of selection of technology, which provides the starting point for industrial development actions. This would necessitate, inter alia, close links with UNIDO's Industrial and Technological Information Bank (INTIB) through the provision by each African government of a national counterpart to liaise with INTIB and identify immediate and practical needs of each country in this field.

44. Industrial technology manpower is in particularly short supply in Africa. Education and training are ultimately the basic solution to this problem. However, a certain flexibility in the approach of existing educational and training institutions coupled with adoption of unconventional and innovative methods of training in particular, could provide a measure of the quality and quantity of skills needed in this field. Both long and short-term actions are needed. Particular attention has to be paid to a number of skills and capabilities required for the selection, acquisition, adaptation and development of technology. Specific short-term training courses using the existing institutions to the maximum extent possible may be required. Considerable use will have to be made of the instrument of co-operation among developing countries so that they complement each other in providing training and education facilities. Multidisciplinarity dictates that much stronger links have to be established between the various educational, training and production elements both within the government and the business community. This is best done around specific tasks in the upgrading and reorientation of existing manpower as multidisciplinary teams in group training courses.

45. Several African countries have some technological institutions which vary in their functions and effectiveness and suffer from many handicaps. Although new institutions for industrial technology will no doubt be needed, appreciable progress could be achieved by enhancing the capabilities of existing institutions and relating them organically to the execution of the

industrial technology functions in the country. Better linkages between the institutions in different disciplines, the identification or establishment of 'centres of excellence' could go a long way in satisfying the most urgent needs in national industrial technology development.

46. A balanced approach to institution building would call for an approach which looks at the functions or services which the institutions represent rather than at the institutions themselves. In this way, it is possible to see to what extent the technological functions and services required have an institutional basis in the country and what the gaps, definitions and redundancies are. A check-list for this purpose is suggested. 15/ The institutions themselves should be designed and linked to operate as a technological system with corresponding links to the productive sector. A multidisciplinary approach may have to be adopted increasingly with reference to specific major R and D goals around which mission-oriented R and D projects should be built. The institutional requirements in the field of technology acquisition would require further examination. All this calls for a new approach to the overall question of institution building for industrial and technological development. There is plenty of scope for regional action and co-operation among developing countries in this regard.

47. It is obvious that in all these areas intra-African co-operation is imperative for achieving rapid progress on the national and continental levels. Rather than dwell on the mechanisms for further co-operation, per se, which have already been identified and are fairly well known today, it would be more beneficial to dwell upon the areas of such co-operation and the desirable modes in each aspect of the major elements of strategy considered above. A more systematic approach to co-operation and collective self-reliance is suggested in the document on this subject.

48. External assistance in industrial technology will continue to be of considerable value to the majority of African countries for some time to come. It is doubtful whether the maximum possible use has been made so far of such assistance or that new sources have been tapped to the

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15/ See document, Industrial Technology Institutions, Table 2, prepared for this Symposium.

maximum of their potential. There is as yet no clear strategy for integrating external assistance with national effort. The main outlines of such a strategy would indicate the prime importance of defining national needs and particularly their order of priority; being well-informed on the capabilities and interests of the donor; skilfull and careful negotiation of the external assistance programme; making a proper assessment of the cost to the recipient and careful monitoring and implementation of the programmes. A document on this subject highlights the above considerations.

49. Finally, UNIDO's present and forthcoming activities in the field of industrial technology, as approved by its governing bodies, as well as their historical antecedents have been outlined in a document. Its services in this field, interrelated with the other aspects as well as the overall strategy of industrialization would continue to be available to support national and regional efforts in building African industrial technological self-reliance.

50. The deliberations of the Symposium, it is hoped, would enable: -

(a) each African country to decide to adopt at least a minimum programme in the field of industrial technological development and formulate the contents of such a programme (for which important elements and illustrative models are before the Symposium); and

(b) the African countries individually and collectively, to monitor the action taken in the implementation of the Lagos Plan of Action and other relevant inter-governmental decisions in this field;

The UNIDO secretariat would continue to provide assistance, as required, in both these respects.

ACTION IN THE FIELD OF TECHNOLOGY POLICY AND PLANNING IN AFRICA

I. TECHNOLOGY POLICY AND PLANNING TODAY 1/

1. Technology policy is an integral part of the overall development policy of a country and is conditioned by it. Development policies reflect the choice of life-style and consumption pattern, which dictate the demand for products and services, and hence technologies. This choice in its turn, is the outcome of a prevailing set of social values, internal social relations, current legislation, economic, industrial, trade and foreign policy and international relations of the country.

2. Technology policy is a basic function of government aimed at creating a framework in which decisions concerning the exercise of technological choice can be made and implemented. Technology planning is more. It implies the existence of a formally constituted and internally consistent set of goals, objectives and instruments. A technology plan consists of a set of programmes, sub-programmes, projects and activities. Each of these elements sets out to describe the problem in hand, the scope of work planned, the deliverables (expected outcome), the time horizon of completion as well as the funds allocated (local and foreign). It may also specify which individuals or institutions are to carry out the work. A plan thus seeks the optimum utilization of human and material resources to achieve the main directives and objectives of the technology policy. The plan should also specify the mechanisms for performance assessment and for the accountability of the planning authority to the Government, as well as of those responsible for carrying out the elements of the plan to the planning authority.

3. Whereas all countries should seek to formulate at least a framework for technology policy within which basic choices can be made, the preparation of comprehensive technology plans may not be at present feasible for countries with limited regulatory and supervisory

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1/ The Technological Self-reliance of Developing Countries: Towards Operational Strategies (UNIDO/ICIS.133).

capabilities and where institutional continuity has been and remains a problem. Furthermore, what is particularly important is that drafting and ratifying a technology plan does not necessarily mean that the plan can be carried out successfully.2/

4. For the majority of developing countries, the need to develop a technology planning capability will no doubt become increasingly apparent and urgent. The development of a real capability in this direction, however, will not be achieved overnight. All types of planning are, of course, usually easier to describe than they are to practise and experience with technology planning is no exception. In the case of the developing countries this experience barely stretches over a decade. It was only in the early 1970s that such countries as Argentina, Brazil, India, Mexico, Philippines, the Republic of Korea and those of the Andean Pack set out to control technology imports. In the mid-1970s, the first technology plans - prepared by Brazil, Mexico, Pakistan and Venezuela - appeared. The importance afforded technology by the developing countries is evidenced by the fact that by 1977 the number of countries exercising government control of technology imports had, according to UNIDO estimates, increased to about 30. In some countries (e.g. the Republic of Korea) this was motivated by the desire to accelerate growth and development along the lines prevailing in the industrialized countries. In recent years, the way in which technology has been used and abused has emphasized the need for other development alternatives, and hence for alternative products and technologies. Thus, the crucial role of technology in bringing about - or militating against - alternative development patterns and life-styles has received increasing attention. 3/ The development of indigenous technological capabilities has been identified as a basic requirement in any developing country regardless of its development strategy or political orientation.4/

2/ B.M. Udgaonkar, in "Scientific Temper and Public Policy", in Science Today, May, 1980, p. 11, says of India - a country that is well advanced in industrialization: "..the Planning Commission itself continues to be poorly equipped for S and T planning. It has not had the persuasive power with the government to be able to implement what it itself has prescribed."

3/ Conceptual and Policy Framework for Appropriate Industrial Technology, (ID/232/1).

4/ Maximo Halty-Carrere, Technological Development Strategies for Developing Countries: Review for Policy Makers, Institute for Research on Public Policy, Montreal, Canada, 1979.

5. While regulations and programmes have helped to build up technology institutions and to strengthen the bargaining position of the developing countries as technology importers, they have gone little further than the review and approval of technology supply arrangements at the enterprise level. Problems associated with technology absorption and adaptation have so far generally received little attention or have not been dealt with in an integrated framework of analysis and action. Even where technology plans have been prepared, the relationship between these plans and national development strategies has been found to be weak.5/

6. In discussing technology planning, it is good to realize that few people today have the same sort of blind faith in planning that was prevalent at the end of the fifties and the beginning of the sixties. Even in centrally planned economies, attempts are being made to correct apparent rigidities in planning and to increasingly liberalize the operation of the economy. In non-centrally planned economies there are only a handful of countries that have medium-term plans which play a role in allocating resources. The trend of playing down the importance of comprehensive plans has continued because of the many difficulties encountered, not so much in the formulation phase of such plans, but rather in their implementation. Planning is made difficult because, in spite of the calls for increased self-reliance, it is a fact that the economies of most developing countries have become more instead of less open to the world economy. Thus, comprehensive planning is particularly difficult in the technology field. It is even doubtful if in the majority of African situations today, a comprehensive plan is feasible. It is the principles behind technology planning that are relevant. It would be more practical to think first in terms of partial plans and sets of programmes relating to specific actions in particular sectors, or even broad guidelines, in priority areas, but always within the framework of a national policy in technology matters that would ensure that care is always exercised to avoid imbalances. This would permit the flexibility that is necessary if the guidelines or partial plans are to bear any significant relation to reality. After all, no plan is a useful plan if it cannot be implemented.

5/ See, for example, UNCTAD, Technology Planning in Developing Countries, (TD/238/Supp.1), May 1979.

It should also be noted that in setting out to plan its technological future, a nation is seeking to control and manage something which is pervasive and which refuses to recognize sectoral distinctions and ministerial responsibilities. Of all the things which human beings might set out to plan, the planning of technology is undoubtedly one of the most elusive and difficult tasks and can only be attempted effectively as a series of integrated actions on several fronts.

7. Yet without technology planning, a country will find it difficult to decide whether the technological inputs into national development efforts ought to be imported or be met from domestic sources. Nor will it be possible to ensure that the technological inputs are appropriate from the viewpoints of resources use, employment creation, income redistribution, basic needs satisfaction and environmental suitability. In general, systematic progress towards the strengthening of endogenous capabilities and the substitution of appropriate domestic technologies for imported ones will be impossible without the existence of a broadly planned framework covering a relatively long time-frame within which individual development projects can be fitted.

8. In their efforts towards formulating technology plans, African countries should seek to create a framework for effective interaction between government, private enterprises and institutions for science and technology. They will need to give careful consideration to such matters as the needs, resources and socio-economic objectives of the country; the promotion of a social climate which encourages the application of technology in different sectors and at different levels; the formulation of measures designed to stimulate local technological capabilities; the improvement of traditional technologies; the setting up of machinery for the selection and assessment of technologies and techniques; the selective import of know-how and its adaptation to local requirements; the development of technology packages based on new technological advances and the development of manpower for the management of technology. Thus, the preparation of a technology plan

is a truly multidisciplinary national effort involving all the groups that will implement the plan, in a sound, interactive manner. Individuals and organizations from various government departments, the public and private sectors, labour organizations, development finance organizations, and R and D institutions should be actively involved in drafting the plan. This would guarantee their commitment to its successful implementation. In short, the environment so created should, at one level, inspire the confidence of industry and research, engineers, technologists and scientists and, at the other, seek to mobilize the creative problem-solving capacities of ordinary people at the local level.

9. The effective exercise of a technology function and of a technology planning capability would seem to imply the existence of scientific and technological intelligence, or the capacity not simply to appropriate information; but also to utilize it, that is, turn it into knowledge. Technological intelligence can be seen as an essential component of a capacity of a nation to identify its relevant strengths and weaknesses, to understand and analyse threats and opportunities of different kinds and to translate the resulting knowledge into policy and action. 6/ It is doubtful whether any of the world's nations, developed or developing, has yet developed a real social intelligence, although several countries, notably Japan, have demonstrated a technology intelligence capability.

II. THE OBJECTIVES OF TECHNOLOGY POLICY

10. In formulating technology policy, the first question is not 'what technology' but rather 'technology for what'. 7/ The answer to this question will depend upon the answers to the broader questions of 'development for whom' and 'by whom'. Technology policy can thus only be formulated on the basis of clearly defined development goals and objectives and in terms of decisions concerning the type and volume of

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6/ Stevan Dedijer: 'The IQ of the Undeveloped Countries and the Jones Intelligence Doctrines', in Technology in Society, Vol. 1 (1979).

7/ Conceptual and Policy Framework for Appropriate Industrial Technology (ID/232/1).

goods and services which need to be produced and the resources to be mobilized and deployed. In this context, the production of the 'right' goods with the 'wrong' technology could in some respects be considered preferable to the production of the 'wrong' goods with the 'right' technology. It is worthwhile emphasizing here the decisive role that current thinking on development strategies plays in shaping a country's technology policy. Social values and life-styles dictate the demand for goods and services which, in turn, determine the technology choices. Appropriate choices could lead to better utilization of indigenous resources. For example, a strategy of import substitution for products demanded by the urban and more affluent sectors of the population decides, a priori, that greater reliance will have to be placed on foreign products and technologies, while emphasis on satisfying the basic needs for the majority of the rural or less affluent sectors, might revive and upgrade some indigenous technologies. The "Guiding Principles" of the African Strategy for the Third Development Decade approved in Manrovia in 1979 state that "The [development] strategies [in Africa] are characterized by a persistent confusion between growth and development and fail to measure advance by appropriate socio-economic indicators or indices of general well-being".

11. The technology policies of the developing countries are likely to be guided by a common goal, namely the desire to exercise greater control over their social, economic and industrial development by promoting technological self-reliance; a pre-condition for meeting the basic material needs for their poor and underprivileged masses. Policies will need to address the problem of controlling and managing foreign technology inputs on the one hand and of stimulating the development of indigenous supplies of technology on the other. This implies the effective integration of two main streams: the 'flow stream', with its emphasis on the selection and acquisition of foreign technology and its subsequent adaptation, absorption and diffusion; and the 'stock stream', with its emphasis on the development of endogenous technological strengths and the promotion of the capacity to innovate.

12. As noted earlier, the emphasis in the past has been firmly on questions relating to the transfer or flow of technology; the question of the development of stocks has received only scant attention. It will be the task of technology policy to harmonize flows and stocks. Attempts at harmonization will need to recognize, however, that the two streams are not independent or mutually exclusive, but rather interactive at different levels. It may also be necessary to tackle the problems associated with each stream within different time-frames. The development of the capacity to control foreign technology inflow might be afforded short-term importance. Without such a capacity, policies aimed at fostering endogenous technology development and the capacity to innovate are likely to be continuously undermined.

13. The exercise of a national technology function obviously requires that the national science and technology system be made to work. We know, however, that these systems are, for a variety of reasons, frequently underdeveloped in developing countries. Typically, technological capacities are not strongly linked to industrial production, and the modern sector frequently operates independently of the traditional sector. It will be one of the key tasks of policy to address the following problems: to link the conduct of technological activities and the development of technologies organically with the growth of production; and to recover systematically and selectively the traditional technological base by weaving modern methods into the traditional tapestry of a developing society. If this is achieved, the technology system will be able to react better to stimulation and a revision of inputs within realistic time periods.

14. Experience gained in developing countries suggests that these and similar problems can best be tackled when science and technology policy are formulated and implemented separately. Certainly, science and technology policy cannot be categorically differentiated with any clarity since they overlap to a great extent.[8/] Yet there is a difference in

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8/ See Junta de Acuerdo de Cartagena: Technology Policy and Economic Development, International Development Research Centre (IDRC), Ottawa, 1975, pp. 7-8.

emphasis which is of great importance to developing societies. Science is essentially attitudinal and science policy has the objective of encouraging the acquisition of scientific and technological understanding which may - or may not - be of use in the development of knowledge directly applicable to the pursuit of economic and social goals. The objective of technology policy, on the other hand, is to stimulate the generation of the scientific and technological knowledge to be applied in the solution of well-defined problems in certain areas of production and in social welfare. Although science and technology policy are both concerned with the generation of scientific and technological knowledge, a basic difference lies in the fact that in the case of technology policy the knowledge concerned is organized, promoted, financed etc. by policy-making institutions with the explicit purpose of using it to serve specific social and economic needs. In other words, technology policy is defined by objectives external to the scientific world as such. Technology policy is oriented towards the finding of acceptable solutions within a given social context and time-frame. Since its objectives are essentially production and social welfare, and it is not developed in the abstract, it is subject to decisions of a scope much wider than merely solving technical problems. This does not, in any way, belittle the role of scientific endeavour in African technological development, particularly in developing the stock stream and upgrading traditional technologies of a country as a whole in the long run.

15. Moreover, as is well known, scientific knowledge usually flows freely without significant constraints whereas technological know-how is a commodity which is traded on the world market and is vigorously protected.

16. Separate, but interlinked, policies for science and for technology should make it possible to grapple more effectively with technology problems and to articulate a more satisfactory response to questions concerning the development of indigenous technological capabilities.

III. A FRAMEWORK FOR NATIONAL ACTION

17. In this section, a framework for national action in the field of technology will be outlined. 9/ It consists of four interrelated steps which will be discussed in some detail. The steps are:

(a) A broad consensus on the desired mix of appropriate technology and the pattern of national technological capabilities;

(b) An assessment of the present status of technological capabilities and identification of gaps and shortcomings;

(c) The formulation of strategy in terms of policies, programmes and institutions, together with the financial and manpower resources needed for its implementation;

(d) A reassessment of the coherence of ends and means as well as arrangements for co ordination and monitoring.

18. Given the complexity of the third world universe, methodologies and blueprints for the formulation of a technology plan would appear to be of doubtful relevance. The purpose of the framework outlined below is not to present a step-by-step approach to the formulation of policy but rather to list and discuss what might be termed indicative issues. Its purpose is to foster the awareness that technology is a resource and that there is a continuous need for clarity in the relationship between ends and means in technology policy.

19. The framework is based upon the three essential pillars of policies, programmes and institutions. Policies by themselves can only act like levers or valves which can be used to channel or to cut off the flow of national resources or energies. The specific orientation of resources and

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9/ See in this connexion, Strengthening the Technological Capabilities of Developing Countries: A Framework for National Action (A/CONF.81/BP/UNIDO).

energies is conditioned by programmes of action. Institutions are the instruments which formulate and implement policies and programmes. The framework suggests that excessive reliance on any one of these three pillars at the expense of the other two has to be avoided.

(a) National consensus on technology mix

20. The first step towards an effective technology policy is reaching a broad consensus on the desired mix of appropriate technology and subsequently on the pattern of national technological capabilities. Though technological capabilities in a general sense will be required whatever the technology mix, clarity is essential for the generation of particular types of capabilities. These in turn will be derived from national development objectives. As mentioned earlier, a product mix reflects the social demand of the more powerful elements in society, the current value system and the life-styles thought to be desirable. The "Guiding Principles" note that "it [is] no longer desirable and feasible to replicate alien life-styles, production patterns and consumption patterns. Efforts to do so in the past have often led to a continuing state of unhealthy dependency, persistence of mass unemployment, poverty, wide and increasing disparities in the distribution of income and wealth and gradual loss of cultural identity." If the benefits of technology are to be spread throughout the population, then its application and the capabilities required should cover a very wide field of national activity. If people are to benefit from technology, people should be involved. Their ability to seek, acquire and utilize technology and their desire for better technology should be increased. Technologies that make people more productive and draw on their talents are to be looked for. Subject to this, the technology mix, and therefore the desired pattern of technological capabilities, may vary for each country. In countries with a surplus of labour, the emphasis may be on labour-intensive industries while in countries with a shortage of labour, it may be on labour-saving technologies and skills to operate sophisticated machines. In the case

of export-led growth, the technological capabilities of the export industry sector would receive priority. Wherever possible, the desired levels of particular technological skills should be quantified. Broad norms should be adopted bearing in mind that technological skills should be created as an infrastructure ahead of demand rather than as an ad hoc response to demands as they emerge at a particular point in time.

21. The selection of the most appropriate technological mix requires the identification of alternative products and technological needs at both the macro level — of sectoral priorities and the technological inputs for each priority and critical manufacturing sector — and at the micro level of individual industrial enterprises. At the macro level, sectoral priorities can normally be identified through national plans and growth strategies. At the technological level, such priorities have to be broken down into the requirements of process or production know-how, the supply of technical inputs, provision for techr gical services, specialized manpower training for management and plant operations and the like. These, in turn, are determinants of and closely dependent on the choice of technology from among various alternatives that may be available. At the micro level, technological needs principally comprise aspects such as improvement of productivity, quality control, institutional technical support to industry (including information linkages), which have to be tackled on a national or even regional basis, but which relate primarily to the working of individual enterprises.

22. In the case of developing countries, sectoral technological demand should and needs to be also identified at the regional level. Several regions in parts of Africa, and particularly in Latin America, lend themselves effectively to a regional approach in respect of several priority industrial sectors such as fertilizers, petrochemicals and capital-goods production. Such identification could constitute a prerequisite for strengthening the bargaining position of regional industrial units in respect of technology acquisition and the development of regional technological capability.

(b) Assessment of the present situation

23. An assessment of the present status of technological capabilities and of the effectiveness of national technology systems, aimed at identifying gaps, limitations and deficiencies, has not yet been carried out by many developing countries. It is, however, a prerequisite for the proper formulation of a strategy.

24. Reviews of existing situations are notoriously static undertakings. It is essential that an assessment of technological capabilities takes place in a dynamic and development-oriented framework, being cognizant of global and regional technological trends and developments on the one hand and national development aims and ambitions on the other.

25. An assessment of technological capabilities may include evaluation of the following:

(i) Technological manpower. The strength of the existing technical and scientific manpower will need to be quantitatively and qualitatively evaluated, as will likely developments in patterns of development and utilization. The extent of brain drain, if any, may need to be assessed. The evaluation of manpower resources should be undertaken, keeping in mind, reallocation possiblities since increase in existing manpower may require a gestation of three to five years, unless brain drain is reversed or expatriate manpower brought in. The categories of manpower to be assessed would include scientists, science graduates, research and development (R and D) personnel, teachers, engineers (civil, mechanical, electrical, chemical, metallurgical, electronic etc.) engaged in production, teaching, consultancy, design and other occupations; middle level technicians of various types; trained artisans; traditional artisans etc.

(ii) Indigenous technologies. Many developing countries have yet to obtain a clear picture of the traditional technologies available to them. Such technologies, developed over centuries and representing accumulated experience, are likely to be appropriate to local conditions and particularly relevant to the problems of rural areas and to the development of activities in such areas as agro-processing and building materials and construction. The inventory and evaluation of indigenous technologies obviously should take place with a view to identifying the possibilities for their systematic upgrading and improvement through the application of modern science and technology. R and D institutes in developing countries have an important role to play in assessing indigenous technologies.

(iii) Sectoral developments. An assessment of the status of technological advance and of technological manpower in specific sectors will need to be made. The sectors should include not only individual industrial sectors, but also technological service capability areas such as consultancy, design and construction. High priority industrial sectors are likely to include food processing and engineering industries, as well as the 'industrializing industries' which allow for the optimal utilisation of local natural resources and for the longer-term accumulation of technological capabilities. The assessment of sectoral developments should cover not only large-scale industrial units and technologies, but also small-scale and traditional technologies.

(iv) The impact of policy. a. The effective exercise of a technology function requires a careful assessment of the scope for implementing policy and for government intervention and regulation in the technology market. In making such an assessment, it must be recognized that there are a range of contextual considerations involving social, political and economic structures which constrain policy formulation and implementation and that policies can have an indirect as well as a direct effect on the development of technological capabilities. The technology system operates

within an overall constraining frame of an intellectual climate, a system of values, attitudes and modes of behaviour, as well as of current legislation. The direct impact of this on strategies, policies and plans and in the definition of the composition of social demand may be obvious, even though such impacts defy easy generalization. Less obvious is the indirect impact on the components of the science and technology system of policies governing such areas as taxation laws, import controls, custom duties, the influx of foreign capital and labour. All these will have a profound effect on the operation of the technology system and together constitute what might be termed as implicit science and technology policy.[10/] Experience has shown that, in many areas, implicit technological policies are able to run directly counter to the explicit technological policies contained in science and technology plans. It is the contradiction which frequently lies behind failures in policy implementation.

b. Another area requiring careful investigation concerns the identification of relevant instruments for influencing the patterns of demand for technology. Only the maximum possible participation of people from all sectors of society could cause significant changes in demand patterns for goods and services. In the past, emphasis clearly has been placed on the supply side with an implicit belief in the existence of a purchasing law which governs technology supply/demand relationships. In reviewing possibilities for influencing technology demand, attention should be given to such instruments as industrial programming and priority setting, industrial financing and state purchasing arrangements.

(v) Internal diffusion of technology. The state of diffusion of technology within a country both vertically through different sectors and groups of society, as well as horizontally amongst members of the same group or in the same sector and the existence of conditions to promote such diffusion should be assessed. Internal mobility of technical

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10/ The IDRC's global project on science and technology policy instruments provides ample and interesting examples of implicit science and technology policies from several countries. Only one African country was involved marginally in this project. See Francisco Sagasti: 'Science and Technology for Development: Main Comparative Report of the Science and Technology Policy Instruments Projects', IDRC, Ottawa, 1979.

personnel promotes transfer and diffusion and enables the training and transfer of skills to a much larger number of persons than would otherwise be possible. The economic relationships between the urban and rural areas have to be examined to see how the strengthening of such relationships could contribute to the growth of technological skills in the rural areas. The facilities and instruments available for the promotion of innovation also have to be examined. It easily can be seen that an assessment of the possibilities for promoting transmission mechanisms may call for the identification of 'social carriers' with an objective and subjective interest in the application of a certain type of technology.

(vi) Technological institutions. a. An assessment of the capacities of existing institutional infrastructure will be essential. Such an assessment should identify the function performed by institutions, the means at their disposal and their potential for change and development. Technological institutions cannot be construed in the narrow sense of industrial research organizations and the like. The assessment should also cover such institutions as information centres, project formulation and evaluation centres, investment promotion agencies, investment boards, technology regulating agencies, productivity councils, design institutions, consultancy and other technological service agencies, extension centres for small industries, institutions for technological education, and research institutes. In sum, the review should include promotional, regulatory and service institutions since their activities will involve implicit policy and impinge in a variety of ways on the process of technological development. In this sense, it may be more appropriate to think in terms of functions and services to be performed rather than in terms of institutions per se. since, ultimately, it is there where major interest lies. This approach would require the specification of these functions and services and their correlation with the potential offered by available institutions.

b. In assessing existing institutional capabilities, obviously it will be essential to go beyond mere numbers (of technical personnel, expenditure incurred and so on) to a qualitative evaluation of the output of the institutions. The possibilities of strengthening the institutions,

extending the scope of their activities to include more functions and services, avoiding duplication in their work and ensuring co-ordination should be identified. The place of the respective institutions in the government hierarchy, their involvement in decision-making for industrial and technological development, and the contacts they have with industry and the public are critical factors in assessing their effectiveness. The role of research institutes in essential technological functions such as extension, pilot plant and commercialization of technologies should also be assessed.

(vii) Summary. The above assessment should provide sufficient information and insights to identify future possibilities. It will provide an understanding of the scope for technology policy and the possibilities for government intervention and regulation in the development of technological capabilities. More specifically, it would make it possible to identify sector and branch priorities and important inter-sectoral relationships with significant linkages and backward and forward multiplier effects. Furthermore, it will permit an understanding of available and needed institutional infrastructure and of manpower requirements. It provides an extensive basis for identifying priorities in a range of interrelated areas and of evaluating the advantages and disadvantages associated with technology alternatives at different levels. In short, it ensures that technology policy will be organically linked with national economic, social and industrial development objectives.

(c) Policies and policy instruments

26. A large number of policy instruments are available for attaining technological objectives and achieving the technology mix deemed most desirable. The effective application of such instruments, however, will require the identification of the structural forces and deficiencies which are likely to invalidate their utilization. One of the basic arguments in this document is that contextual factors may be decisive in determining the success of technology policy-making.

27. Policy instruments can take various forms and be of the explicit or implicit type. They include national laws and regulations for licensing of production capacity of industrial enterprises (as in India) or the defining of new and necessary industries (as in Mexico), controls over majority foreign equity holdings, employment of expatriates, controls over imports, incentives for exports and import substitution, regulatory control over foreign technology, regulation for use of domestic consultancy agencies and technical services, various forms of financial assistance and incentives for small-scale and rural industries and the like. In most countries, several fiscal and regulatory instruments are utilized in combination with one another. A number of governmental and semi-governmental agencies are consequently involved in dealing with one or other policy instrument. One of the criticisms often made is the multiplicity of governmental regulations and agencies with which domestic industry has to deal. While adequate co-ordination is undoubtedly necessary and bureaucratic delays need to be minimized, the complex and manifold issues of industrial and technological growth in most developing countries necessitate that governmental agencies play a critical and determinant role in several policy areas. The nature and extent of such a role obviously depends on the circumstances and objectives of each country but the nature and magnitude of the problems are such that the free play of market forces may only accentuate existing gaps and problem areas.

28. As noted above, policies and instruments relating directly to technology have to be viewed within the framework of overall economic and industrial policies. By and large, however, such policies and mechanisms, as well as the legislation reflecting such policies and within which such mechanisms function, need to be defined in respect of:

(a) the role of both existing and new private foreign investment;

(b) fields in which foreign technology is considered particularly necessary, and measures designed to ensure adequate technology flows, including patent laws and tax benefits;

(c) production and service sectors in which foreign technology should not be encouraged, including technical and management services,

merchandizing and internal sales, and sectors where domestic capability is either adequate or should be developed;

(d) the establishment and development of a regulatory mechanism to regulate such inflow in accordance with prescribed and well-defined guidelines;

(e) incentives and measures to encourage domestic technological growth, including tax rebates for R and D expenditure, limited duration of foreign technology agreements etc.;

(f) incentives and measures to promote technological servies, particularly consultancy and engineering services, including tax relief and regulatory action such as insistence on local consultancy agencies being appointed as prime consultants in selected fields;

(g) financial assistance and support to domestic technology agencies.

Such a list of policy measures and instruments relating directly to technology can only be illustrative and not exhaustive and must be formulated in the context of each country or region.

IV. GENERAL POLICY GUIDELINES

29. In every developing country, technology policy will certainly need to address the essential question of selective action. As noted above, the definition of the technology mix which is socially optimized requires the systematic identification of sector- and product-specific alternatives and the careful analysis of the various constraints associated with each of the options. Despite the enormous differences among African countries, five general guidelines could be gleaned from the Monrovia Declaration and the Programme of Action for the African Industrial Development Decade.[11/] They are of particular relevance in the identification of the most appropriate technology mix:

11/ Monrovia Declaration of Commitment of the Heads of State and Government of the Organization of African Unity on Guidelines and Measures for National and Collective Self-reliance in Social and Economic Development for the Establishment of a New International Economic Order (AHG/ST.3 (XVI), Rev.1).

(i) Elaborating criteria for technological priorities and choices. Starting with the development strategy of the country and its social economic objectives and policies, the criteria for ordering priorities of action in the technological field will have to be clearly defined. Technological choices, based on sound and comprehensive information on technologies and technological products, will also reflect the development strategy, life-style and product mix. Such criteria and conscious choices would define next the priorities for funding programmes and projects in technological development, whether in dealing with the flow stream or developing the stock stream. Such criteria should reflect the maximum of complementarity and cohesion between national development policies and plans and those in the technological field;

(ii) Transforming needs into effective demand. The gap between the needs of African society, or more specifically, the needs of the underprivileged majority, and effective demand, that is to say the demand which can enter monetary exchange relations, is dramatically increasing. Decreasing fulfilment of basic needs and overconsumption in some urban growth areas are familiar symptoms. A conscious policy to reconcile needs with effective demand thus becomes of utmost importance. This would imply three interrelated priority activities: the identification of social needs (which raises a fundamental question concerning the degree of involvement of the majority defining these needs); the definition of criteria for the adjustment of effective demand to social needs (such as maximizing the basic needs satisfaction of the poor, the productive integration of the labour force, the use of local natural resources, the use of local scientific and technological capabilities and traditional skills, and so on); and restructuring the supply side and resolving the problems of the choice of products and the technologies differentiating between growth and development and emphasizing equity;

(iii) Social optimization of using material and human resources (natural and energy resources, manpower, institutions etc.) Most African countries still have to develop the basic preconditions for effective control over the natural resources located within their frontiers, that is to say, national capacities

to detect, exploit and process such resources. Thus, utmost importance should be afforded to activities in this field. These should include a systematic search for areas in which co-operation between African countries appears feasible. Availability of natural and in particular energy resources should have a determining effect on the contents of industrialization strategy as regards choice of sectors, choice of process and techniques. Against the abundance of natural resources, manpower in Africa is relatively scarce and expatriates have been prominent in its industrial development. This would call for careful consideration of the most effective ways in which valuable resources can be used. In Africa today, there are also several institutions involved in technological development and industrial R and D; 12/

(iv) Support for agriculture. In this context the promotion of self-sufficiency in basic foodstuffs is especially important. Industrial support for agriculture, would help guarantee self-sufficiency in food a target that is given top priority in the Guiding Principles of the Monrovia Declaration. This support applies to sectors producing agricultural inputs (implements, fertilizers, pesticides, irrigation equipment etc.), to sectors serving transport and distribution requirements and to those processing agricultural goods. Possibilities for the application of science and technology to increase agricultural productivity, to improve post-harvest technology and to introduce innovations into plantation industries, animal fisheries and forestry are very considerable;

(v) The identification and strengthening of industrializing industries. Priority should be given to the identification and promotion of the so-called industrializing industries. Such a strategy includes, inter alia, the development of the engineering and machine tool industry the production of textile and agricultural

12/ See document on Industrial and Technological Manpower and document on Industrial and Technological Institutions, both prepared for this Symposium.

machinery, and a reorientation of basic industries, processing locally available resources which would aim to increase the share of down-stream activities and to foster the integration of the country's industrial and agricultural production;

(vi) Effective control of key sectors. Without control there will be little progress in the direction of autonomous decision-making and little influence over the process of growth or, indeed, development. Such control is a basic precondition for the establishment of dynamic inter-industry linkages. It involves control of the market, of essential inputs of forward and backward linkages as well as over R and D of technologies. This has led in some countries to selective nationalization of key sectors. Such policies should recognize, however, that ownership should not be confused with control and that it is control which counts;

(vii) Developing mechanisms for continuous monitoring and corrective action. As mentioned in paragraphs 3-6, policy formulation still leaves a range of questions not yet answered and planning is made difficult by a number of internal and external factors. This calls for the effective operation of mechanisms for monitoring actual performance, feeding back information in good time for corrective measures to be formulated and executed. Developing countries, in particular, can ill afford the waste of time and the squandering of the resources that would be brought about by failure to keep a close watch on implementation and taking suitable measures in time.

30. Technology policy will need to address problems and outline options at different levels. National strategies for technological development should be based upon the recognition that the international technology situation and the international division of labour are not static but rather dynamic. National strategies should thus reflect an appreciation of global and regional trends and developments, a consideration which will become increasingly important as efforts in the direction of collective self-reliance and technical co-operation among developing countries and economic co-operation among developing countries (TCDC/ECDC) are intensified.

31. As seen above, an essential ingredient of technology policy is decisions concerning sector and branch specific product and process technologies. Such decisions can only be articulated at the enterprise level. The enterprise level is thus of critical importance. Technology choices at this level, however, cannot be left to the discretion of individual entrepreneurs and to market mechanisms. The interest of the nation will not necessarily be compatible with that of individual or of groups of entrepreneurs. Individual enterprises may well be motivated by profit rather than social welfare considerations. Profit maximization may well encourage them to import foreign technologies under conditions which perpetuate national technological dependence. One of the essential functions of technology policy is thus to guide the actions of entrepreneurs in socially desirable directions. In most cases this will necessitate the creation of a system of incentives as well as of regulation and control.

V. POLICIES FOR SELECTED AREAS

32. Technological self-reliance implies the capacity to select, acquire, adapt and absorb foreign technology inputs (regulating the flow stream) and of developing an indigenous base and the capacity to innovate (the development of stocks). It would seem appropriate to review broad policy options under each of these main headings.

(a) Selection and acquisition of technologies.

33. Policies aimed at strengthening the capacity to select and acquire technologies will need to recognize that, as stressed above, developing countries require a judicious mix of technologies in order to achieve their development objectives. They will need to utilize "the largest and the smallest, the most complex and the simplest, the most expensive and the cheapest, the latest and the best, and the tried and the true". 13/ All will be required at one time or another. In some categories of industries, such as heavy engineering, electronics, heavy chemicals and some types of infrastructure, there will be no substitute for the most modern, capital-intensive technology which will need to be imported. In general, however, developing countries would appear to possess a special need for technologies which meet the following criteria: 14/

(a) High employment potential, including indirect employment through backward linkages with national suppliers and forward linkages with national processors, distributors and users;

(b) High productivity per unit of capital and other scarce resources;

(c) Higher labour productivity in the context of increased employment, that is, the maximization of the productivity of labour in the economy as a whole;

(d) The utilization of domestic materials, expecially of raw materials previously considered of little value;

13/ International Institute for Environment and Development, 'Mobilizing Technology for World Development: Report of the Jamaica Symposium', London, March 1979, p. 1.

14/ See Hans Singer, 'Technologies for Basic Needs' International Labour Organisation. 1977, p. 32.

(e) A scale of production that is suitable to serve local markets (unless exports are involved), with special consideration given to small, fragmented markets in rural areas;

(f) Low running costs and cheap and easy maintenance;

(g) Maximum opportunity for the development, as well as use, of national skills and national management experience;

(h) Dynamic opportunities for the further improvement of technologies and feedback effect on the national capacity to develop new technologies.

34. For the modern industrial sector, the main task will be to extend technological choice as far as possible and to increase the measure of selectivity. Experience has shown that decision-makers in enterprises, government agencies, and financing institutions are often inadequately aware of the implications, direct and indirect, of the choice of one technology rather than another. All too often, the alternatives available are not known, let alone considered.

35. Instruments which can be employed by developing countries to promote the selection of appropriate technology could include, for example, the following; 15/

(a) Differential direct and indirect taxation (e.g. tax exemption or lower taxation for products and enterprises in the small-scale sector or those utilizing newly developed or indigenous technologies);

(b) Differential financial and credit policies (for example, lower rates of interest and liberal credit for products and enterprises in the small-scale sector or those utilizing newly developed or indigenous technologies);

15/ See Draft Report of the Second Consultative Group on Appropriate Industrial Technology (ID/WG. 279/12) and also Report of the Technical/Official Level Meeting to the Ministerial Level Meeting, International Forum on Appropriate Industrial Technology (ID/WG. 124/Rev.1) and Report of the Ministerial Level Meeting, International Forum on Appropriate Industrial Technology (ID/WG 282/123).

(c) Industrial policies concerning size of units and criteria for expansion (for example, reservation of certain products for manufacture in the small-scale sector only; policies discouraging more assembly industries based on imported components);

(d) Trade policies on import of capital goods or raw materials (for example, import control; not permitting import of equipment of too large a capacity; phased programmes for the reduction of import content of raw materials and components);

(e) Policies on foreign investment and import of technology (for example, discouraging turnkey contracts; not allowing foreign investment or import of technology in specified areas; associating local consultants or R and D institutions in selection of technology).

36. Policies aimed at regulating the acquisition of foreign technology should not only cover technology per se, but also equipment (which embodies technology) and foreign investment (which is a vehicle of technology and invariably predetermines it). This is particularly important in Africa because of the weakness and very limited scope of the capital goods industry. Shortage of capital has often led to foreign sources of capital making technological choices that are by no means the most appropriate. A policy of regulating the flow of foreign technology will obviate distortions in the pattern of industrial growth and avoid an undue outflow of foreign exchange. To be effective, such a policy should have both regulatory and promotional aspects. It should protect indigenous technologies and emerging technological capabilities where they satisfy national requirements. It should encourage inflows where there are gaps in production, technologies or technological capabilities. It should be also a matter of policy to specify those technologies which need to be protected and those which need to be encouraged to grow. A mechanism for screening technology contracts will also be necessary. Such screening could ensure that the technological services required are clearly specified; that technology packages are unpackaged wherever possible to admit contributions from indigenous technological capabilities; that adequate provision is made for the training of local technicians; and that there are no unwarranted restrictions on the further dissemination of the technologies and the technological capabilities involved. Although each developing country may have its own approach towards the extent of production or regulation of foreign technology, the establishment of a screening mechanism will enable the continous and systematic monitoring of foreign technology inflows which does not exist in many developing countries at present.

(b) Adaptation, absorption and improvement of technologies.

37. Policies of technology adaptation, absorption and improvement should focus on the process of ridding imported technologies of their rich country ethnocentricity and of stamping them with the societal imprint of the importing country. No less important will be the process of upgrading local technologies so as to improve their productivity.

38. The adaptation of imported technology may necessitate, for example, the scaling down of the technology to the size of the local market, a process which has already been satisfactorily demonstrated for several processes, including bricks and cement, paper, textiles, packaging, sugar and a wide variety of agricultural equipment. Adaptation will also necessitate the matching of the technology to available local skills which, in some cases, may require maximizing its labour intensity and capital savings.

39. Since technology adaptation is the means of linking imported technology to national R and D, policies designed to enhance capacities for adaptation and absorption will need to give due consideration to the building up of national R and D capabilities and to forging closer links between R and D institutions and industries.

40. Adaptation to the satisfaction of a technical authority could be imposed as a condition in contracts for the acquisition of foreign technology. The costs of adaptation could receive preferential treatment in taxation. Adaptation to local raw materials and components could be secured through a phased programme of reduction of imported materials and components.

41. Absorption of technology in a narrow sense could be facilitated by policies which insist that foreign technology and investment inflows be accompanied by adequate training of local personnel both in terms of the number of persons trained and the extent of their training. Absorption becomes easier if research institutes and industry are involved in decisions on which technology to import.

42. Long-term policies for the absorption of technology should concentrate on human resource development. Policies that promote a greater involvement of scientists and technicians in the development problems of the country will be needed including, where necessary, the restructuring of their salaries and responsibilities.

43. Long-term policies aimed at technology absorption require that developing countries make serious reappraisals of their educational policies.

(c) Development of technologies

44. Policies designed to strengthen the capacity for innovation will need to recognize that the process of building up scientific and technological infrastructure and capabilities is necessarily a complex, time-consuming process that has to take place at all levels of society and may need to be supported by basic changes in the educational system. The development of the capacity to innovate requires much more than the building up of R and D institutions. The notion that technology development is rooted in the existence of high-level R and D centres takes a too narrow view of the process of technological innovation. It is also historically inaccurate. In countries where development has been decentralized and community development programmes initiated, experience has shown that local governments, local organizations, agricultural co-operatives and the like, as well as motivated individuals, can be technological innovators. Technological innovation is a bottom-up as well as a top-down process: innovation comes from the users of technology as well as scientists and engineers.

45. In spite of all the problems they face, scientific and technological research institutions in Africa have shown themselves quite capable of generating ideas that are potentially of value if properly developed and exploited. However, innovation is not the prerogative of the scientist. The practitioner at any level (particularly at the shop-floor level) as well as the end user are sources of significant innovative ideas of considerable potential. The great advantage of these ideas is that they often reflect firsthand experience and deep insight into the actual needs of the user. They are often capable of producing working models, but considerable engineering effort is needed to transform the basically-sound concepts into a economic reality. Another important task of policy in Africa today is to promote the application of such firsthand experience and to facilitate the process of the commercialization of new technologies. The few pioneering examples of successful commercialization need to be studied and the reasons behind their success identified.

46. Development can be promoted through the levying of taxes on industry, the proceeds being utilized for R and D purposes. Tax rebates could be allowed on the R and D expenditures of foreign owned enterprises to encourage them to set up such facilities. In India part of the condition of approval for the import of technologies is that the importing organization should set up R and D facilities within the period of the contract so that the need for continuing the import beyond that period is obviated. Other mechanisms have been adopted in Asia and Latin America with varying degrees of success. Such experiences merit consideration so that appropriate incentives be applied in Africa.

47. To preserve traditional technologies and capabilities, protection could be provided by way of the reservation of lines of manufacture, policies of government purchases etc. The adoption of technologies developed locally (for example by research institutes or industrial enterprises) could be encouraged by tax concessions or by liberal conditions of industrial approval.

48. For widespread dissemination of technology and for encouraging innovative capabilities, the promotion of self-employment and techno-entrepreneurs should be encouraged as a matter of policy. Concessional financial assistance through financial institutions will be important in this respect. Policies of worker participation in production and technology decisions will also be of help. Patent laws and financial encouragement for innovations and their application are necessary. Special incentive schemes aimed at universities and academic institutions designed to promote innovative activities may also need to be devised. The aim is to create or encourage a section in society with a vested interest in industry and which would exercise its entrepreneurial and technical skills in industrialization. A number of special instruments for promoting technology adaption, absorption and development will be discussed.

49. The fountain-head of technological innovation in satisfaction of social demand, is an alternative development strategy and a new life-style. The Guiding Principles of the Monrovia Declaration remind us that existing life-styles and patterns of economic growth in industrialized countries as well as in developing countries have led to serious environmental degradation and rapidly increasing social costs, natural resource depletion, technologically-created unemployment, alienation, pathological urbanization, erosion of family and community life and a deterioriation of the quality of life in general. There is also doubt about the desirability of the dominant patterns of growth and life-styles from the developing countries, and their suitability in the long run. It is obviously up to the peoples of Africa to search for new and feasible development alternatives, life-styles and consumption patterns. This search is essentially a multidisciplinary effort involving social and natural scientists as well as technologists. It is in fact a search for new technological products and appropriate technologies to produce them. This could not, and should not, be carried out by governmental organizations, since they call for the maximum participation of people from all walks of life. Experience in other parts of the world, particularly in India, favours the establishment of autonomous bodies, as the most effective means of strengthening the search for development alternatives that could be realized here and now.[16/]

16/ See Y. Nayudamma: Science and Technology for Development - Indigenous Competence Building (ID/WG.301/3), pp. 11-25.

VI. TRANSNATIONAL CORPORATIONS 17/

50. A special word is required on policies concerning relations with transnational corporations which still play a predominant role in Africa. Not only have they been sources of technology; but often the suppliers of capital investment. This latter function cannot be discussed without reference to the national policy on foreign investment in general. However, since transnational corporations retain oligopolistic control over technology in a large number of manufacturing and service sectors, a considerable proportion of technology acquisition will continue to take place through their operation. Technology plans and policies will thus need to channel the operation of transnationals according to national objectives and priorities.

51. Policies aimed at regulating the activities of transnational corporations should recognize the inherent conflict between the profit-maximization objective of transnationals on the one hand and the development of national scientific and technological capacities on the other; hence the need for a regulatory and monitoring system. Elements of this control function will need to focus on the extent of the local integration of the foreign subsidiary, including the utilization of technologies appropriate to the country's needs and conditions, the extent of the utilization of local resources, and the extent to which the foreign subsidiary is involved in building up indigenous capacities.

52. Once technological needs have been defined and the most appropriate technology mix identified, the specific role and the possible pattern of corporate relationships with transnational corporations in various sectors of the economy can be established. In certain branches, particularly high-technology industries, it may be necessary to utilize transnationals both as a source of investment and as suppliers of proprietory technology. In sectors where the domestic industry has the necessary entrepreneurial capability and technological base, technological needs may be served by licensing and other contractual arrangements without foreign capital

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17/ Transnational Corporations and the Industrialization of Developing Countries (ID/CONF.4/14).

participation. In certain fields, it may not be desirable to encourage foreign technology flows in order to utilize and enhance domestic innovative capability. This approach would be relevant in sectors where appropriate domestic technology is available or where foreign technology has been adequately absorbed by domestic industrial enterprises.

53. The technological requirements of linkage industries constitute an important element of negotiations with transnationals. In the case of mineral industries, which are particularly important for Africa, technology for downstream processing stages would be a significant aspect to consider and the interests of both the host country and the enterprise would need to be harmonized. Similarly, the extent and nature of domestic integration and the increase in value added over a defined period need to be established in the course of negotiations. The development of domestic marketing and managerial expertise, besides operational skills, should also be identified as being an important responsibility of transnationals in various sectors.

54. An important aspect of negotiations with transnational corporations relates to the disaggregation of the technology package. Transnationals tend to aggregate the investment function with the various technology elements, including project engineering, production technology, management and marketing. From the host developing country's viewpoint, it is important that the package should be unbundled and evaluated in terms of its various elements. The unbundling of the technology package is important for determining the cost element of each part in the package, but of even greater significance is the possibility for domestic industry to participate in the supply of inputs and project engineering services. Even if the cost of domestic goods and services tends to be above the world market price, this may nevertheless be justified in the initial stages of industrialization in the long-term interest of developing domestic capabilities. The extent of unpackaging will be subject to negotiation and is usually limited to certain sectors where transnationals can ensure that the technology is used only by a subsidiary or affiliate under their control or is sold only in the form of a complete system, and not as separate components. Similarly,

where foreign engineering contractors with the skills to combine various inputs are themselves dependent on the technology supplier, the incentive to unpackage may be weak or lacking. In such cases, a great deal may depend on the technical and managerial expertise and contracting skills available in the host country. This underscores the great emphasis that needs to be placed on the development of domestic capabilities in consultancy services.

55. Efforts in the direction of unpackaging should obviously aim at maximizing the use of local inputs, especially technological services. Policy guidelines can be prescribed concerning restrictions in the use of foreign personnel, training programmes for domestic personnel at various levels, and enterprise-level R and D. Import restrictions and controls can significantly affect greater technology flow for linkage industries and adaptive use of local materials and parts. Export incentives and insistence on export commitments by the subsidiaries of transnationals can, on the other hand, improve the balance of payments performance of transnationals and achieve better quality production.

56. It is important that the impact of operation of the subsidiaries and affiliates of transnational corporations on domestic technological development is monitored on a continuous basis. The review process should monitor the path of technological development, the R and D undertaken by the foreign affiliate, and the adaptions performed to suit local conditions and requirements. This review should cover existing subsidiaries and affiliates and also new enterprises in which transnationals are involved.

57. Special attention may also need to be given to the high costs resulting from the extensive usage of foreign brand names and trademarks by transnational corporations. Measures which can be used in this respect include the compulsory use of domestic brand names which, after a period of time, obviate the need for foreign brand names. The diffusion of foreign technology can be facilitated by restrictions on the duration of licensing agreements (usually five to 10 years). The shortening of the period of patent validity below the norms of the international patent system can also be introduced, as has been done by such countries as Brazil and Mexico, and the possibilities for introducing patents in vitally important sectors can be severely restricted.

VII. TECHNOLOGY PROGRAMMES

58. Technology plans and policies will need to be translated into programmes and, eventually, sub-programmes, projects and specific activities. In the preceding discussion a number of areas in which action programmes could be initiated were indicated. In this section, the need for action in a number of typically critical areas will be discussed. These areas are the development of agro-industries, the engineering and machine tool industry, special programmes for small and medium enterprises, the development of a technological service capability, the creation of industrial extension services, the creation of information networks, and technical education and training programmes. The section concludes with a brief description of a possible action programme for a high priority area: the more effective integration of technological capabilities with productive activities.

(a) The development of agriculture-related industries.

59. The Monrovia Declaration gives first priority in the next United Nations Development Decade to African regional self-sufficiency in food. This implies intensification of activities in the agricultural sector. Industrial programmes will have to analyse the needs of agriculture. This will cover both industrial inputs to agriculture (fertilizers, chemicals, tools, agricultural machinery etc.) as well as the down-stream linkages into industry (mainly the handling and processing of agricultural products).

60. Whether a country embarks on the production of fertilizers and chemicals would depend on its natural resources and the volume of production needed. However, production of agricultural tools and some types of agricultural machinery, particularly suited to local conditions, almost certainly will have to figure prominently in the technology programmes. This will reduce the dependence on imported machinery which is not always of the right size or type for local conditions. The need for food processing is already recognized and food industries figure prominently in African industry. However, it often seems to be characterized by inappropriate demand for such inessential products as soft drinks under brand names. Intensification of

efforts towards self-sufficiency in food is called for as well as special programmes to develop these industries further, both qualitatively and quantitatively, while reducing the predominance of foreign technology in this vital field.

(b) The development of the engineering and machine tool industry

61. One of the most important of all industrializing industries is the engineering and machine tool industry. It constitutes the basis for much industrialization, and experience in developing countries has shown that a broad-based industrial structure cannot be sustained without the existence of a growth-oriented engineering sector. The engineering industry is traditionally an important source for the growth and development of technical manpower and a focus for the process of technological innovation. In fact, development of agro-industries depends heavily on the progress achieved in engineering industries. It is thus advisable for all developing countries to assign high priority to the development of the engineering industry, especially the production of machine tools, whenever market size and scale of activity make the production of machine tools economically feasible.

62. The development of the engineering sector may call for the setting up of facilities to produce ferrous and non-ferrous castings, forgings, machine tool and machine shop equipment, fabrication (including the production of welded components and stampings), rolling, bending and pressing facilities, heat treatment and plating and steel rolling mills.

63. Raw material supplies will be of decisive importance, especially steels, castings and forgings. With respect to steel, construction steel (mild steel), alloy steel and sheet steel are the most essential raw materials required in the production of engineering products. [18] Whether a developing country should develop its own iron and steel industry depends upon a number of factors, one of which is the availability of necessary

18/ UNIDO has recently prepared standard project documents for the establishment of metal production development units, which are essential to both industrial and technological development, as well as viable and practical means for their quick diffusion in least developed countries.

mineral resources. Developing countries which are without supplies of iron ore, coal and abundant power and which have not reached a high level of industrial development will import whatever steels are required to develop their nascent engineering industry.

64. The availability of ferrous and non-ferrous castings depends upon the existence of foundries and forge shops. Thus their development should, where necessary, be afforded high priority. Since cast and forged components are made specifically to drawings, they can be produced more advantageously in the country itself.

65. The decision to develop a national machine tool capability should not depend upon size of market considerations. Virtually every human artifact is made on machines which are themselves made on machine tools. In the smallest and least developed developing countries a machine tool industry can and should be developed. It might, for example, be organized on a cottage industry basis and involve the production of essential spare parts.

(c) Small and medium enterprises

66. Special programmes may be required to promote the technological development of small- and medium-sized enterprises. An environment which encourages initiative by small firms is likely to be more competitive and is able to promote an active search for more appropriate technologies. A small firm is usually less inclined towards vertical integration so that it is more likely to rely on small, relatively labour-intensive local producers and suppliers than a large enterprise would be. Small-scale industries also have a critical role to play in integrating the agricultural and industrial sectors, a key aspect of development policy in Africa today.

67. It should be remembered, however, that local small and medium enterprises need considerable support in dealing with the problems they

customarily face. They generally lack, for example, the necessary resources to maintain specialized personnel for technological management and are usually short of the technicians required to maintain and supervise effectively ongoing production processes. Linkages based on contract systems with centralized financing and decentralized production or on industrial co-operatives, have proved effective in many cases.

68. The effectiveness of small and medium enterprises could be improved through support programmes involving R and D institutions, industrial extension services and technological service organizations. Governments might seek to develop entrepreneurial skills in small and medium enterprises through programmes aimed at reducing the risks incurred by groups of entrepreneurs in the development of their technological capacities. There are in Africa today examples of small-scale non-competing industries producing items for which there is social demand and acceptability within the limitations of a small national market.

(d) The development of a technological service capability

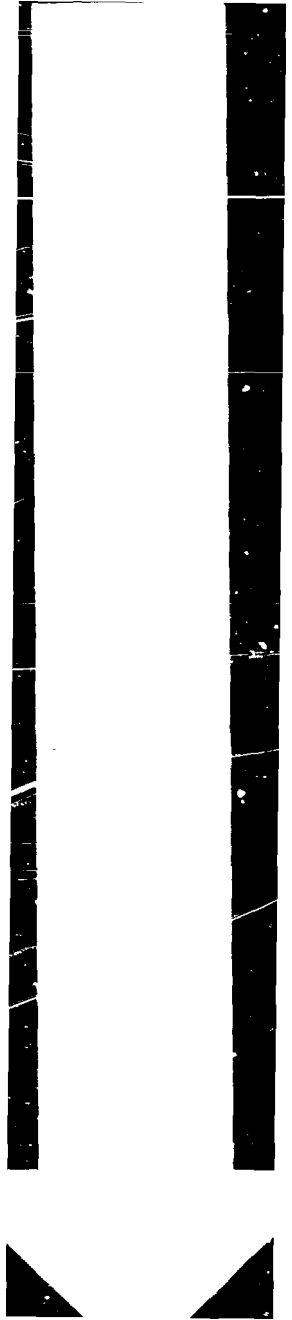
69. Inadequate technological service capability constitutes a major constraint in most developing countries. Such services range from macro-level industrial planning to micro-level project identification, feasibility studies, plant specifications, detailed engineering designs, civil constructions and machinery installation, and plant commissioning, start-up and operations. While the extent of the gap varies from country to country, the most significatn gap, even in fairly industrialized developing countries, is in respect of detailed engineering and design and sectoral consultancy services through nationally-owned units. This makes disaggregation of foreign technology packages extremely difficult and also creates a critical gap in infrastructure. It also results in undue and repetitive dependence on foreign design and engineering services with a consequential impact on the pattern of investment for particular projects, the requirements of capital goods and equipment and subsequent plant operations and management. In the less developed economies, the gaps in consultancy services are even more marked and extend to almost the entire range of service activities indicated above.

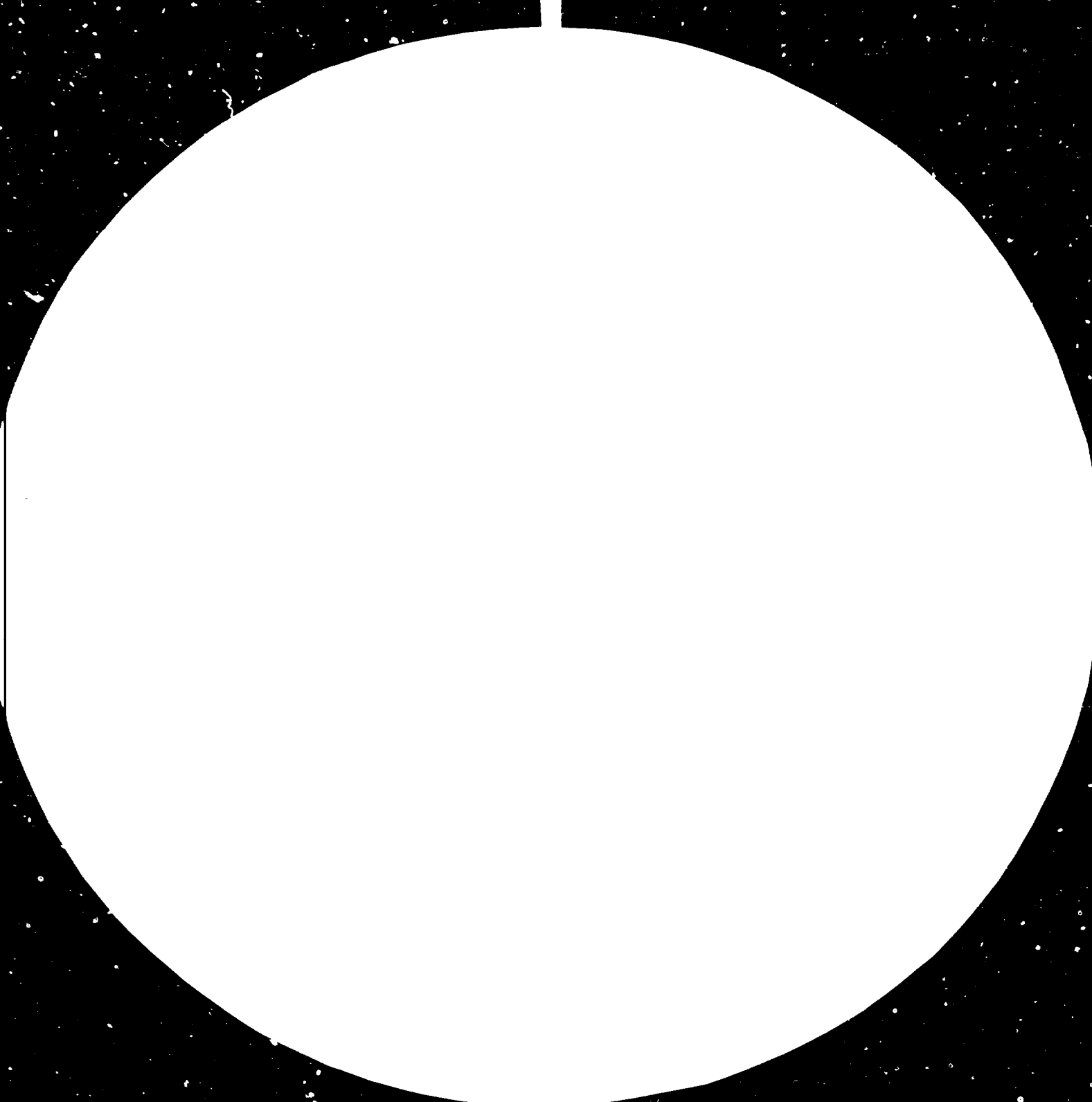
70. The identification of gaps in service capability has to be done both on a country-wide basis and for critical and priority sectors in each economy. An appropriate policy package also needs to be prescribed and the extent to which preferential treatment is necessary for national or regional consultancy services, including engineering and designing capability, needs to be defined and necessary norms and guidelines identified regarding the use of such domestic capability in an increasingly progressive manner at successive stages of industrial growth. It may also be necessary to provide technical and financial support to national consultancy firms undertaking detailed engineering and other technological services, particularly in priority production sectors.

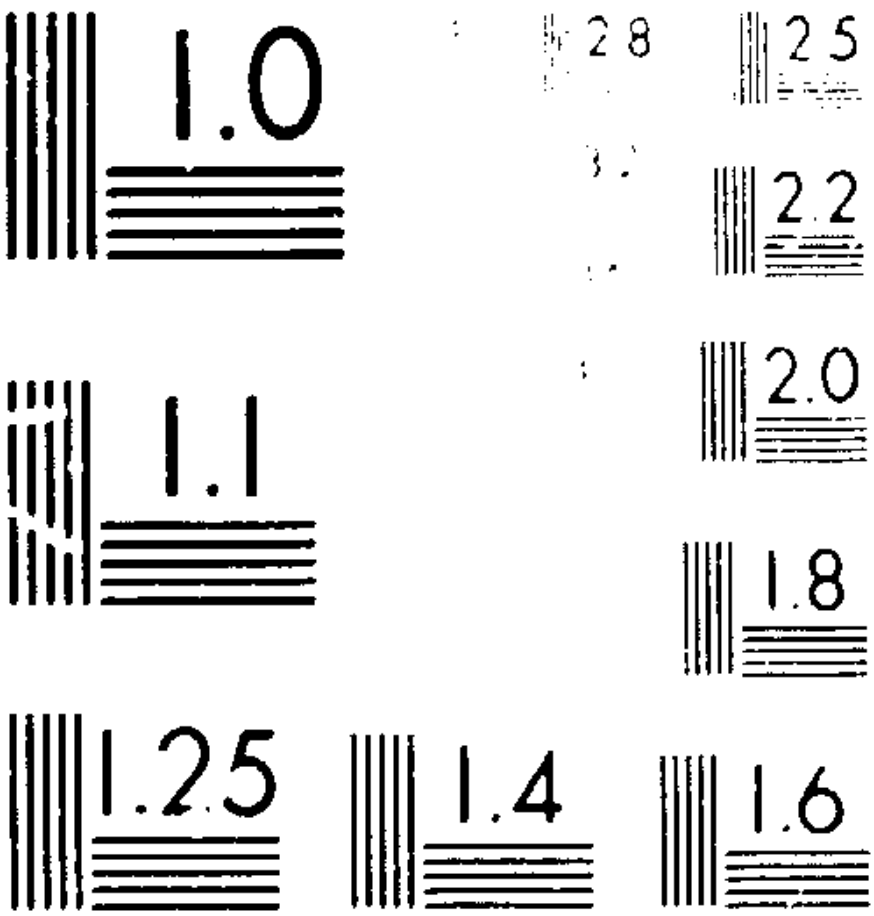
71. Technological services include the promotion of standardization, quality control, joint testing facilities, productivity, metrology and other such general service functions. They also include maintenance and repair of equipment and installations. A number of institutions already exist in Africa in several of these fields. However, they have not yet left their impact on industrial development in Africa, nor have their services been sought after by the foreign sources of technology. Productivity organizations in a number of African countries have also proved very useful in identifying specific production problems at the micro level in several industries, particularly small-scale enterprises.

(e) Industrial extension services

72. Extension services are well-established in agriculture; but not in industry. Such services could serve to accelerate the growth of manufacturing industry, especially in small- and medium-sized enterprises and, in time, provide an important input into the strengthening of national R and D activities.



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Industrial extension services could be used to: 19/

(i) Identify and resolve, to the extent possible, problems faced in manufacturing. It may be necessary, however, to refer back the more complex problems to R and D institutions for advice or resolution;

(ii) Identify new areas for the adaptation and development of appropriate technologies. Such areas might include leather, processed food, metallurgy, forest products and building materials. The work would be undertaken either in the extension centres themselves, or in indigenous R and D institutions, according to needs and resources;

(iii) Familiarize industries within the country with development and improvements in related techniques;

(iv) Train local professionals;

(v) Provide essential support for future expansion into R and D institutions and assist in the growth of other institutions;

(vi) Couple industrial technology with social technology, so as to be able to identify end users of the services and achieve credibility with them through effective action.

(f) Information needs 20/

73. Up to date, comprehensive and reliable information is essential for the formulation of technological policies and plans and their implementation. Such information needs are of considerable variety and scope, ranging from statistical, socio-economic, financial data to information on the whole technology spectrum beginning with identification of investment opportunities, pre-feasibility

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19/ See Commonwealth Secretariat, Co-operation for Accelerating Industrialization: Final Report by a Commonwealth Team of Industrial Specialists, London, 1978, pp. 30-31.

20/ See document on Industrial and Technological Information prepared for this Symposium.

and feasibility studies to information on technologies, plant and equipment, contractual conditions, legislation, operation and maintenance, training, adaptation and marketing. Technological information is proprietary and is not freely available. Few decision-makers, managers and operators in Africa today realize the extent of their need for information for correct decisions and actions, nor are they generally aware of the existence of relevant information, either at home or abroad. Information needs change continuously and sometimes rapidly with developments inside the country and abroad. These specific features of industrial information call for special consideration in the formulation of national information policies and plans.

(g) Technical education and training programmes [21/]

74. The relative scarcity of manpower in Africa has already been noted. Furthermore, illiteracy is still widespread in Africa despite remarkable innovations in education in some African countries. The educational system is still heavily biased towards the white collar professions. Technical and vocational education and training are still socially of a lower status. Even at the tertiary level there is a disproportionate bias towards the humanities and away from the technological disciplines.

VIII. KEY AREAS OF ACTION

75. It is thus clear that concerted action in a wide range of inter-related fields is needed. It is also clear, however, that it will not generally be possible to 'do everything at once', even if this were considered desirable. There is thus an overriding need for selective action in areas which will lead to an immediate and demonstrable improvement in technological capacities.

21/ See document on Industrial and Technological Manpower prepared for this Symposium.

76. One area in which action could yield very substantial results is in bringing technology and production into a relationship of co-operative association and mutual reinforcement within a framework of balancing supply and demand for technology. The main features of such action would be:

(a) Specification of demand for technology on the basis of the development goals of growth and equity;

(b) Identification of supply stocks of natural resources, manpower, institutions, external assistance, national capabilities in selecting technologies and equipment;

(c) Definition of the priority industries. For example, in Africa today it generally could be said that the food, agro-industries, engineering and non-competing small-scale industries will have priority in most cases;

(d) Considering the very wide variety of technological choices available in each of the priority industries, and balancing the supply and demand sides of technological capability, whereby a number of basic elements of a technology policy and a minimum of technological programmes could be formulated.

(e) For this purpose, expenditure on technology selection, acquisition, adaptation, absorption, development and application in the selected sectors may need to be expanded considerably above the current average level of expenditure for the rest of the economy. National policies and other public and private institutional programmes and instruments would be developed and applied so as to ensure the desired results. The supporting services, skills, legislation and regulations required would be gradually expanded to serve as an indigenous basis for promoting the development of other sectors, thus ensuring that there is a general advance, not only in technology, but also across the broader front of social and economic development.

77. In the nature of things, such an exercise may have to be carried out in stages. What is important is to take the first few steps with a clear framework for action in mind. It appears necessary for each country to develop and use a kit of basic tools for technology policy and planning which could be enlarged in due course. In this connection, consideration

may have to be given to the following lines of action:-

(a) As regards technology planning, as has been the case with development planning itself, the initial step cannot avoid being one of collecting and bringing together an aggregate of relevant programmes in the identified sectors. Major considerations in drawing up such technology programmes have been outlined earlier. After such a compilation, it would be necessary to match it with the technology demand as derived from the industrial and overall development plans. In addition, since the gestation period for technological manpwer, particularly in the case of engineers and scientists is relatively long, action to create and train such manpower will have to be undertaken in the framework of a longer term framework than, say, a five-year development plan.

(b) As regards technology policy there are at least four key areas in which immediate action is necessary and this may constitute a minimum programme in this field for each country;

(i) Assessment of relevant fiscal, monetary, trade and industrial policies in order to see that the effects are not contradictory but rather contributory to the objectives of technological development;

(ii) An assessment of the existing technological policies and the ostensibly non-technological, or implicit, policies mentioned above, to see how far they are consistent with and contributory to the development objectives of a country;

(iii) Initiation of a system to monitor technology imports, including equipment to ensure that they contribute to the growth of production and the fulfilment of development objectives. Such a monitoring system should have, as it develops, a mix of regulatory as well as promotional aspects to achieve optimum results. A variety of models exist in regard to national approaches to the acquisition of technology. Developing countries have therefore a basis of actual experience which they can utilize in selecting a model or creating one most suited to their requirements. 21/

21/ See National Approaches to the Acquisition of Technology, Development and Transfer of Technology series No. 1; Functions and Organization of National Offices for Transfer of Technology (ID/WG.228/3/Rev.1). Recent Developments in the Regulation of Foreign Technology in Selected Developing Countries (ID/WG.275/8); Review of Legislative and Administrative Systems for the Regulation of Technology Transfer Agreements (ID/WG.206/2); Guidelines for Evaluation of Transfer of Technology Agreements, Development and Transfer of Technology series No. 12.

(iv) Formulation of policies for promoting endogenous technological development and technological services. Major national roles for endogenous technological development would need to be formulated and pursued within a viable time frame. Here again several policy models exist in developing countries themselves from which other developing countries could select and develop ones of their own.

(v) The function of the broad monitoring of action in these various fields should be the specific responsibility of a unit close to development policy-making levels.

78. Perhaps, Africa today is fortunate in still possessing a fairly wide margin in the freedom of choice. Thus optimum development policies unfettered by prior commitments to ways of life whose failure is manifest today could lead to more equitable societies with fewer social tensions and disruptive forces and greater participation of the majority of the population, particularly women, in the development effort and in enjoying the benefits. Technology policies and plans based on such premises could lead to greater integration of rural and urban development, to the wide diffusion of technology to a decentralized production system based on appropriate technologies, either from the flow or stock streams.

I. INSTITUTIONS AND INSTITUTION BUILDING

1. Policies, plans and programmes require institutions or instruments to implement them. Yet, the role of institutions should neither be over-estimated nor over-simplified, as if their mere establishment would solve all problems. The value of institutions lies in their ability to provide a measure of continuity and a collective interaction of experience so that they become, in due course, depositories of technological capabilities. However they can only be effective as the policies and programmes that they help to implement.

2. The institutional framework for industrialization is complex and may be grouped broadly according to function, for example, policy, planning, evaluation, monitoring, regulation and control; resource allocation; support services, research and development (R and D) and technology; manpower development etc. Industrialization involves the building and management of institutions that harmonize and integrate resources, technology and human effort for productive processes. As such it must be considered as a total system, consisting of a whole organization of sub-systems and elements. Technology institutions are but one of such sub-systems.

3. It is realized increasingly that the rate of industrial and economic growth is catalysed and propelled by the rate and level at which technology is applied and used. Therefore technology policy planning and programming is integrated with industrial policy and planning. The technology spectrum, apart from policy and planning, covers a wide range starting with a creative idea through research, development, engineering, design, process, production, product, commercialization, market, management etc. These are all sub-systems of the technology system. An integrated system's approach is thus called to integrate the various sub-systems of the technology system into the industry system.

4. Technological institutions contribute to industrialization at the following different stages:

(a) the formulation of industrial and technological strategies, policies, plans, programmes and projects;

(b) the initiation, implementation, evaluation and monotoring of industrial projects and programmes;

(c) the rendering of technical services to industrial plants.

A detailed account of the possible contributions of technological institutions is given in Appendix 1.

Institution building

5. "Institution building may be defined as the process of establishing or transforming an organization into an integrative organic part of the community in a way that will help the organization to plan a pro-active role and in projecting new values and become an agent of change in the community."[1/] An institution must be both efficient and effective. To be effective, its output should be increased both qualitatively and quantitatively against socio-economic objectives and benefits.

6. An institution should have set goals, objectives and criteria for priorities. It should have challenges and opportunities, carefully conceived roles, well-defined tasks, a clear sense of purpose and its programme should be representative of its role in society, as well as infused with societal values. An institution must have purpose, a function, an ability to survive and to serve its clientele relevant to needs, time and environment. The effectiveness of the institution is judged on its contacts with the industry, the public and by its involvement in decision-making on economic, industrial and social development.

7. The strategies and approaches to institution building will vary from country to country in accordance with environment, priorities and the level of existing institutions.

8. Much has been said about the strategies and approaches to institution building and about the master-plan approach and organization around-the-person approach. No one can deny that in any institution it is the people that count and not the buildings and equipment. This applies even more so in a creative innovative scientific institution. For a basic research establishment, where creative geniuses should be left alone, the organization-around-person approach has greater significance. Even here, in "big" science, trans-disciplinary activity needs a master-plan approach. Further experience in regard to some advances research centres built around-the-person

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1/ Institutions Building in Education and Research, ed. G. Rave Mathai et al, All India Management Association, New Delhi, India, 1972.

shows that when the person leaves, the institution collapses. Such an institution also has a tendency for a high degree of in-breeding. Rarely, one follows either the master-plan or organization-around-person approach and institutions are better built on the basis of goals, functions and programmes.

9. Experience shows that where goals are set clearly; technological tasks well defined; tasks matched with talents and a trans-disciplinary task force set-up; and given good leadership, authority and responsibility, and the necessary in-puts, time and again the institutions have delivered results on time, if not ahead of time.

Patterns of institutions[2/]

10. An integrated and co-ordinated approach is needed for science and technology competence building. Establishing institutes alone, or indiscriminately importing technology will not help in achieving the objectives. A total technology system should be covered to make each sub-system effective. Institutes should be based on goals, functions and programmes. They can be promotional, regulatory or service institutions. This calls for a netowork of institutions for:

(a) goal setting;

(b) technology information intelligence and assessment;

(c) Technology acquisition:

(d) technology generation;

(e) technology delivery and utilization;

(f) technology support services;

(g) technical manpower development;

(h) rural institutes;

(i) regional and international institutions.

2/ Ref. Patterns of Institutions Building, Y. Nayudamma, lecture at Nehru Science Centre.

The technology institutional infrastructure needed for industrial development has been well covered.[3/] Past experience in building a wide array of such institutions around the world should help in building new or reorganizing the old institutions. However, each country may choose its own patterns to suit its own conditions. The patterns of institutions to serve each functions are presented below, with illustrative models.

(a) Goal Setting

(i) Centre for Development Alternatives (CDA)

11. The basic question is development of what and for whom? Technology is the answer but what is the question... In regard to industrial development, there are presently two set models, namely the high -capital, -energy, -machinery, -management, -technology and pollution-intensive model, and the other, labour-intensive but less productive village industries model. Both are not acceptable; but then what are the alternatives? An institution may be needed to study each industry as a total production system. The sub-system of such a system are raw materials, processing, marketing, management, etc. One may study alternatives for each of these sub-systems against a set criteria, for example: the maximization of returns for natural, human and monetary resources; equitable distribution of net gains; additional gainful employment; the increasing of workers' skills and problem-solving capabilities so that they are self-reliant and self-confident and can live in harmony with their own environment. Criteria may vary from country to country depending upon the chosen path of development. Such a study will reveal that in one sub-system, sophistication is needed and another sub-system could well be labour-intensive. Such an analysis could be done only by a trans-disciplinary group of economists, production engineers, social scientists, scientists, technologists, systems analysts, financial, marketing and management experts, industrialists, bankers and administrators.

3/ Institutional Infrastructure for Industrial Development, Lawrence L. Barber, UNIDO/ICIS.36, July 1977

12. Arriving at such alternatives would help:

(a) The decision-maker both at the plant, policy and government levels to take more rational decisions;

(b) To build a trans-disciplinary culture and a task force approach to deal with trans-disciplinary development processes. Such a culture is lacking in many countries;

(c) To unpackage a total technology package and to improve the bargaining capacity in dealing with transnational companies;

(d) To keep the public, press and goverment aware of the alternatives so that they may, if required, apply "polite persuasion" and "concealed compulsion" to make the decision-maker take the right decisions.

13. Centres for development alternatives should be autonomous, with the freedom to present their findings based on systematic scientific study.

(ii) Policy and planning bodies. National Councils of Science and Technology (NCST)

14. Science and technology policies should be interwoven and integrated with economic, trade, industry, external international and other policies. From the national development goals and alternatives, flow the technology policies, and from policies the plans, programmes and priorities, sector-wise for each industry, and inter-sector-wise. For every country an autonomous institution such as a NCST is needed to undertake such a task and provide means and funds to implement technology plans. It may be located in the National Planning Commission or in the President's or Prime Minister's Office.

(iii) Promotional and Co-ordinating Agencies (PCA)

15. Promotional and Co-ordinating Agencies may act as good links between the science and technology community and policy-makers and provide a two-way flow for formulation and implementation of research policies and programmes. Such PCAs will interact with the NCST. The job of the PCA is to identify and define technology tasks; translate national needs into technological tasks; assign the tasks to the appropriate institutions, individuals or task forces; provide facilities and funds and monitor the progress of the projects.

16. Such PCAs may have laboratories under their own umbrella or support independent institutions. They may be government or private; autonomous, semi-autonomous, or registered societies, commissions or corporations. These could also be national science academies or professional institutions or associations.

17. Some examples are separate councils for secientific and industrial research; agricultural, medical, space, electronics or energy research etc. Yet another pattern found mostly in Latin America is the state-owned autonomous foundations or corporations, where the state and development banks join together, either to set up institutions and fund them or help the industrial sector to get its work done at the research institute. This pattern is used at the Institute for Industrial Technological Research and Technical Standards (ITINTEC, Lima Peru), the Centre for Research and Development (CEPED, Brazil) and the Institute for Industrial Development (INDI, Brazil).

(b) Technology Information, Intelligence and Assessment[4/]

18. Technology tasks and priorities are derived from development objectives. Technology choices depend upon available alternatives. This calls for technology intelligence which involves awareness; access to information; ability to search for, collect and assess indigenous or imported technologies and arrive at alternatives and choices. Skills are also needed to determine criteria for relevance and choice and to evaluate the economic and social cost-benefits for a project including environmental impact. Competence is needed to unpackage a technology package and to improve the bargaining position. An early warning system is also needed to make a country aware of the scientific advances which may have a great impact on national economics.

19. To obtain such knowlodge and competence a country may set up:

(a) science and technology information centres;

(b) technology banks and a registry of patent information and imported technologies;

(c) technology regulatory agencies for import and export;

(d) teams for technology assesment, feasibility and pre-investment studies etc.;

(e) teams in investment centres and industrial development banks.

4/ See the document Action in the Field of Industrial and Technological Information in Africa prepared for this Symposium.

(c) Technology Acquisition

20. All countries import technology: more so by developing countries. However, indicriminate imports are injurious to the country. Technologies should be screened in regard to:-

(a) national relevance and local factor conditions;
(b) determination of suitable terms and conditions;
(c) disaggregation of the technology package;
(d) adequate adaptation, absorption and improvement of imported technology.

21. A proper institutional mechanism is needed badly in developing countries in the area of technology acquisition. 5/

22. To screen and to choose, one should have choices and alternatives. Such alternatives may be found at institutions like CDA or technology information and assessment centres as described earlier. Such capabilities do not exist and where they do, they work in a disjointed fashion. This requires institutionalization, integrating such sub-systems into a total system.

23. The choice should be arrived at jointly by the group that are interested in it and going to implement it: institutions concerned with goal setting, public and private industry, financial institutions, indigenous R and D and Consultancy Engineering firms and regulatory agencies. They should all be involved in choosing, adopting, absorbing and improving acquired technology.

24. Even where the scientific infrastructure is not big, a small trans-disciplinary team comprising economists, social scientists, scientists, technologists, systems analysts etc., will be able to serve this very important function. A well trained team associated with the President's or Prime Minister's office, will play a crucial role, particularly in regard to technology acquisiton.

25. The success of the Korea Institute of Science and Technology (KIST) in the Republic of South Korea is attributed mainly to its capacity in this area. Similarly, the succes of Japan is reportedly due to the fact that

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5/ See National Approaches to the Acquisition of Technology, Development and Transfer of Technology series No. 1; Functions and Organization of National Offices for Transfer of Technology (ID/WG.228/3/Rev.1). Recent Developments in the Regulation of Fereign Technology in Selected Developing Countries (ID/WG.275/8); Review of Legislative and Administrative Systems for the Regulation of Technology Transfer Agreements (ID/WG.206/2); Guidelines for Evaluation of Transfer of Technology Agreements, Development and Transfer of Technology series No. 12.

the Ministry of International Trade, export and import firms, the entrepreneur, the banker and the R and D institutes work in unision as a single team to collect information and to assess, select, adapt and improve upon the imported or indigenous technology.

(d) Technology generation

26. Scientific research is both basic and applied. A variety of research institutes exist. An institute will be effective only if it becomes a part of a total technology spectrum with well-defined goals and objectives.

27. The advice is often given that basic research is not essential for a developing country. What is basic today is tomorrow's applied reasearch. It is the basic research that gives breakthrough technologies and creative leadership.

28. Basic research is carried out mainly in universities, higher institutes of technologies, advanced research centres set up within or outside the university campus. These may be national, regional or international centres. Centres of excellence may be set up by the universities or separately funded by PCAs. As indicated earlier, the strategy of orientating organizations-around-the-person may be the best approach for such centres.

29. The applied and industrial research institutes are set up to conduct research both for problem-solving and forward-looking research and to generate, disseminate and sell technologies relevant to the national needs; to better utilize resources, to substitute imports and promote exports; to set standards, quality control and improve productivity. They should be planned as a part of the total system with firm linkages with industry and others concerned.

30. The applied and industrial institutes may be state, federal, regional, international autonomous, semi-autonomous; government corporations or societies; private, non-private foundations or research centres captive to the private industry or public enterprise, or to an individual ministry. Such institutes may be co-operative research associations, managed jointly by industry and government. Industrial research centres can also be located in technological universities and higher institutes of learning. What is important is that they are autonomous.

31. An institute may be oriented to a single discipline, for example chemistry and physics, or a single industry for example leather or food, or a single purpose or may be a multipurpose institute covering resource surveys, research, pilot plants, extension, training, standards etc. They could cover only basic or applied research for both. Institutes such as research laboratories may also be set up to meet the special needs and utilize resources of an undeveloped region.

32. These institutes may be funded fully or partly by the government or by the industry directly, or through research contracts. Some institutes may have to run partly on profits ploughed back from their production units. Yet another method of funding is to make the institute a technology partner with the industry to generate, acquire, adapt, absorb and improve upon technology. The institutes may have thus a captive industry of their own.

33. Another pattern is for the PCAs to define what the national priority projects are and to assign them to individual institutions or a group of institutions or to a trans-disciplinary, trans-organizational task force, utilizing the best of the abilities and facilities available, and to fund such projects as a national priority. Such a funding mechanism will also bring about a trans-disciplinary culture that is so much needed in several countries. National priority projects may also be put out for tender.

34. ITINTEC obtains funds through taxation of industry (two per cent); it scrutinizes the projects and their priorities and assigns the projects to the industry, individually or collectively to conduct research. 6/ If the industry does not accept the job, it will be assigned to national research institutions. Several countries offer incentives for encouraging industry to conduct research on its own or through contact research with the national laboratories and universities.

35. Research conducted by the industry undoubtedly has a greater prospect of being utilized. The motive for this research is profit maximization and the areas for research may or may not fit into the national goals and priorities. Incentives should be given to industry to conduct research only in the areas of relevance to national needs and priorities.

6/ The Industrial Research Institute in a Developing Country, a Comparative Analysis, J.P. Blackledge, USAID, 1975

(e) Technology Delivery and Utilization

36. It is not enough to conduct research, it is necessary to sell and deliver technology at the doors of those who need it. One reasonably sure way would be to have research responsible to industry itself. Even then, in developing countries with protected markets, there is no incentive for industry to do research and the industry set up with collaboration depends upon the foreign firm for research.

37. The technology delivery system may be organized as follows:-

(a) technology transfer centres;
(b) extension services centres;
(c) information centres;
(d) consultancy, design and engineering companies;
(e) poly-technology clinics;
(f) district industry centres;
(g) adoption of villages or districts by scientific institutions;
(h) voluntary agencies involved in the rural development;
(i) technology brokers;
(j) national R and D corporations etc.

The delivery systems may be a part of a research institute like in agricultural research or may be separate agencies with a strong link between a research generator and user. The consultancy services or the industrial technical service centres of the universities may also play a role.

38. If technology is for people, people should be involved. To people, seeing is believing. If it could be practically demonstrated how through the application of science and technology their living and working conditions can be improved, drudgery reduced, economic returns increased; then the people will believe in the use of technology. Their scientific attitudes and scientific temper will improve to constantly look out for a change for the better. Therefore, social transformation is a pre-requisite for technology to be fully utilized. Popularization of science through the media of journals, books, films, science centres, science museum etc. have yet to play a positive role in most developing countries. If only the potential creative, innovative abilities and problem-solving capabilities are improved, every person will become an asset in society.

(f) Technology Support Services

39. In the technology acquisition, generation, transfer and utilization, several institutions lend support.

40. Industria service centres, management development centres, universities, professional associations, both local and foreign consultancy firms; standards organizations, national registries for patents, technology imports and technology transfer; repair and maintenance centres, market intelligence centres etc. provide such support services.

41. Technological extension, consultancy and advice would cover both the technical and managerial fields. Technical advice is related to selection of technology, equipment, plant layout; equipment installations, maintenance, modification; raw material use and changes; process improvement and innovation; productivity, quality control and testing; product design and re-design. Managerial advice is, however, related to investment, organization, personnel, purchase, market, public relations, project profiles and pre-investment studies etc. 7/

42. Development banks have a major role to play. They may help in ensuring institutes' results joined with industrial interests; jointly seek an entrepreneur, jointly provide the evaluation of projects; pre-investment studies; technology for environmental protection; identify gaps in the industrial spectrum and adoption and modification of technology for small and medium-scale industry development. The development banks may also provide risk capital to set up pilot plants, proving plants particularly for commercializing indigenous technology facing undue competition from proven imported technology. National development research corporations and others also may act as technology brokers.

(g) Technical Manpower Development

43. This topic has been dealt with in a separate paper, 8/ but a brief mention may be made here to emphasize the need for trained manpower at different levels such as skilled workers, technicians, technologists, scientists, production engineers and managers. Special training is needed in the areas of selection, acquisition, adoption, absorption and development

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7/ Lawrence L. Barber, UNIDO/ICIS.36, July 1977

8/ See the document Industrial Technology Manpower in Africa prepared for this Symposium.

of technology. Similarly, special competence is needed for research management, policy and planning and evaluation of research.

(h) Rural Institutes

44. Modern technology is born out of urban industry. Even research institutes located in cities are cut away from rural realities. Further the technology for the rich and the elite may not necessarily suit the poor. There are technologies to increase the skills and productivity and problem-solving capabilities of the people, particularly in the rural areas. Traditional technologies have a place. The science behind tradition has to be studied, improved upon and alternative technologies developed to meet the real needs of the poor. Imported technologies may not be relevant or suited to local resources and the native genius of the people. Technologies have to be presented to the rural people in a manner and language understood by them. Therefore, technology should be aligned to the needs of the country.

45. The main question is how to institutionalize the system. One way is to locate research institutes in rural areas which would be aware of actual problems and make relevant research. Rural universities are based on this concept. In this case it should be ensured that creative research does not suffer because of intellectual isolation.

46. Another way is for urban research institutes to have a special rural cell or extension centre in the rural areas. Yet another way is to send the research workers to the villages at frequent intervals to familiarize themselves with rural problems, so that their research programmes can be reassessed and made relevant.

47. A number of institutes have sprung up in recent years for developing the so called village, rural, appropriate, intermediate, alternative, and soft technologies in several countries, including African countries. Some of these tend to work with considerable zeal but in an isolated fashion. How far these have been effective and if not why they have not been so deserves careful scrutiny.

48. The major function of the rural institute should be at two levels:-

(a) to improve tools, techniques and skills at the village level;

(b) to improve leadership and entrepreneurial qualities.

49. The examples of Brazil and Colombia in setting up institutes like the Foundation for the Development of Scientific and Technical Research (FICITEC) and a combine in Brazil like SEPLAC, CEPED, EPEX which help research institutes offer credit, technology and extension services for rural areas are models that can be tried. For instance in India, the Council of Science and Industrial Research (CSIR), has attempted with mixed success to adopt districts containing two to three million people, to bring science and technology to the doors of the rural people.

(i) Regional and International Institutes

50. Complexities and rising costs both in basic and applied research are forcing nations to co-operate and set up multilateral institutions. These may be simple co-operative efforts; a network of national institutions or international institutions set up by international, governmental or non-governmental organizations.

51. The national centres that have proved to be a success could also be considered as international centres, whose facilities could be utilized by other countries.

52. Some of the outstanding examples of international centres are the International Institute for Applied Systems Analysis (IIASA), the United Nations University and institutes like the International Rice Research Institute etc.

53. Another interesting pattern is that of the International Development Research Centre (IDRC) and the Consultative Group on International Agricultural Resources (CGIAR) which define problems of national and regional interest and fund research in appropriate institutions or set up international institutes in developing countries.

54. Networking of similar national research institutes in the region would help to pool abilities and facilities, reduce costs, time, achieve the desired results and build self-reliance. Networking of institutes in bio-sciences, chemistry etc. are being attempted by the Committee on Science and Technology for Development in Developing Countries and the International Council of Scientific Unions, COSTED/ICSU in Asia, Africa and Latin America. Centres of excellence for both basic and applied research sould serve as regional or international centres.

55. Some fruitful results have also been obtained by networking institutes in the developed countries with those obtained in developing countries. Some examples are the Battelle Institute collaborating with KIST.

56. Technology institutes should have close and firm linkages with related institutes within the country, forming a part of a total integrated system. To supplement and compliment their competence, they may establish close contacts with other institutes within the region, across the African continent and other developing and developed countries of the world.

II. AFRICAN INSTITUTIONAL ARRANGEMENTS FOR INDUSTRIAL TECHNOLOGY DEVELOPMENT

57. In the light of the above classification of institutions, according to type and function required for industrial development, it will be useful and essential at this stage to make an overall survey and assessment of the technological institutions now available in Africa, the functions performed by them and their relevance to national development objectives, government policies, programmes and perceptions, and industry's problems and needs.

58. It can be seen from Table 1 that policy-making for science and technology do exist in most countries in Africa. How effective these have been is yet to be assessed. The African regional science and technology promoting agencies are the Science and Technology Unit of ECA; UNESCO's Regional Office for Science and Technology (ROSTA) and the Science and Technology Commission of the Organization of African Unity. Several UN agencies like FAO, UNESCO and UNIDO deal with sectoral issues.

59. Contrary to widely held belief, Africa does possess a sizeable institutional structure for indigenous technology operation. In fact, most African countries do have some kind of basic institutional infrastructure for the development of industrial technology, it is even possible that the institutional preconditions for self-sufficiency in technology production in the region have been underestimated. Ten years ago, UNESCO studied the scientific and technical potential of 40 African states which indicated that 3,300 scientific and technical research

Table 1: Policy-Making Bodies for Science and Technology in African Countries

Country	Ministry of Science or ministerial science policy committee	Science planning body - general	Multisectoral body for co-ordinatig scientific research	Co-ordinating bodies for scientific research					
				Natural sciences research	Agricultural research	Medical research	Nuclear research	Industrial research	Environmental research
Algeria	x		x					x	
Burundi									
United Rep. of Cameroon		x	x		x	x		x	
Central African Empire		x	x		x				
Chad			x		x				
Congo			x		x	x		x	
Dahomey			x		x	x		x	x
Egypt	x		x	x	x	x	x	x	x
Ethiopia			x	x	x	x		x	x
Gabon	x	x	x	x	x			x	x
Ghana		x	x	x	x	x		x	x
Guinea	x	x	x	x	x	x		x	x
Ivory Coast	x	x	x	x	x	x		x	x
Kenya		x	x	x	x	x		x	
Lesotho									
Liberia		x		x	x	x		x	
Libya		x		x	x				
Madagascar	x		x	x	x				x
Malawi			x	x	x				
Mali		x	x	x	x	x		x	
Mauritana									
Mauritius									
Morocco					x		x		

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				Natural sciences research	Agricultural research	Medical research	Nuclear research	Industrial research	Environ-mental research
Niger		x	x	x	x			x	
Nigeria		x	x	x	x	x		x	
Rwanda		x			x				
Senegal		x	x	x	x	x		x	x
Sierra Leone									
Somalia									
Sudan		x	x		x	x		x	x
United Rep. of Tanzania		x	x	x	x	x		x	x
Togo	x		x		x	x			x
Tunisia	x	x		x	x	x			
Uganda		x	x		x	x			
Upper Volta	x	x	x		x	x		x	
Zaire		x	x	x	x	x	x		
Zambia		x	x		x	x	x	x	

Sources: (a) Science and technology in African Development (UNESCO document SC/CASTAFRICA/3), Table 1

(b) National Papers on UNCSTD

institutions existing at the time, and covering almost all branches of science, no less than 355 were involved in some aspect of industrial reasearch. 9/ It is safe to conclude that the number of industrial research institutions has grown since then. In addition, a fair number of bilateral, multilateral, subregional and regional industrial and technological institutions have been established also. Some examples are the Association of Industrial Technology Organizations, African Network of Scientific and Technological Institutes, African Regional Centre for Technology, the Remote Sensing Council, the Mineral Resources Development, Industrial Property Office, Network of Education Innovation for Development, the Regional Centre for Engineering Design and Manufacture, and the Regional Centre for Soler Energy. These are some intergovernmental agencies. The non-governmental agencies are the African University Associations, based in Ghana and the African Association for Advancement of Science and Technology, based in Senegal.

60. Some examples of industrial and technology development institutes are the Mauritius Sugar Industry Research Institute, the Nigerian Institute of Palm Oil Research, the Engineering Industrial Design Development Centre Egypt; the School of Industrial Technology, Mauritius; the Industrial Technology Consultancy Centre, Ghana, etc.

61. There are several rural technology institutes and centres in Botswana, Kenya, Lesotho, Liberia, Mali, Nigeria, Swaziland, Tunisia, the United Republic of Tanzania, Uganda, Upper Volta, Zaire and Zambia.

62. A recent document gives a detailed account of science and technology organizations and projects in Africa. 10/

63. In terms of numbers, Africa would appear to have more industrial and technological institutions and research personnel that it is frequently given credit for. While the impact, and perhaps also the overall number, of these institutions is still far short of the demand, it would be worthwhile assessing and evaluating their effectiveness in meeting the technological needs of the African countries. Such an evaluation is important, not only in improving effectiveness, but also in identifying the gaps that have to be filled by new institutions and in planning for the establishment of such new institutions.

9/ See the document Industrial Technology Manpower in Africa prepared for this Symposium.

10/ Prepared for the Conference of Governmental Experts and Technical Co-operation Among Developing Countries, Nairobi, Kenya (TCDC/AF/7, March 1980), 12-20 May 1980

III. ASSESSMENT OF PERFORMANCE OF EXISTING AFRICAN TECHNOLOGY INSTITUTIONS

64. The institutions may be assessed not only for their efficiency but also effectiveness in meeting national needs and acting as change agents. The institutions can also be examined in the light of its research to real needs, its indigenous competence to regulate imports of technology and for engineering, production, commercialization and utilizing technologies acquired or generated.

65. In an anxiety to catch up with advanced countries, developing countries have followed imitative strategies for growth and institution building. This has resulted in an enclave character with institutions becoming a part of an elite system, alienated from the majority of the people living in rural areas. Most research institutes have been oriented more towards science than technology. Though technology is people- location-resource and culture-specific, the research carried out has often been oriented internationally rather than within the context of a country. It is time institutes reexamined and reassessed programmes and also studied traditional technologies with a view to improving them. The existing skills in the country have to be upgraded, not uprooted.

66. Past experience has shown that science and technology will not automatically interact with society even if the infrastructure has been built, talented scientists recruited, funds and facilities provided. Several internal and external constraints affect the functioning of the institutes.

67. Institution building raises many problems relating to co-ordination and monitoring of activities. It is a difficult process that needs a good deal of time, effort and money before an institution can be expected to fulfil the functions for which it has been envisaged. It either takes over some of the functions of older institutions or assumes new functions. In either case, it could face a lukewarm reception or even hostility and lack of recognition. In the early years the success of a new institution largely depends on the tenure, personal qualities and standing of the director vis-à-vis government and business. Institutions that fail to assert themselves, establish their viability and prove their value in their early years usually exit afterwards in a limbo of marginality and frustration, as they continue in vain the search for a positive role that

would justify their support. Once an atmosphere of disenchantment has set in, internal discipline breaks down and it can become extremely difficult to revitalize a demoralized institution without resort to measures that may not be always socially acceptable.

68. As mentioned earlier, although a number of countries have science and technology policy bodies, apparently only a few have institutions to regulate the flow of foreign technology in Africa, for example, Algeria, Egypt, Ethiopia and Nigeria etc. These are still in their infancy and not much can be said about their effectiveness.

69. The result is that in a number of cases, inappropriate technology has been imported on terms and conditions that not only adversely affect the foreign exchange resources of the African countries, but inhibit local technological innovation. Furthermore, even where contracts with foreign firms and enterprises include clauses for the "Africanization" of the top technical and management cadres, there is no systematic government machinery to ensure that these obligations are fulfilled.

70. Further, for historical reasons, arising from not distinguishing between science and technology, emphasis in most African countries has been placed on the establishment of industrial R and D institutions, presumably to promote technological self-reliance and develop indigenous technologies. However, in order to create the required national technological capability, there is a need for an effective technological infrastructure which includes not only the research institutions, but also the other elements of the development process such as government entities, development banks, universities and polytechnic institutes etc.

71. A joint UNIDO/UNDP study shows, however, that once established, these institutions are usually left out of the mainstream of the industrial development process. 11/ In most cases the government is not fully aware of what the contribution of the institution should be. There is little monitoring of the effectiveness and evaluation of research results and then utilization. The staff of industrial research institutions do serve on various government committees from time to time; but there is no consistent attempt on the part of most governments to use their expertise regularly

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11/ Joint UNDP/UNIDO Evaluation of Industrial Research and Service Institutes. UNIDO/EX.79.

in planning similar functions. Technology acquisition, adaptation, absorption and improvement on imported technologies . The institutions need more goals, well defined technology tasks and greater active participation in formulation and implementation of technology policies, plans and programmes.

72. Several African governments are attempting to control or reduce importation of foreign technology in an attempt to reduce trade deficits and strengthen indigenous capacities. But the many hundreds of industrial research institutions in Africa still do not participate actively in technology transfer and adaptation which is the golden road to innovation. A systematic study of locally available technologies and the upgrading of these technologies through the application of modern science and technological know-how is an important activity of these institutions.

73. The survey by an UNCTAD team [12/] of a few African Technology Institutes shows lack of indigenous capabilities and adequate mechanisms for (a) identifying technology needs; (b) searching for alternative technologies; (c) evaluating and choosing relevant technologies from indigenous or imported sources; (d) adoptation, diffusion, generation and utilization of technologies.

74. The structure, size, organization and management of an institution is critical to its smooth operation. Its governing council comprising of enlightened leaders representing different interests like industry, government, academic bodies plays an important role in posing challenges, giving direction, support and guidance and providing active linkages. But unfortunately such councils tend to be more honorary than operationally oriented. In the absence of the government or industry making specific demands on the institution, the director and staff formulate programmes which they consider relevant or which are internationally oriented.

75. A venture-oriented, flexible, decentralized participative management and creative leadership are needed to maintain research institutes and provide an environment conducive to creative activity. Mobility of scientists and a fresh flow of talents are needed to make institutes effective. The present administrative set-up is rule and procedure oriented and not result and achievement oriented.

12/ Technical Report of Exploratory Mission 1976.

76. Not only in Africa, but in all developing countries, there are several internal and external constraints for technology institutes. These are the lack of:

- clear goals
- proper planning and co-ordination
- leadership
- finance and foreign exchange
- trained manpower
- incentives and prestige for technologists
- links with industry, government and other academic bodies; consultancy and engineering firms and extension services
- spare parts
- maintenance and repair services
- communication and intellectual interaction and an environment conducive to creative research and a critical mass in each discipline
- common research in industry-culture

Such constraints contribute to the ineffectiveness of any technological institution. Failure to define goals, objectives and technology tasks and provide links are the major causes for ineffectiveness. Despite such severe constraints some African technology institutions have a number of achievements to their credit.

IV. A FRAMEWORK FOR ACTION

77. A critical examination of the general patterns of institutions, the existing institutional arrangements in Africa and a preliminary assessment of their performance should help identify priority areas for new institution building and activate and strengthen the existing institutions. Short and long term plans may also be drawn up for action at national, regional and international levels. These are discussed below.

National Level

78. The priorities for strengthening existing institutions or building new ones can be seen in the light of action programme in the different areas discussed in the symposium, as well as in regard to the different industrial sectors. The Plan of Action for the Implementation of the Monrovia Strategy for the Economic Development of Africa [13/] have specified seven priority industrial sectors, as follows:

Food and agricultural industries
Building materials and construction industries
Engineering industries
Metal industry
Chemical industry
Forest-based industries
Energy industries

79. Taking each of these industries as a separate production system and knowing technology contributes to it in several ways, the specific tasks have to be delineated. Only then would the type of institutions, new or old, that would undertake these tasks become clear.

80. The earlier discussion also brings out clearly that the technology spectrum itself has many sub-systems. The institutional gaps, deficiencies and redundancies could be identified more clearly by using a check-list or a diagnostic matrix as given in table 2 below.

13/ Plan of Action for the Implementation of the Monrovia Strategy for the Economic Development of Africa (ECM/ECO/9(XIV) Rev. 1).

Table 2: Institutional gaps and deficiencies: A Diagnostic Matrix

Functions \ Sectors	Food and Agro-Industries	Bldg. material and Construction	Eng. Ind.	Metal industry	Chemical industry	Forest-based ind.	Energy industry	Other sectors
Selection of Technology								
1. Technological information and awareness								
2. Tech. evaluation								
3. Feasibility study								
4. Project evaluation								
Acquisition of Technology								
5. Acquisition process								
6. Negotiation								
Adaptation of Technology								
7. Adaptation of products								
8. Adaptation of processes								
9. Adaptation of equipment								
10. Adaptation of raw materials								
11. Survey of raw materials								
Absorption of technology								
12. Manpower planning								
13. Manpower training								
Development of technology								
14. R and D								
15. Pilot plant								
16. Scaling up								
17. Upgrading traditional technology								
18. Commercialization								
19. Extension								

Table 2: Institutional gaps and deficiencies: A Diagnostic Matrix

(Cont'd.)

Functions \ Sectors	Food and Agro-Industries	Bldg. material and Construction	Eng. Ind.	Metal industry	Chemical industry	Forest-based ind.	Energy industry	Other sectors
Technological Services								
20. Testing								
21. Quality control								
22. Standards								
23. Market analysis								
24. Techno-economic studies								
25. Consultancy								
26. Basic engineering								
27. Detailed engineering								
28. Problem-solving								
29. Production engineering								
30. Productivity								
31. Product design								
32. Technology awareness								
Contribution to Policy and Planning								
33. Tech. surveys								
34. Tech. programmes								
35. Tech. policy								
36. Tech. planning								
37. Development planning								
38. Tech. forecasting								

81. Once the national needs, technology tasks and priorities are determined, a systematic search may be made among the existing institutions capable of matching and serving these needs. For this purpose, as a first step, a Directory of Technological Institutions may be prepared for each country since information about the various institutions that constitute the technology spectrum is rather scanty.

82. A similar study might be made of the existing technical manpower, and the level of technical competence and also to assess the future technical manpower needs, based on the demands of industry.

83. The next step would be to analyse the strengths, weaknesses and opportunities of each technology institution and the factors which might affect them. A study should be made of their present efficiency and effectiveness against set goals and the gaps should be identified where new institutions might be created, existing ones strengthened or combined and non-productive ones phased out.

84. As regards the demand and supply side of the technology system, it may be better initially to think in terms of functions or services rather than institutions per se. A balanced approach would be to see how these functions or services could be provided either by the existing institutions or by setting up task forces and building new institutions where it is deemed essential.

85. An integrated and systems approach is called for in developing indigenous technology competence. Sporadic or disjointed efforts or establishing a few institutions here and there will only lead to waste. No matter what the other constraints are, every country should attempt to be self-reliant in that it should be sufficiently competent to make an autonomous decision. This may or may not require large institutions. A trans-disciplinary group of economists, scientists, technologists, production engineers, systems analysts, social scientists, planners,

financiers, industrialists and administrators may be entrusted with the task of collection, analysis and assessment of information and providing the decision-maker with alternatives and choices relevant to national needs and priorities. Even a small country with little or no infrastructure for industry and industrial technology will be greatly benefitted if such a group is set up and located close to the seat of power and decision-making. If it is to be institutionalized, Centres for Development Alternatives or national technology centres may be established.

86. Such a team or centre may also help in identifying the real needs of the country, translating these needs into technological tasks and assigning them to competent institutions. Goal setting and posing challenging problems are very important, particularly to science and technology institutions.

87. The main focus must be on setting clear goals, functions and services and getting the job done by trans-disciplinary and trans-organizational task forces matching the tasks with talents and facilities wherever they may be found. The emphasis is not on building institutions but on getting the job done by a teamwork approach.

Strengthening the Existing Institutions

88. Having recommended focusing on functions and services, rather than institutions. alternative mechanisms for performing functions or providing services should be carefully considered. If a country is willing to forego the prestige of having an institution, even one of doubtful value, it should consider the pragmatic approach of using existing institutions to do the new job. This could be achieved in a short period of time and without too much expense by restructuring the institution, providing fir~ linkages with other institutions and by allocating additional tasks and responsibilities together with supplemental inputs. This may be an interim measure that might well fail to meet fully the long-term national development

goals; but it safeguards against the establishment of institutions that are underutilized. Such an approach calls for considerable governmental guidance, management and supervision which, as has been noted earlier, are not often provided by governments to existing institutions. Examples of alternatives for a variety of functions are given below:

Functional Activities	Existing Institutions (Capable of undertaking the activities)
Support Services	
standard specification, analysis, testing, quality control, certification etc.	government or independent testing laboratories
technical information	national libraries, university libraries and departments
Technical Extension Services	
problem-solving, trouble-shooting, industrial engineering	productivity centres, consulting engineering firms, small industries service centres
Training	
graduate level	universities
vocational level	productivity centres
	factories
Research and Development	
product and process development, materials	R and D institutions
	universities

Policy and Planning

Technology, information assessment, acquisition	National Councils for Science and Technology Planning Commission

89. It has often happened in the past that more than one institution, even in the same country, works on the same problem. Such duplication should be avoided unless the approaches to tackle the problem are different. Even then, the lines of responsibility should be clarified and resources concentrated for achieving maximum benefit.

New Institutions

90. Where it is considered necessary to establish a new institution, the process may involve the following practical steps.

(a) Examine whether the new functions could not be entrusted to an existing institution;

(b) Examine the time horizon of the activity and check whether it is needed on a relatively short-term basis or whether it will be a permanent new function and investigate its long-term prospects of quantitative and qualitative development. It may well be that an ad hoc arrangement is more suitable to actual needs;

(c) Check whether the institution will be in a position to play the role envisaged for it in good time or whether there is need for interim measures that should be closely co-ordinated with the process of institution building;

(d) Elaborate a complete feasibility study detailing resources needed, time schedule and implementation phases. Wise planning would see to it that each phase could stand on its own and prove of value, even if consequent phases are delayed a very common occurence in developing countries.

91. Though many countries have national science and technology councils, the majority of them have not clearly established the competence for technology assessment, technology choice and technology acquisition. As stated earlier, a trans-disciplinary team or CDA may well tackle this task. But trained people are needed for this purpose. The task of training such a trans-disciplinary team of people in this very critical area may be taken up urgently.

Shared Programmes

92. Once a portfolio of projects of national priority is available for each country, they may be assigned to a competent institute, or institutions or task forces drawn from different organizations within the country and across the countries that have a mutual interest in these programmes. In the case of services and R and D institutions, effective linkage has a "Gestalt" effect, since the exchange of information on what other institutions can do, are doing, or have done is in essence the building-up of collective experience and wisdom. Linking up institutions is not without its problems, particularly if it infringes on the autonomy of the institutions or tends to establish a hierarchical structure of institutions. Setting goals,defining the tasks and subtasks clearly, who is to do what, authority and responsibility, distribution of benefits accrued thereby etc. have to be clearly spelt out at the very beginning of the project. How to give the individual researcher the desired degree of freedom and flexibility and yet make him or her a part of the team requires good management. Yet, an institution that is obviously better endowed and that has wider experience and contacts and which enjoys the respect of others could, and should, play the leading role in the network, national or regional, of similar institutions. By acting as a focal point for the exchange of information and experience, assignments beyond the capabilities of a single institution could be tackled with success. Furthermore, in the past, it has often been the case for external assistance from the same source to be fragmented, in a repetitive

manner, over similar institutions in the same country or in different countries, to the dissatisfaction of both the donor and the recipient. If this be rechannelled on a bi-multilateral basis from a single donor to an efficient network of institutions, the role of the leading institution in the recipient network becomes decisive in ensuring maximum benefit to all participants. There are indications that the sources of external assistance might also favour such an arrangement.

Twinning of Industrial Technology Institutes

93. Yet another way of supplementing and complementing an individual country's competence is to have a sister relationship between an institution in a country with a similar institution in another country in Africa or in any other developing or industrialized country. Exchange of personnel both at senior and junior level, exchange of information, manuals, books etc., joint research projects, sharing of equipment and facilities etc. over an agreed period of time would prove very helpful. UNIDO might assist in bringing about such a twinning programme.

Lead Centre or Centre of Excellence

94. Another variant of the same approach to effectively using leading institutions, is designating them as regional centres and entrusting them with regional responsibilities, in addition to their national ones and strengthening them as appropriate.

Networking of Institutions

95. Institutions set up for specialization of specific disciplines may be brought together as a network to cover the total spectrum. A network for bio-sciences, chemistry or design consultancy and engineering enterprises are examples. Each may specialize in a given area but put together the network provides total competence. Such networks could be national, regional and international.

96. In all such cases, clarity of objectives and tasks, each unit or centre's sense of involvement, pride of achievement and each supplementing and complementing others' competence is important. Co-operation is best among equals.

External Technical Assistance

97. This is discussed in detail in a separate paper. 14/ Foreign assistance plays a critical role in institution building and care should be exercized to recongize its relevance to local needs. Attention should also be paid to make good use of the African scientists and technologists that are presently abroad. Bilateral scientific and technology collaboration agreements could also be properly utilized for technical aid, assistance and co-operation.

Regional Level

98. The importance of regional and international co-operation among developing countries is well recognized as an instrument for promoting collective self-reliance. Some of the institutional arrangements in this regard are indicated below.

(1) Joint programmes for research and training in skills;
   (a) research management;
   (b) methodologies of evaluation of technology assessment and technology and future etc.

(2) Setting up of, or using the existing centres of excellence for serving the needs of a region.

(3) Regional activities could include such as:
   (a) studying development alternatives;
   (b) joint access to technology and patent information;
   (c) technology assessment, technology and future, joint acquisition of technology;

14/ See the document External Technical Assistance prepared for this Symposium.

(d) acquisition of technology;

(e) industrial technology generation, transfer and utilization;

(f) development of appropriate or alternative technologies and improvements on traditional tools, technologies and skills;

(g) setting standards;

(h) developing capacities for the production of instruments, equipment and process controls.

(4) Increased utilization of technological services of other developing countries;

(5) Greater inflow of techniques and processes between enterprises in developing countries;

(6) Networking similar or related institutions.

99. Such regional activities will be governed basically by the ground rules as applied to the joint endeavours within the country. Such co-operative ventures could be between the African countries and between them and other developing countries and developed countries.

International Level

100. International agencies that offer assistance in technology areas would include:

United Nations Agencies, International financial institutions, non-governmental and inter-governmental organizations, bilateral and multi-lateral aid agencies.

Some of the patterns of international institutions have been mentioned at the beginning.

101. By way of immediate action, UNIDO in co-operation with other organizations could help internationally in:

(a) Organizing a well designed training programme for a trans-disciplinary team from each country in the areas of technology assessment, technology choice, development alternatives etc. This may be done by keeping a core group at UNIDO and bringing the teams for each country to UNIDO or the core group or groups going to each country or by blending both mechanisms. The World Bank and others who may have a complementary role in this area may be utilized;

(b) preparing inventories of African technological institutions, their capabilities and identifying their needs for assistance;

(c) identifying common R and D and other problems that may be of mutual interest to a group or groups of countries promoting the implementation of action programmes in the relevant fields;

(d) helping to set up national centres, centres of excellence, regional centres, networks of institutions etc.;

(e) organizing joint training programmes in the area of research management and other special skills needed;

(f) helping to set up CDA type of networks and helping to build collective self-reliance in several sub-systems of the technology spectrum;

(g) promoting regional, international co-operation between the African countries themselves and between them and other developing and developed countries.

Appendix 1

POSSIBLE CONTRIBUTIONS OF TECHNOLOGICAL INSTITUTIONS TO INDUSTRIALIZATION [1/]

A. National industrial planning, programming and evaluation

1. Macro-planning stage

Technological forecasting
Techno-economic analysis
Provision of technical information and data required for:

- The preparation of national development strategy and plan
- The establishment of the required institutional framework
- Decisions on decentralization (industrial parks and estates)
- Development of small-scale industry
- Exports and import-substitution considerations
- The establishment of infrastructure and power requirements
- Manpower development
- Other technical inputs to the development plan

2. Sectoral planning stage

Identification of technical possibilities
Technology plan
Translation of macro-stage targets into sectoral targets
Provision of technical information and data required for:

- Establishment of sectoral priorities
- Development of a strategy for sectoral development
- Analysis of intersectoral relationships
- Development of sources of information and data
- Proposals of goals and programmes
- Manpower requirements

1/ UNIDO ID/WG.246/6 9 March 1977 Utilization of National Technical Institutes in the Developing Countries for Industrialization. Report of an Expert Group Meeting, Trinidad, February 1977.

3. Project planning stage

Provision of technical information and data required for:

Identification of project options

Selection of appropriate technology

Decisions on new projects or expansion of existing productive capability

Selection of indigenous or foreign technology

Development of industrial priorities

Manpower development

4. Specific considerations for planning

Assessment of availability and adequacy of project site

Assessment of inputs, such as raw materials, fuel and power, trained labour, managerial talent

Analysis of the social and economic appropriateness of technologies

Analysis of employment opportunities, marketing, industrial production and financial implications

Assessing a number of auxiliary factors such as housing and health services

5. Project evaluation

Development of evaluation criteria

Assessment of the relationship of the project plan to the sectoral and national development plans

B. The initiation of industrial projects

1. Identification of project concept (preliminary analysis) stage, project profile

Formation and technical analysis of project concepts (project profile)

Identification of:

Processes and products suitable for commercialization (indigenous and foreign sources)

Technical requirements

Functional and operational performance requirements

Technical approaches

Techno-economic analysis

Operational concepts

Market analysis

Manpower and materials requirements

Possible subcontracting arrangements

Financial requirements

2. Preliminary selection stage

Provision of technical information and data required for:

Deciding on alternative approaches

Developing a systematic basis for identifying benefits and penalties of alternative approaches

Minimizing disadvantages of alternative approaches

3. Feasibility (formulation) stage

Establishing evaluation and effectiveness criteria and weighing factors (for example, environmental, technical, economic and social)

Performing cost-benefit analysis

Conducting siting studies

Assessing alternative technologies

Developing or adapting network planning techniques and, where necessary providing computer support

Performing operations research studies, where necessary

Verifying the suitability of alternative technical approaches

Developing practical schedules

Developing preliminary cost plans

Evaluating and assessing the alternative approaches based on established criteria

Assessing manpower and training requirements

Studying backward integration

Identifying potential problems

Determining the need for standardization and quality control

Defining future R and D needs

4. Evaluation (post-feasibility evaluation) and decision to invest

Acting as consultant to decision maker and assisting him in the technical analysis and evaluation of the findings of feasibility studies

5. Acquisition of technology

Provisions of technical information and data required for:

Negotiating joint ventures

Negotiating technology transfer

Preparing tenders and bids for joint ventures

Evaluating the tenders for joint ventures

Negotiating licence agreements

C. Project implementation

Defining performance of systems engineering on industrial projects

Defining detailed project structure and scope

Providing technical inputs from indigenous and foreign sources

Planning in detail and controlling project implementation

Selecting raw materials and parts (indigenous or foreign sources)

Determining level of subcontracting

Factory siting

Carrying out geologic surveys

Acquiring land

Making detailed utility plan

Preparing a detailed manufacturing plan

Finalizing process and product

Selecting factory equipment

Establishing procurement specifications and data

Constructing factory building(s)

Production and plant layout

Installing and checking-out equipment

Preparing detailed process and product specifications

Commissioning plant

Recruiting and training personnel

Developing factory management skills, organization and procedures

Providing testing and analytical services

Trouble shooting and solving problems during the life of the project

Watching over the implementation of licensing or joint-venture agreements

D. To the evaluation and monitoring of projects and programmes

Technical evaluation and monitoring

Technical evaluation of on-going production

A continuing analysis of market and technological trends

Identification of new opportunities arising from market changes and new technology

Identification of changes arising from revised national and sectoral plans

Providing technical information and data required for assessing the short and long-range industrial and economic trends of the country and the changing needs of industry

Technical services to industrial plants

Testing, analysing and evaluating raw materials and intermediate products

Testing and analysing finished products for standardization, quality control and certification

Providing specific information on the current state of world knowledge on industrial, technological and techno-commercial fields

Carrying out instrument repair, maintenance and calibration

Designing specialized equipment, where possible

Trouble shooting in industrial plants

Carrying out technical and management consultancy in such areas as market studies, cost accounting, efficiency and productivity studies, industrial engineering, plan layout and management

Carrying out technical investigations designed to improve the quality of finished products and increase process efficiency

Developing new processes for current or new products, at both the laboratory and pilot plant levels

Carrying the results of technical investigations on products and processes into the commercialization stage

Carrying out techno-economic studies and market analysis

Undertaking engineering design and service work

Training technical staff

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ACTION IN THE FIELD OF INDUSTRIAL AND TECHNOLOGICAL INFORMATION IN AFRICA

I.THE SPECIFIC FEATURES OF INDUSTRIAL AND TECHNOLOGICAL INFORMATION

1. Information for industrial and technological development serves the needs of a variety of end users. These encompass R and D personnel, technologists, managers of industrial plants engineers, economists, planners, investors, financiers, entrepreneurs, as well as market analysts, sales personnel, Government and decision makers. The type of information they need is also of considerable diversity. It includes socio-economic data and statistics, information on current plans and projects for the public and private sectors, financial data, information on technologies, equipment, management practices, patents, on-going industrial-technological research and technology contracts and legislation. Such information which has to be recent and continously up-dated has to be obtained from a large number of sources inside the country, at the regional and global level. It is transmitted to the end users in many forms ranging from oral communication to computer printouts. It includes the provision of on-site expertise, advice at a distance as well as supply of documentary information. Consequently an industrial and technological information system needs to have three main features:-

(a) a multidisciplinary outlook, combining technical and socio-economic interests so as to meet the variety of needs of its clients;

(b) an ability to find its way around the world of relevant knowledge, some of it proprietary, together with mastery of documentation, analysis and retrieval techniques, that would permit it to find answers to its clients' questions, from any source along the streams of flow of information and package them in the form that directly meets their needs;

(c) a capacity to inspire confidence at whatever target level of end users through the ability to provide the right information in the right form at the right time.

2. It is important to constrast these features with the work of the information scientist and technologist who carries out a conventional information function which is mostly concerned with the down-flow of information from its original source where knowledge is stored, towards its destination where knowledge is in demand. The industrial and technological information system works in the reverse direction, upstream flows of information from needs relating to the specific purpose of optimizing industrial and technological development and operations to points along the information flow or stores of

knowledge yet untapped, where such needs can most likely be met.

3. A discussion of industrial and technological information needs in Africa and how best to approach them at the international, regional and national levels, will therefore be marked by the characteristics of the industrial and technological information system. It will refer to a very limited extent to the availability of documentation systems, which will be useful where they are in operation, but will not be of much immediate and direct service to industry where industrial and technological information is largely proprietory and only accessible at a cost, contrary to the world of science, education and culture where knowledge is literature-based and free.

4. The industrial information officer, at the core of this system, provides an irreplaceable interface between end users of industrial and technological information with advisory or decision-making responsibilities, particularly in pre-investment technology selection, as well as managerial, engineering or mercantile responsibilities in ongoing industrial operations.

5. The objective viewpoint is that no country with a measure of industrial development ambitions, relating to cottage, small, medium and heavy-scale industry in any quantitative combination should do without an industrial and technological information structure. Such structures be exist in almost every country in Africa, either as a fully-fledged servicing centre or in an embryonic state within a broader structure [1]. Various training programmes for industrial information officers have been organized by UNIDO, particularly an annual eleven-week course at the All-Union Institute of Scientific and Technical Information (VINITI), Moscow. Diverse other courses are offered on an ad hoc basis in countries with particular experiences and success in the industrial information function.

II. INDUSTRIAL AND TECHNOLOGICAL INFORMATION SOURCES

6. As regards the upstream sources of information, several organizations in the United Nations system are involved in channelling information of relevance towards a particular target group of socio-economic activity. They do this with a measure of co-ordination between them but with differing emphasis

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[1] UNIDO is compiling a directory of information systems and services in developing countries. Information so far collected in this regard is available.

placed on ways and means to reach end users. The United Nations Educational, Scientific and Cultural Organization (UNISIST) has made progress towards developing a world-wide unified governmental approach to information policy-making as well as the functions of the librarian, the archivist and the data bank operator or distant interrogator on the professional level. Through appropriately equipped recipient focal points, the developing countries have a closer access to world-wide sources of information in a specific area. Plans for the development of a world-wide system for the exchange of scientific and technological information that emerged from the United Nations Conference on Science and Technology for Development (UNCSTD), Vienna 21-30 August 1979, foresee the accelerated progress of tele-informatics to bridge the information gap to give access to data banks and other sources of information on an instant world-wide answer-to-question basis. The World Bank is a valuable source of economic and financial information on a world-wide scale. Bibliographic data banks giving access to literature have been developed, such as INIS to cover non-restricted literature on atomic energy; AGRIS to cover world-wide publications on agriculture; DEVSIS on a regional basis, including DEVSIS-AFRICA, for papers on development policy-making. The referral system of the United Nations Environment Programme, INFOTERRA, has been developed to serve environmental concerns as a data bank giving access to individuals and institutions as sources of knowledge to tap on an ad hoc basis rather than as authors of studies and reports. Under the programme of technical co-operation among developing countries (TCDC) a network is also being established for developing countries to exchange information among each other.

7. UNIDO operates on a wavelength of its own, which has been chosen not through any search for institutional originality, but rather to fit in with UNIDO's specific responsibility which is to improve and accelerate industrialization towards the 25 per cent Lima target. Advertising UNIDO's Industrial Inquiry Service as the mail order technical assistance clearly reflects its orientation towards the solution of specific practical problems. The pre-investment stage and the decision-making responsibility have priority over the ongoing operation of existing enterprises, as stressed by developing countries themselves in the Lima Declaration and Plan of Action. The technology selection process was singled out from the total field being covered under industrial information activities, to be served by the recently established Industrial and Technological Information Bank (INTIB) of UNIDO. Another useful system for information on technology contracts is UNIDO's

Technology Information Exchange System (TIES) [2]. The more TIES continues to grow and the larger the number of countries participating in it, the greater its value in negotiating technology contracts becomes. While most information activities generated within the United Nations system tend to come forward as information systems and data banks, what UNIDO has to offer consists of computer assisted services . United Nations information systems and services have all been identified and listed by the Inter-Organization Board for Information in the United Nations, together with listings of the corresponding national institutions [3].

8. Outside the United Nations system, there exists a large number of sectoral data banks and information systems of particular relevance to industrial development. These are too numerous to list or discuss here. The main point is that access to them is now quite simple and not costly. However, the value of the information obtained through these networks and its relevance to the needs of African industrial development remains to be carefully assessed for the variety of situations and needs to be found in Africa. Nevertheless, it is possible to state that while information from some of the large international banks and investment houses is particularly useful on statistical, economic and financial matter, it is doubtful whether other commercial information banks and data bases fully and directly meet the requirements of the selection and acquisition of technology.

9. There is a lack of information on Africa itself, particularly in the area of relevant information for the sound planning of industrial development. Some information is mainly statistical data. African countries still have to embark on the formidable job of ensuring that such data is gathered systematically, in a regular and reliable manner, and according to relevant definitions that need not necessarily be those of other regions, or even the international organizations. However, they should not cut themselves off from these statistical data bases. The problem was recognized and solved in Latin America some time ago. The other type of information that is still lacking is that of the socio-economic structures, their trends and future plans, as well as ongoing technological research and industrial activities and projects.

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[2] To date, 25 countries have joined TIES, UNIDO publishes the TIES Newsletter bi-monthly.

[3] Directory of United Nations Information Systems and Service, Inter-Organization Board for Information Systems (IOB), Geneva, 1978.

10. The TCDC Conference identified this gap and called for South-South exchange of information and UNDP is starting a pilot scheme for the purpose. In short, most information on Africa comes from non-African sources.

III. INDUSTRIAL AND TECHNOLOGICAL INFORMATION NEEDS IN AFRICA

11. Many African information institutions, essentially libraries and documentation centres, seem to have been established without much thought as to whether, and to what extent, they might consider joining forces and budgets to develop between them the capability of accessing at a distance data banks and other sources of information as a joint service, for the benefit of all sectoral user groups. This is a course of action which will obviously be forced upon them by the spread of the world-wide network. However, their diversity is commendable when it is considered that information needs in science, education, agriculture, medicine and industry, are neither served by the same sources nor through the same methods. Industry presents the specific feature of being based on knowledge, much of which is proprietory and little of which is literature-based, and which involves end users of information who want their problems solved rather than material to look up, read and ponder over.

12. Industrial technology consists of hardware and software. The majority of foreign technology is transferred in Africa today as equipment. The bulk of investment and foreign capital goes into the purchase of equipment. Information on equipment is perhaps a top priority in Africa today. It is this knowledge, or know-how , which has not been consciously transferred; hence the continued dependance and the failure to develop the stock stream through mastery of the know-how and its transformation into equipment and processes. It is necessary for the sound development of industry that in each African country one specific structure employing one or more industrial information officers, serve industry exclusively, developing by constant and concentrated practice a capability to interface with the end user of industrial and technological information in industry, so as to become their antenna and problem solver.

13. To date many people from African countries have participated in UNIDO training programmes designed to assist them to become competent information seekers, analysts and re-packagers, but even more so, to become extension officers on the widely recognized model that has long applied to agriculture, visiting their industrial and technological clientèle at whatever level, gaining their confidence, identifying their problems, supplying information, whether solicited or not. The measure of success in this latter function seems to have been limited. The function is not only related to the information specialist. There has always been a problem in identifying specific information needs in African countries in advance of demand and in channelling whatever inquiries were received through national industrial information structures to sources of information within the country or, more commonly, abroad.

14. It is felt that the strengthening of industrial and technological information structures in African countries, relating these more intimately to development bank activities, engineering consultancy and industrial R and D functions internally and to whatever documentation structures are being developed locally, as well as to outside reliable, independent and comprehensive information sources abroad (for instance INTIB) should be a broadly recognized priority.

15. Industrial information services, though distinct in nature and mode of operation will, by necessity, be developed within the general framework of the national information policy in each country. It is a matter of information policy for a developing country to take a hard look at government level at the situation of information activities in order to determine whether a computer capability ought to be established at the service of all to access information sources abroad and collect information generated on site or whether a central, completely multi-disciplinary documentation base might most usefully be established or strengthened. However, when it comes to relate this to industrial information needs, and to determine where to establish an industrial and technological information sub-system this definitely belongs in the zone of overlap between industrial and technological information needs and national information policies.

16. In that zone, two visions are likely to be brought to bear and possibly to blur issues for the governmental decision-maker to decide upon: the vision of the information scientist and technolgist as passed on to related practitioners, the archivist, the librarian, the data bank operator

or distant interrogator; and the vision of the industrial and technological information officer. As described earlier, the latter looks upstream the flow of information based on the end users' needs in a certain field. Called upon to contribute to information policy, he or she will remind decision-makers in the government that the end users' needs have to be given equal importance to those of information system operators; that industry in particular may prefer to take information preferably in a few words or lines provided through personal contact rather than from computer print-outs of references to documents, the original of which are distant and difficult to acquire, and the analysis of which is tiring and time-consuming.

17. Between national documentation bases and computer terminals, there is an absolutely essential information analysis and information extension service that has to be filled in order to meet information needs in industry at any scale (cottage, small, medium or heavy). Such a function cannot be left unfilled without seriously impairing the capability of nascent industries to operate knowledgeabley. This is the basic difference between information and knowledge. It adds a new function of information generation, rather than just information handling. In order that such an industrial information officer not only contribute wisely to the determination of an information policy under which the interests of industry can be served, but also serve the requirements of industrial planning, management, engineering and salesmanship, he or she will most likely have to be a technical person with experience in industrial operations and exposure to the economic aspects of industrial investment and operation. The industrial and technological information structure to be set up should be operated by a person with such a profile, with a broad-minded polytechnical scope of intellectual interest, belonging to the same background in social and economic terms as the officials or entrepreneurs. He or she should be versed in documentation techniques. On the basis of the best international experience available (that of Canada, Denmark and France among industrialized countries, Mexico, Ecuador and seven countries in South-East Asia, interlinked by the TECHNONET network in Singapore), it can be stated that whenever African countries wish to place an industrial information officer, or a team of such, in an autonomous centre or as part of some Ministry or R and D centre, industrial and technological development will surely profit. It might even be suggested that a young internationally educated engineer-cum-business school graduate, looking forward to playing a leading role in the industrialization of his or her country,

whether at the governmental level or in a spearheading capacity in the private sector, could do no better than to devote himself for several years to the problem-solving function of an industrial information officer.

18. The problems of technology selection, acquisition and development figure prominently throughout this paper. It is thus necessary to look a little more closely at the process of developing INTIB to serve the technology selection process. If INTIB is to be brought to bear upon concrete technology selection dilemmas as they arise in African countries, it is obviously imperative that some national structure be established with an INTIB responsibility of its own at the national scale. Naturally, the national partners of INTIB will be industrial information officers rather than information scientists and technologists. They should also be very close to the individuals or institutions entrusted with the responsibility of carrying out these functions.

19. INTIB, addressing itself as it does to the technology selection process in 20 sectors of industry, is not only of concern to a multiplicity of entrepreneurs, whether from the private or the public sectors, all of whom are difficult to reach, even for a national industrial information structure. It also concerns a more limited and accessible circle of investment bankers responsible for the economic aspect of projects submitted to them for funding rather than for the technological contents of such projects. Furthermore, engineering consultants, many of whom are setting up firms in developing countries, endeavour to win the confidence of a local clientèle in advising on technologies to be set in motion but who still need an information back-up, that can be provided by INTIB. The teams of industrial information officers will also have their hands full in identifying operational needs of ongoing industrial enterprises and helping them to meet these from a multiplicty of information sources.

20. It is worth remembering when discussing policy matters that the nature of the industrial information fuction does not differ between countries of differing levels of development even though the size of industrial information services may.

IV. A FRAMEWORK FOR ACTION

Clear Definition of Needs

21. The information needs of industrial and technological development are of an unusual variety and change very rapidly with further development, or along the path of progress from an identified investment opportunity up to production, marketing and upgrading of machinery and products. The needs vary from sector to sector and involve both national and foreign sources. The success of industrial and technological information services depends entirely on their ability to provide the information needed on the spot. The planning of such services should be anticipatory and one step ahead of the progress of industrial development. As mentioned earlier, the key activity is to have access to up-to-date sources of information rather than to build up huge data bases.

Identification of Sources

22. It is unfeasible to expect the national or regional industrial information service to physically possess all the sources of information it provides, nor is this necessary. What is essential is to know where the information can be obtained and the intrinsic value of this information.

23. A good information service should continually search for new sources of useful information needed in the country or the region, as well as assess the realiability and comprehensiveness of the information acquired from various sources. More often than not, the sources are much closer at hand than might be thought at first. The information may already be in the country or within a regional organization. Efforts in ascertaining the nature and availability of information from such sources close at hand should come before the search for sources far away. It is worthwhile, in an African context, to pay special attention to the number of newly-established data bases on appropriate technologies, particularly for rural development and small-scale industries in various parts of the world.

Efficient Linking with Information Sources

24. Because of its very diffuse and varied nature, industrial information is more dependent on a large number of sources than, for instance scientific or scholarly information. In the upstream search, characteristic of the industrial

information officer's approach, once the sources are identified, it becomes imperative to establish efficient linkages with these sources. This does not necessarily mean sophisticated and expensive telecommunication or information systems; a telephone conversation or a personal visit may be the most appropriate means of efficient linkage, because the volume of information from one source is not usually large, yet the sources may be varied in nature and scope.

Strong Relations with Users of Information

25. This is a key issue in developing effective information services today. The person called upon to take decisions in African industrial development, whether in the government, public sector or private business, does not necessarily appreciate the need for information in formulating optimum decisions, nor do they know, if they appreciate the value of information in decision-making, that valuable and relevant information can be speedily obtained.

26. They will only gain credibility if they adopt an active, if not relentless, attitude, going out of their way to provide unsolicited information until people come to appreciate the value of their services and seek them. This is a crucial function of the industrial information system and its officers and the test of success. It is obvious that in order to reach this stage the information officers will have to be well-informed about events in their country and capable of identifying the end users, on the one hand, and the existence of readily-available useful information on the other.

Building a Technological Intelligence Capacity

27. Industrial information on technology involves proprietary rights that cost money. Raw information in itself can be confusing, contradictory and even downright false. Very serious damage could occur if such information is relied upon. Besides, in the gathering and ordering functions, there is a pressing need in developing countries to assess and evaluate information, that is to turn it into intellingence or knowledge. The industrial information service will not only be handling information; but also generating information. INTIB is a clear case of this crucial activity in technological development. The subject of building technological intelligence capabilities in developing countries is now being debated on a world-wide scale. The most pressing needs are perhaps those for market intelligence and some capacity to keep track of new technologies and current thinking on technological forecasting, i.e. what is now known as technology awareness . This is a multi-disciplinary group activity that needs special training. Universities, technological

institutions, and particularly the African Regional Technology Centre (ARTC) could well pay increasing attention to this aspect of technological development and to building up a capability to assess and judge raw information on technology, particularly that obtained from sources that may have vested interests. They will have to link themselves closely to the individuals or institutions responsible for the various activities involved in technology transfer, on the one hand, and the sources of information , analysis and comparative studies on technology, on the other.

Building a Cadre of Industrial Information Officers

28. The whole approach to industrial information here is concentrated on the industrial information officer. As mentioned previously he or she is a multi-facetted person and it is obviously going to be difficult to select and train a sizeable cadre of such persons. Two basic problems militate against significant progress here, the rather low social status in the industrial development employment and the limited prospects of promotion and career development. Latin American countries have tried certain approaches, such as the involvement of young engineers and scientists in information work, to overcome similar problems and appropriate measures for African conditions have to be identified.

Short-term Actions

29. Certain short-term actions have to be carried out, while the above actions are being planned and executed over longer time horizons. These are:-

(a) the identification of present information priorities:-

The priority sectors for industrial technological development in Africa have now been established. As regards the type of information; types of equipment, technological processes, contractual and financial conditions and data, and patents are obvious priorities for a variety of sizes of industrial enterprise in the chosen sectors;

(b) the improvement of linkages between existing sources (nationally, regionally and internationally):-

(i) Within the guidelines of the national information policy of the country, the relations between the industrial and technological information services, with their specific features, and other national information services should be streamlined. The location of the industrial and technological information function should be carefully examined, bearing in mind that rather than being a depository of information, it is an exchange that aims at the smooth and rapid connection of the user to the source of information needed;

(ii) Thus networking of existing services within the country as well as regionally, calls for immediate action, standardizing the modes of query, communication and reply and ensuring maximum availability of the sources of information with all their variety and dispersion through focal points and centres;

(iii) There is an immediate need for a thorough survey of industrial and technological information sources and services throughout Africa, with continuous updating and widespread dissemination of such information. This could lead to spontaneous or planned formation of groups of users in the development, finance and R and D areas so as to advise in good time on information needs;

(iv) Links with foreign sources should be strengthened selectively, bearing in mind the vast improvement in telecommunications and the remarkable reduction in the cost of using some of them. There is an immediate need for better awareness of UNIDO's services and publications and widespread use of such facilities.

(c) <u>strengthening local sources and data bases</u>:-

(i) There is particular need for readily-available information on patents, which should not be difficult nowadays, and on technologies, which is still a problem, particularly for new technologies, Omnibus Catalogues on equipment of various kinds is always in demand and should be always ready at hand;

(ii) National data bases in most countries still have a long way to go before they could provide reliable, up-to-date statistics and data. Putting the local data bases in order is a task which is essentially not that of industrial information; but which seriously affects its viability.

(d) <u>establishing a technological intelligence capability</u>:-

(i) This calls for the initiation of multi-disciplinary training programmes and the continuous involvement of a group, or groups, in monitoring events and performance with the country, the continent and world-wide. UNIDO has a direct responsibility in this area ;

(ii) Being essentially an information generation exercise, it could address itself for a start to the immediate task of continuing to prepare industrial profiles for small-scale industries in the priority sectors, analysing, in particular, the alternative technologies available;

(iii) The development of INTIB and the wider involvement of national information services both in disseminating information from it and in providing it with information is a task that involves both the international organization, as well as the developing countries;

(iv) UNIDO should expand its work on the problems of technology selection and decision-making so as to provide suitable and relevant guidelines on actual current problems.

(e) training of industrial and technological information personnel:-

In order that these short-term actions may be undertaken, there is an immediate need for greatly expanded activity in training, at all levels, and particularly on the regional and continental African levels, to complement UNIDO's training courses and to achieve considerable increases in qualified industrial information officers, familiarizing them with recent developments, and strengthening the working relations between sister organizations, nationally and regionally.

30. The above suggestions should not convey any sort of impression that engaging in a tangible industrial and technological information activity necessarily represents immediate progress which might prove costly in terms of funds and manpower. Any embryonic structure in a ministry of industry or planning board and any devoted individual attention to the function, even part-time is better than nothing, to begin with, and provides the basis for eventually building up something stronger, at the pace at which industrialization of a country progresses.

31. One suggestion, in line with UNIDO's mail order technical assistance function, is that in each African country one official be entrusted to study the matter, to examine the state of the art of the industrial information function in their country, and to correspond with UNIDO's Industrial Information Section. From a dialogue of this kind no doubt ways and means could be found to strengthen what exists, establish what does not, and to secure continent-wide co-operation in this area.

Abbreviations used in this document

AGRIS	International Information System for the Agricultural Sciences and Technology, Food and Agriculture Organization of the United Nations (Rome, Italy)
DEVSIS-AFRICA	Development Sciences Information System (Addis Ababa, Ethiopia)
INFOTERRA	International Referral System for Sources of Environment Information, United Nations Environment Programme (Nairobi, Kenya)
INIS	International Nuclear Information System, International Atomic Energy Agency (Vienna, Austria)
INTIB	Industrial and Technological Information Bank, United Nations Industrial Development Organization (Vienna, Austria)
TECHNONET	Asian Network for Industrial Technology Information and Extension (Singapore)
TIES	Technological Information Exchange System, United Nations Industrial Development Organization (Vienna, Austria)
UNISIST	World Science Information System, United Nations Educational, Scientific and Cultural Organization (Paris, France)
VINITI	All-Union Institute of Scientific and Technical Information (Moscow, Union of Soviet Socialist Republics)

INDUSTRIAL TECHNOLOGY MANPOWER IN AFRICA

INTRODUCTION

1. This paper deals essentially with industrial technology manpower rather than the wider issues of manpower development in Africa. There is a wide range of functions to be performed by industrial technology manpower. Broadly speaking, these cover:

(a) Technology selection: including scanning for available technologies, evaluation and assessment, feasibility studies etc.;

(b) Technology acquisition: mechanisms, legal and contractual conditions, negotiating skills, regulation of flow of technologies, monitoring of implementation etc.;

(c) Financing and investment in technology projects and project evaluation: financial analysis, market surveys and projections, mobilization of internal and external finance;

(d) Assimilation and adaptation: management, production engineering, maintenance, manpower development, modification and adaptation of soft and hardware;

(e) Development of technology: technological R and D, engineering, commercial production and distribution;

(f) Technological services: standards, metrology, consultancy, design and testing.

2. Although accurate statistics on African technology manpower are not available,[1/] it seems obvious that in almost all African countries today there are serious gaps in most of these functions. In particular, the functions of technology acquisition, assimilation and development may be cited.

3. The technological manpower needs are part of the overall manpower needs in Africa. Manpower is particularly critical in the context of African industrial development as a whole. Although many African countries are endowed with abundant natural resources, most of them lack comparable reserves of qualified human resources. This is partly due to to underpopulation (table 1 shows that there are several countries

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1/ See document Action in the Field of Industrial and Technological Information in Africa prepared for this Symposium.

in Africa with a population of less than five million). It is also attributable to the fact that the existing population is still not equipped to provide all the skills needed in the necessary numbers. There is no assessment of the present manpower needs for industrialization and technological development;[2] but there is no doubt that these will be considerable for the whole of the next decade if Africa is to increase its rate of industrial expansion to the 11 per cent per annum required for meeting the Lima target.

4. In the fifties, with very few exceptions, relatively high proportions, ranging from 30 per cent to over 80 per cent, of the limited high-level manpower requirements in Africa were met from foreign resources.[3] For example in Zambia at the time of independence, there were only 1,200 Africans with secondary school certificates and only 108 Zambian graduates. Similarly, the first manpower survey in the United Republic of Tanzania in 1962/63 showed that over 80 per cent of all jobs that required a university education were occupied by non-Africans. Faced with this situation, the African Ministers of Education, at their first conference in May 1961 in Addis Ababa adopted the Outline Plan of Education for Africa. This set out a twenty-year programme (1961-1980) of mass education. Although the African countries have made enormous progress in meeting the targets, if a random sample of 100 school-age children is taken it will be found that about 90 receive only primary education or less.[4] Traditional educational and institutional facilities cannot provide enough places for all those who are willing to learn because school organization, material requirements, curricula structure and courses offered still cling to inherited patterns, notwithstanding some promising educational innovations in Ethiopia, the United Republic of Tanzania etc. over the past two decades. Hence, many African countries find themselves faced with manpower shortages as their economies grow.

2/ In 1968, ECA estimated that Africa needed to train about 30,000 management and supervisory personnel, 52,000 scientists, engineers and technologists, 112,000 technicians and foremen and 1,722,000 skilled and semi-skilled workers (E/CN.14/WP.6/18, p. 13)

3/ ECA (1978), Manpower development and utilization policies and strategies with special reference to indigenization of African economies, C/CN.14/CAP.7/10, Economic Commission for Africa, Addis Ababa, 16 November 1978.

4/ See Education in a Rural Environment, UNESCO, Paris, 1974.

Table 1

Population of African Least Developed Countries around 1975

Total population in 1975 by sex and country (Unit: thousands)				5-24 years age groups by sex and country		
Country	Male	Female	Total	Male	Female	Total
Benin	1,514	1,560	3,074	690	701	1,391
Botswana	320	371	691	162	173	335
Burundi	1,859	1,906	3,765	825	830	1,655
Central Africa Empire	861	929	1,790	392	403	795
Chad	1,925	2,098	4,023	863	918	1,781
Ethiopia	14,111	13,864	27,975	6,371	5,994	12,365
Gambia	256	253	509	109	109	218
Guinea	2,187	2,228	4,415	961	977	1,938
Lesotho	566	582	1,148	234	237	471
Malawi	2,341	2,576	4,917	1,086	1,123	2,209
Mali	2,834	2,863	5,697	1,271	1,255	2,525
Niger	2,282	2,309	4,591	1,038	1,041	2,079
Rwanda	2,024	2,176	4,200	917	978	1,895
Somalia	1,567	1,603	3,170	754	761	1,515
Sudan	9,229	9,039	18,268	4,269	4,137	8,406
United Republic of Tanzania	7,577	7,861	15,438	3,658	3,510	7,168
Uganda	5,692	5,661	11,353	2,593	2,529	5,122
Upper Volta	3,003	3,029	6,032	1,343	1,318	2,661
Total	60,148	60,908	121,056	27,536	26,994	54,530

Source: Population by sex and age for regions and countries 1950 - 2000 as assessed in 1973. Medium Variant - Prepared by United Nations Population Division.

5. The absolute size of a country's population influences the number of nationals in the 5-24 years school age population and, consequently, the local potential for the production of trainable nationals, assuming that there are adequate physical facilities and financial resources, as well as the socio-political will to enable all to go to school. Educational and training facilities are still limited in Africa. School enrolment indicates that not all eligible school-age populations are going to school or find facilities to do so, especially at the secondary level. There is also gross imbalance in the distribution and use of available places in secondary level institutions. This is particularly significant since this is the level that produces the skilled manpower at the routine executive level. It is largely due to the bias at the secondary level, accentuated by social values and wage structures for different types of jobs and qualifications, and perpetuated by the former colonial premium set on clerical work, that African countries experience recurrent shortages of middle and lower-level technical personnel and skilled operatives needed in industry and agriculture.

6. While the increase in the primary enrolment ratio since 1960 is smaller than that envisaged in the Outline Plan of Education for Africa, the expansion of enrolment ratios at the secondary and tertiary levels has exceeded the targets set in the plan. This would not be a cause for concern had not the proportion of enrolment in technical and vocational courses appeared to have dropped and the attempts to increase substantially the proportion of science and technology students in higher education fallen short of requirements.

7. One disturbing fact is that engineering and agriculture are the smallest groups of study in most African countries.[5/] This has serious consequences for the building up of an adequate potential for technological development, particularly in industrialization, the mechanization of agriculture and for economic growth and national development as a whole.

5/ Tables 14 and 15, UNESCO, National Science Policies in Africa, No.31, Science Policy Studies and Documents 1974, Paris, France.

Similarly, the low percentage of students in agriculture (with the exception of Mauritius) is obviously undesirable for countries seeking self-sufficiency in food as top priority. Furthermore, the tendency has been to concentrate only on basic and applied sciences rather than on developing the practical ability to perform through sensitization to the importance of the multidisciplinary approach in solving real life problems. This has led to recurrent complaints by the business community that African educational systems fail to give sufficient attention to the practical problems of the world of work.

8. Furthermore, African countries have not only to increase their skilled manpower as rapidly as possible but also to use it efficiently and effectively as it becomes available. More specifically, it is necessary for each African country to give particular attention to the following problems:

(a) The salary structure and social status of skilled manpower, including promotional prospects. The appropriate levels of differentials between skills of various types; relating remuneration to job specification rather than to paper qualifications. Linked with this is the problem of incentive schemes that would encourage the strengthening of national technological capabilities;

(b) On-the-job training and prospects for vertical mobility for semi-skilled manpower as well as high-level personnel;

(c) Motivating, training and upgrading unskilled labour;

(d) The question of adult illiteracy;

(e) The problems of "school-leavers" and brain drain".

9. Focusing on the African stock of manpower for technological velopment, the following general remarks can be made:

(a) Africa lags far behind the world figures for scientists, engineers and technicians (see table 2). The figures for Africa are one fourth to one third those for Asia and almost one tenth of those for Latin America. They are two whole orders of magnitude below those of developed countries;

(b) The distribution of scientists, engineers and technicians in Africa is very uneven (see table 3). It ranges from over half a million to as little as a few hundred;

(c) There are still considerable numbers of non-nationals in many African countries (see notes for table 3);

(d) The number of scientists, engineers and technicians engaged in research and experimental development is limited (see table 4). Their percentage distribution over the various fields varies considerably (table 5), with natural sciences and agriculture predominating in many countries and engineering and social sciences far behind in most African countries.

Table 2

Technological capacity, selected indicators[a/]

(Averages expressed as medians for 1970 or latest year available)

Per 10,000 population	Developed market economy countries	Developing countries and territories		
		Africa	Asia	Latin America
Science and technology				
Ratio of total stock of scientists and engineers	112	5.8	22.0	69
Ratio of technicians	142.3	8.3	23.4	72.2
Scientists and engineers engaged in R and D	10.4	0.35	1.6	1.15
Technicians engaged in R and D	8.2	0.4	0.6	1.4

a/ The size of the sample countries vary by indicator.

Source: UNIDO, 1979, International flows of technology, (Vol.3, UNIDO/IOD/326).

Table 3

Number of scientists, engineers and technicians in African and selected non-African countries

Country	Year	Definition of data	Total (SET)	Scientists and Engineers	Technicians
			(1)	(2)	(3)
African countries					
Botswana[1]	1972	ST	1 527	786	741
Egypt	1973	ST	...	593 254	...
Djibouti	1973	ST	35	35	-
Ghana[2]	1970	EA	21 993	6 897	15 096
Kenya[3]	1975	EA	11 009	5 130	5 879
Libya[4]	1973	EA	+18 921	+8 319	+10 602
Nigeria[5], [6]	1970	ST	35 126	19 885	25 241
Seychelles[7]	1973	ST	...	+300	...
Sudan[8]	1971	ST	+16 431	+13 792	+2 639
Togo	1971	EA	672	461	211
Tunisia[9]	1974	EA	11 135	3 421	7 714
United Republic of Cameroon[10]	1970	ST	+3 500	...	...
Zambia	1973	ST	37 000	11 000	26 000
Non-African countries					
Brazil	1970	ST	1 718 822	541 328	1 177 494
Canada[11]	1971	ST	...	621 645	...
Federal Republic of Germany	1970	ST	1 189 000	1 083 000	106 000
India	1971	ST	+1 174 500	...	...
Netherlands	1971	ST	+742 000	+442 000	+300 000
Pakistan[6], [12]	1973	ST	...	111 000	...
Switzerland	1970	ST	...	175 090	...
USA[6]	1976	EA	2 605 000	1 647 000	958 000
USSR[13]	1975	ST	22 796 300	9 477 000	13 319 300

Key
ST = Stock of scientists, engineers and technicians;
EA = Number of economically active scientists, engineers and technicians;
SET = Scientists, engineers and technicians.

NOTES:

1/ 557 of the scientists and engineers in column 2 and 171 of the technicians in column 3 are non-nationals.

2/ 1,761 of the scientists and engineers in column 2 and 317 of the technicians in column 3 are non-nationals. The figures in column 3 do not include social sciences and humanities.

3/ Data refer to persons in gainful employment.

4/ Approximately 79 per cent of the scientists and engineers in column 2 and 34 per cent of the technicians in column 3 are non-nationals.

5/ Data relate to the year 1970/1971.

6/ Not including data for social sciences and humanities.

7/ Approximately 150 of the scientists and engineers in column 2 are non-nationals.

8/ Data relate to the year 1971/1972.

9/ Data are underestimated.

10/ Approximately 1,000 of the total in column 1 are non-nationals.

11/ Data for scientists and engineers refer to university degree holders only.

12/ Data relate to the year 1973/1974.

13/ Refers to specialists in the national economy (that is to say, persons having completed education at the third level for scientists and engineers and secondary specialized education for technicians). Figures relating to the Byelorussian SSR and the Ukrainian SSR are already included with those of the USSR.

Source: UNESCO Yearbook of Statistics, 1977.

Table 4 Total number of scientists, engineers and technicians engaged in research and experimental development, 1970

Tableau 4 Nombre total de scientifiques, ingénieurs et techniciens employés à des activités de recherche et de développement expérimental, 1970

Country / Pays	Total	R & D scientists and engineers / Scientifiques et ingénieurs employés à la R & D		R & D technicians / Techniciens employés à la R & D	Number of R & D technicians per R & D scientists and engineer / Nombre de techniciens (R & D) par scientifique et ingénieur (R & D)	R & D scientists and engineers per million inhabitants / Scientifiques et ingénieurs R & D par million d'habitants
		Total	of which percentage of part-time / dont pourcentage à temps partiel			
Algeria/Algérie	1 121	587	58	534	0.9	41
Burundi	61	23	17	38	1.7	6
Cameroon, United Rep. of / Cameroun, Rép. unie de	269	184	34	85	0.5	31
Central African Republic / République Centrafricaine	101	39	–	62	1.6	24
Chad/Tchad	129	87	12	42	0.5	23
Congo, People's Republic of / Congo, Rép. populaire du	113	57	30	56	1.0	60
Dahomey	76	29	14	47	1.6	11
Egypt, Arab. Republic of / Egypte, Rép. arabe d'	4 869	2 796	60	2 073	0.7	84
Ethiopia/Ethiopie	662	267	44	395	1.5	11
Gabon	77	41	–	36	0.9	81

Table 4 (continued) / Tableau 4 (suite)

Country / Pays	R & D scientists and engineers[1] Scientifiques et ingénieurs employés à la R & D[1]			R & D technicians	Number of R & D technicians per R & D scientist and engineer[1]	R & D scientists and engineers per million inhabitants[1]
	Total	Total	of which percentage of part-time / dont pourcentage à temps partiel	Techniciens employés à la R & D	Nombre de techniciens (R & D) par scientifique et ingénieur (R & D)[1]	Scientifiques et ingénieurs R & D par million d'habitants[1]
Ghana	1 431	519	58	912	1.8	60
Guinea/Guinée	209	171	81	38	0.2	44
Ivory Coast/Côte d'Ivoire	586	335	27	251	0.7	78
Kenya	2 031	730	39	1 301	1.8	65
Lesotho	32	26	80	6	0.2	28
Liberia	156	80	31	76	0.9	53
Libyan Arab Republic / République arabe libyenne	174	77	73	97	1.2	40
Madagascar	627	340	40	287	0.8	50
Malawi	251	137	45	114	0.8	31
Mali	285	117	6	168	1.4	23
Mauritania/Mauritanie	28	18	–	10	0.6	15
Mauritius and deps. / Maurice et dép.	150	111	29	39	0.4	137
Morocco/Maroc	643	253	10	390	1.5	16
Niger	57	31	–	26	0.8	8
Nigeria	1 630	1 030	54	600	0.6	19
Rwanda	64	20	35	44	2.2	6
Senegal/Sénégal	518	304	47	214	0.7	77
Sierra Leone	232	82	77	150	1.8	32
Somalia/Somalie	37	24	–	13	0.5	9
Sudan/Soudan	995	470	53	525	1.1	30
Tanzania, United Republic of / Tanzanie, Rép. unie de	828	338	16	490	1.4	25
Togo	297	100	5	197	2.0	51
Tunisia/Tunisie	742	318	4	424	1.3	62
Uganda/Ouganda	757	422	42	335	0.8	43
Upper Volta/Haute Volta	171	87	20	84	1.0	16
Zaire	606	354	69	252	0.7	16

Note : 1. Data on scientists and engineers are the total of full-time and part-time personnel.
Les chiffres concernant les scientifiques et ingénieurs représentent la totalité du personnel employé à temps plein et à temps partiel.

Source: UNESCO, National Science Policies in Africa, Science Policy Studies and Documents 1974, Paris, France.

Table 5 Percentage distribution by field of science of total scientists and engineers engaged in R & D and ratio of part-time (PT) to full time within each field, 1970

Tableau 5 Répartition en pourcentage par domaine d'étude du nombre total de scientifiques et d'ingénieurs employés à des activités de R & D et rapport temps partiel (TP) - plein temps dans chaque secteur, 1970

Country / Pays	All fields / Ensemble des secteurs	Field of science / Domaine d'étude									
		Natural sciences / Sciences exactes et naturelles		Engineering / Ingéniérie		Medical sciences / Sciences médicales		Agriculture		Social sciences and humanities / Sciences sociales et humaines	
		Total	PT/TP	Total	PT/TP	Total	PT/TP	Total	PT/TP	Total	PT/TP
	%	%	%	%	%	%	%	%	%	%	%
Algeria/Algérie	100	54	58	1	-	26	80	19	27	1	100
Burundi	100	43	40	–	–	–	–	57	–	–	–
Cameroon, United Rep. of / Cameroun, Rép. unie de	100	40	57	–	–	6	50	50	15	4	–
Central African Republic / Rép. Centrafricaine	100	30	–	–	–	10	–	60	–	–	–
Chad/Tchad	100	21	–	–	–	–	–	46	25	33	–
Congo, People's Republic of / Congo, Rép. populaire du	100	77	40	2	–	4	–	9	–	8	–
Dahomey	100	24	–	–	–	–	–	45	8	31	33
Egypt, Arab Republic of / Egypte, Rép. arabe d'	100	40	41	15	59	28	75	17	84	–	–
Ethiopia/Ethiopie	100	26	60	16	69	18	49	22	27	18	–
Gabon	100	73	–	2	–	–	–	20	–	5	–
Ghana	100	32	67	21	78	4	87	39	37	4	50
Guinea/Guinée	100	65	81	22	100	5	22	8	71	–	–
Ivory Coast/Côte d'Ivoire	100	53	34	1	25	6	100	37	5	3	50
Kenya	100	13	59	11	83	10	72	57	22	9	32
Lesotho	100	88	91	–	–	–	–	12	–	–	–
Liberia	100	51	5	–	–	3	–	41	57	5	100
Libyan Arab Republic / Rép. arabe libyenne	100	49	45	6	100	–	–	45	100	–	–
Madagascar	100	35	50	14	76	6	62	38	15	7	30
Malawi	100	25	59	–	–	–	–	56	20	19	70
Mali	100	71	–	2	–	8	87	15	–	4	–
Mauritania/Mauritanie	100	28	–	–	–	–	–	72	–	–	–
Mauritius and deps. / Maurice et dép.	100	1	100	14	75	–	–	71	11	14	67
Morocco/Maroc	100	25	19	8	–	9	–	50	–	8	70
Niger	100	52	–	–	–	–	–	35	–	13	–
Nigeria	100	29	74	6	63	16	84	47	30	2	96
Rwanda	100	30	50	–	–	5	100	50	–	15	100
Senegal/Sénégal	100	23	47	2	60	37	90	32	2	6	21
Sierra Leone	100	60	88	–	–	–	–	38	63	2	–
Somalia/Somalie	100	62	–	–	–	–	–	38	–	–	–
Sudan/Soudan	100	52	57	–	–	14	100	34	27	–	–

Table 5 (continued) / Tableau 5 (suite)

Country / Pays	All fields / Ensemble des secteurs	Field of science / Domaine d'étude									
		Natural sciences / Sciences exactes et naturelles		Engineering / Ingéniérie		Medical sciences / Sciences médicales		Agriculture		Social sciences1 and humanities / Sciences sociales1 et humaines	
		Total	PT/TP	Total	PT/TP	Total	PT/TP	Total	PT/TP	Total	PT/TP
	%	%	%	%	%	%	%	%	%	%	%
Tanzania, United Rep. of Tanzanie, Rép. unie de	100	25	35	1	–	7	–	65	11	2	–
Togo	100	10	–	–	–	6	33	19	16	61	–
Tunisia/Tunisie	100	23	–	6	–	13	34	40	–	18	–
Uganda/Ouganda	100	26	42	–	–	27	75	43	19	4	66
Upper Volta/Haute Volta	100	13	–	–	–	61	34	16	–	10	–
Zaire	100	64	72	14	80	11	66	11	42	–	–

PT - Part-time personnel expressed as a percentage of total scientists and engineers in each field of science.
Note : 1. See corresponding note on Table 4.

TP - Pourcentage de l'effectif total des scientifiques et des ingénieurs travaillant à temps partiel dans chaque secteur.
Note : 1. Voir note correspondante du Tableau 4.

Source: UNESCO, National Science Policies in Africa, Science Policy Studies and Documents 1974, Paris, France.

A FRAMEWORK FOR ACTION

(a) Long-Term Technology Manpower Development Policy and Plans.

10. A characteristic feature of manpower development is that it cannot be hurried beyond certain limits. The captains of industry, the technologists, the scientists, the technicians etc. of the future are today still within the educational system. The way in which they are educated and trained today should equip them to meet the challenges of one or two decades from now. Thus manpower development has to work on long-term projects, as well as short-term ones facing imminent, if not actually present, needs. The main elements of planned technology manpower development for Africa are:

(a) An estimation of the various kinds of skilled personnel needed, namely:

(i) Top managers and industrial and technological policy planners;

(ii) Managers, engineers, scientists, technologists, economists, accountants, sociologists etc.;

(iii) Vocational, trade and skilled personnel;

(b) Establishing an appropriate institutional infrastructure for meeting these needs over a specific time horizon. This will clearly indicate the order of priorities for the respective roles of the various institutions,[6/] which could be broadly grouped as:

(i) Educational institutions

Universities and other institutions of higher learning
Secondary schools
Technical, vocational and trade schools

(ii) Technical institutes

Management and technology institutes
Research and development (R and D) institutes
Training institutes for the priority industrial sectors

6/ The document on Industrial Technology Institutions discusses this matter is detail.

(iii) Other training programmes

In-service training

In-plant training

National training workshops, training associations etc.;

(c) A definite decision is usually made on the proportion of the government revenue or the GDP which should be spent on the development of the educational and technical infrastructure and on the educational and training establishments themselves;

(d) The general education system is the foundation on which programmes for developing technology manpower rest. It is from amongst the men and women conditioned by this system that technology manpower will be built up. Improvement in the educational system at all its levels and the general enlightenment of society affect technology manpower development in a direct manner. Thus it is important to reform the educational system and the content of the education and training programmes at each level, so that the technological development needs are best met;

(e) Working out suitable programmes for the promotion of adult literacy and the development of a scientific and technological awareness in the population as a whole. The role of the media, that is to say, radio, television, the press, is decisive in this process;

(f) Having assessed, even tentatively, the technological manpower requirements, a manpower development plan with a clear perspective, method, schedule of implementation and financing can then be drawn up making use of existing capabilities and providing for new institutions and modes of education and training.

11. Assessment of manpower needs is a difficult exercise for which there are, as yet, no generally accepted methodologies, especially for developing countries. It should always be remembered, however, that manpower development is a key factor in overall development. If carried out in an appropriate manner, it is a good investment, for any country, at any time. However, trained manpower should not be confined to the needs of ongoing or future projects; but should aim at upgrading the general level of the population in all the basic skills needed for technology development. Such qualified manpower generates self-employment and the spread of entrepreneurial spirit in all walks of life.

12. It is also important in planning to meet the needs to make full use of innovative methods of manpower development in various parts of the world, rather than adhering always to classical forms and modes of education and training.

(b) Short-Term Actions

13. The actions outlined above are of a long- and medium-term nature. In the meantime, industrial and technological contracts will continue to be signed and factories set up. Therefore it will be necessary also for certain immediate actions to be taken for the solution of the industrial and technological manpower problems being faced. Such short-term actions would predominantly consist of short-term training programmes aimed at augmenting the skills and experiences of various industrial and technological personnel in dealing with the immediate problems confronting them.

14. So far, manpower development does not seem to have received the full attention it deserves in the contracting and implementing of foreign technology projects. Training of nationals usually has been confined to mastering the drill of operation of plant and equipment purchased, and a certain amount of maintenance and repair. It is unusual to find a systematic approach to the training of nationals during the processes of design, fabrication, testing, erection and commissioning. Even if this were to be carried out, it is usually at the expense of more expenditure or some delay in implementation. It is not unusual to rely on expatriates to carry out most of the more sophisticated technological tasks across the whole technology spectrum from investment opportunity identification, feasibility study, technology choices, consultancy, design, erection up to maintenance and marketing.

15. Furthermore, the full potential of a variety of existing institutions and possible modes of training does not seem to have been fully realized particularly on the short-term type of action to meet an urgent need. Considerable progress could be made in upgrading and reorienting manpower in relatively short periods of time with some flexibility in modes of operation and ad hoc measures in existing institutions to meet a pressing and clearly defined need and without establishing new institutions or departments in existing ones.

16. The importance of a multi-disciplinary approach has been stressed on several occasions in the working documents of the Symposium. Technological development has been viewed from a systems approach in which a variety of sub-systems staffed by people trained in different disciplines have to work together and interact effectively. It is important that the emphasis on multi-disciplinarity be reflected also during the education and training processes, in course work and in curriculum design. The actions proposed here are built on the preceding ideas and involve actions in the short-term particularly. They do not address the issues of manpower development or education in their totality; but bear in mind that immediate action is a subset of the more comprehensive and long-term plans of educational reform and manpower development.

Optimum utilization of existing educational and training facilities

17. (i) Universities

a. Their role in providing basic training for technical, professional and managerial personnel is well known. However, university courses are generally lacking in a variety of important areas of technological development of a country, for example, production engineering, financial management, industrial economics, business management, areas that are particularly important for the training of technology manpower.

b. In all these functions, the multi-disciplinary approach is essential. Universities are an obvious choice for drawing on expertise in various disciplines. The establishment of technology or development centres or institutes, that provide special courses and carry out mission-oriented research, can accelerate the training of technology manpower.

c. Training, research, consultancy and extension work constitute four principal functional areas in which universities can play a key role in developing an industrial technology institutional infrastructure. At the request of the bodies concerned with stimulating industrial technology, universities could undertake research and provide consultancy services to such bodies or enterprises.

They could undertake, for example, pre-feasibility studies, market and manpower surveys, cost analysis etc. for financial institutions interested in promoting indigenous entrepreneurship. One important aspect which has been overlooked is the direct involvement of universities in industrial extension work, similar to the agricultural extension work already common in some universities. African governments have been slow in calling upon universities to get involved in extension work and in providing them with the funds for research oriented to the needs of industrial extension services.

(ii) Post-secondary technical institutes

These include polytechnics, colleges of technology, management development centres and technical institutions at the upper secondary and post-secondary levels. Their training programmes provide the main source for the staffing of executive, supervisory, operational and field service posts as well as the accounting and clerical services of various industrial promotion institutions. Being less pre-occupied with academic refinements, and more oriented to developing a capability for getting work done, developing research and consultancy services is likely to be directly relevant to the needs of African industrial technology today. African governments have yet to provide these training institutions with the means and encouragement to engage in more extension work in order to promote industrial technology.

(iii) Vocational training institutions

Vocational training centres, trade schools and commercial schools are all concerned with training junior technicians, skilled operatives, craftsmen and other semi-skilled workers. At the operational level, national vocational training centres are also active in some countries. As industrial and business activities in the developing countries increase progressively there would be a definite need to establish more vocational training schools, and to provide advanced training in more sophisticated trades such as toolmaking, electronics and data processing, which are becoming more widespread in technology packages.

(iv) In-plant training institutions

In-plant training workshops or schools providing institutionalized in-house training programmes such as the East African Railway Training Workshop in Nairobi, and the Ethiopian Airlines Training School for Pilots have gained continental reputation. Sometimes several firms in a given industry pool resources to establish their own training school or workshop (for example, the East African Management Institute, Arusha, established to cater to management training needs of the various public enterprises formerly owned by what was formerly the East African Community).

(v) Management training institutes

Institutes of public administration, management development centres, centres for entrepreneurship etc. are principally concerned with developing managerial capability and supervisory skills. In addition to personnel training, they also carry out research directly related to production, finance, marketing and personnel management problems and provide management consulting services to industries and industrial promotion institutions. Their increased involvement in the screening of new technology contracts and diagnostic field research in existing enterprises would provide invaluable training opportunities for a variety of specialists.

(vi) Polytechnic institutes

There is an urgent need for a variety of specializations. Designing of industrial products, tools, fixtures and other production aids, pre-planning methods, engineering, production technology, quality control, material management and value engineering, are some of the essential skills needed in the industrial technology spectrum. To provide training facilities for persons to handle these specialized tasks, polytechnical institutes on the national or regional level could meet some immediate needs, but as time goes on and technological activities grow, more polytechnic institutes may become necessary.

The important consideration is that these institutions must have close links with all organizations performing technological functions. Consideration might be given by industry to the funding of training programmes and the award of fellowships for specific tasks in these institutes.

18. Some of the African countries have sufficient talents which could be reoriented to meet the immediate needs, at any rate as far as manpower of the required skill mix is concerned. The high standards of technical and scientific education in the universities and technical colleges of these countries, has generated intelligent and resourceful scientists and engineers. The technical institutions could normally provide the manpower for the training of managers, higher technical personnel, designers and research staff needed in industry and business. Daring and innovative approaches in all these institutions could enhance African stocks of qualified technology manpower effectively and quickly.

19. While substantial effort has gone into the training of teachers and professors in the educational system, only a few attempts have been made so far to train those professionals responsible for the training and manpower development function in an organization. These professionals (co-ordinators, administrators, managers and directors of training) lack the opportunities for systematically developing their skills. Joining together in an "association for training and manpower development" is a way in which these specialists can develop their profession. Such an association would, inter alia, upgrade knowledge and skills of training specialists, work out new and appropriate methodologies based on original research and actual experience, build a data bank for training opportunities and organize group training programmes for people from other countries.

20. With suitable training and practical experience in more sophisticated technologies, personnel could be trained abroad to become capable of acquiring the necessary knowledge in technology. In so far as in-service and in-plant training is concerned, it may become necessary, and in fact advantageous, to obtain the service of experts from abroad, preferably from collaborating firms engaged in transferring a particular product or process technology and to place local personnel as counterparts to the foreign experts on short deputations so that, after the initial

period and a planned time horizon, the local personnel would take over from the foreign experts. It may also become necessary to intensify the training abroad of key personnel in foreign enterprises and institutions, particularly in other developing countries, to learn the intricacies involved in the product and process technologies.

Specific training for selection, acquisition, adaptation and development of technology

21. Specific training in the skills required for the functions of technology policy, planning and implementation cannot be provided by the formal educational sectors alone. However, research work conducted in the universities to collect information on African and other experiences in this domain and to analyse it in an attempt to point out pitfalls and highlight successes would provide basic material for training in these areas. Exchange of experiences within Africa and with other developing regions, particularly India, the Republic of Korea and Latin America[7] would further facilitate training in these crucial skills. Multi-diciplinary teams could be formed to attend specially designed group training courses, workshops or seminars organized nationally or by United Nations agencies analysing African case studies of the problems involved in the selection, acquisition, adaptation and development of technology. It is important that such teams continue to work together, close to the decision-makers in technology matters.[8]

Establishment of inter-institutional linkages

22. In their central function of providing technical manpower for industrial and economic development, technological training institutions need to develop strong linkages if their contributions are to reflect a systems approach and be effective. The training technological institutions need to develop linkages with national industrial and economic planners; industrial enterprises and the business community, other relevant institutions in the country, as well as with technological institutions in other countries, particularly other third world countries.

7/ UNIDO has organized a number of training courses on these subjects.

8/ See Guidelines for the Evaluation of Transfer of Technology Agreements, Development and Transfer of Technology Series, No.12(ID/233).

(a) Linkage with governmental planning machinery

In their planning functions, national industrial planners require industrial and technological manpower inputs generally provided by institutions from more advanced countries. A close working relationship with the national industrial planning machinery is essential in order to provide an opportunity for the indigenous technological institutions and personnel to contribute by providing the required industrial and technological manpower inputs. Where the industrial technological manpower has not acquired the level of competence to make an effective contribution, a natural approach would be for such personnel to be linked with the appropriate more advanced ones. Decision-makers and national industrial and economic planners also need to encourage indigenous technological institutions and personnel, where these already exist, by making greater use of their services in the full spectrum of industrial and economic development;

(b) Linkages with the industrial and business communities

Although several efforts have been made at the national and international levels to close the gap that exists between technological expertise and industrial and business enterprises, the degree of success so far achieved is disappointing. Concerted efforts at the national level, with international assistance if necessary, would be required to develop suitable approaches; for example, research contracts to promote greater use of indigenous technological expertise by the industrial and business community. Professional societies and productivity councils could play a decisive role in bridging this gap and creating effective working relations between industry, universities and research centres;

(c) Linkages with other national institutions

Linkages between training institutions and other relevant national institutions are directly related to the development of a national machinery and programme for technological manpower development. With a suitable policy framework and national machinery which clearly defines the functions of each institution, linkages between the various technological and training institutions in a country, particularly between multipurpose and specialized training institutions, would be easier to establish and implement.

An action programme in this area would necessarily have to be within the framework of a programme for the establishment of a national policy, plan, programme, machinery and an institutional framework for industrial technology manpower development. However, there would be certain specific situations where action would be required to develop working arrangements between institutions, either on joint training programmes or for complementing and supplementing the other's activities;

(d) Linkages with institutions outside the country

With the rapid pace at which science and technology is changing and with the rapid rate of industrial development taking place in various countries, the establishment of close contact among technical personnel and organizations devoted to industrial and technological manpower development would need to break national boundaries and establish viable and dynamic international linkages. Such linkages would exist between personnel and institutions particularly within the developing countries themselves and also between developed and developing countries. Linkages between technological personnel institutions in developing countries and more advanced foreign ones would help to build more confidence in the local institution since it gains experience by working with more experienced experts and organizations. The linkages, if they involve consultants and technological institutions which already enjoy international recognition, would also help the efforts of industrial and technological personnel and institutions in Africa to win the confidence of the industrial and business communities.

The preceding framework for action within the long- and short-term time horizons closely relates to the institutions involved in technology manpower development. It is useful to remember that reorientation and upgrading of academically qualified personnel is perhaps one of the major tasks in the short run and that considerable progress could achieved in this endeavour over reasonably short periods through ad hoc measures at the national, and particularly at the regional level.

It is also important that the trainees do not drift later into other occupations or that the multi-disciplinary and task force approach are lost in exercising the skills acquired in training.

In the long run, effective technology manpower planning, balancing the supply and demand sides of the exercise over adequate time horizons will ensure the availability of qualified technology manpower in the right numbers, at the right time and with the right education and training.

ANTECEDENTS AND PRESENT SITUATION IN INTRA-AFRICAN CO-OPERATION IN INDUSTRIAL TECHNOLOGY

1. Although arrangements for co-operation among African countries are by no means new, technical co-operation between African countries took longer to come about and is relatively new. The establishment of the Economic Commission for Africa (ECA) and the Organization of African Unity (OAU) in the late fifties and early sixties resulted in a marked increase in intra-African technical co-operation. It received further impetus from the attention manifested at the international level to the importance of co-operation among developing countries, initiated by the action programme adopted by the Heads of States and Governments of the Non-aligned Countries in Algiers in 1973 and the consequent United Nations General Assembly Resolution 2974 (XXVII) which provided the operational content to the concept of collective self-reliance and mutual help among developing countries in their development efforts. The Lima Declaration and Plan of Action on Industrial Development, adopted in 1975, attached particular importance to co-operation among developing countries and indicated a number of specific measures for establishing appropriate machinery for co-operation and co-ordination of efforts of developing countries particularly in the acquisition and utilization of technology.

2. The basic objectives of technical co-operation between developing countries, recognized as the furthering of the national and collective self-reliance of these countries and the enhancement of their creative capacity in solving development problems were also supported by the Fifth Conference of Heads of State or Government of Non-Aligned Countries in Colombo in 1976. The Kuwait Declaration on Technical Co-operation among Developing Countries states that "TCDC is a historical imperative brought about by the need for a new international order. It is a conscious, systematic and politically motivated process developed to create a framework of multiple links between developing countries". 1/ This Declaration was

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1/ A/CONF.79/PC/18.

recognized in resolution CM/Res.560 (XXIX) of the Council of Ministers of OAU, endorsed by the Assembly of African Heads and Government in Libreville in 1977. In December 1977, the United Nations General Assembly endorsed recommendations for Technical Co-operation among Developing Countries adopted by the Governing Council of UNDP.

3. Thus technical co-operation among developing countries emerged as a new dimension of international co-operation for development. The United Nations Conference on Technical Co-operation among Developing Countries was held in Buenos Aires in 1978. Among the activities stated in the Buenos Aires Plan of Action adopted by the Conference, two relate specifically to technology: -

(i) "To strengthen existing technological capacities in the developing countries, including the traditional sector, to improve the effectiveness with which such capacities are used and to create new capacities and capabilities and in this context to promote the transfer of technology and skills appropriate to their resource endowments and the development potential of the developing countries so as to strengthen their individual and collective self-reliance.

(ii) To improve the capacity of developing countries for the absorption and adaptation of technology and skill to meet their specific developmental needs."[2/]

4. Several recommendations address themselves to issues closely related to technological development as discussed by the Symposium: -[3/]

- Recommendation 6: Promotion of national research and training centres with multinational scope
- Recommendation 7: The promotion of greater technological self-reliance
- Recommendation 8: The formulation, orientation and sharing of policy experiences with respect to science and technology
- Recommendation 18: The creation of new links for technical co-operation among developing countries in important substantive areas (specifying research and development (R and D) and the adaptation of technology)

2/ A/CONF.79/13/Rev.1, p.6

3/ ibid., pp. 8-19

- Recommendation 26: <u>The Improvement of information flows</u>
- Recommendation 36: <u>The harmonization of development assistance with technical co-operation among developing countries</u>.

5. The fundamental principle which underlies technical co-operation among developing countries is that technical co-operation among these countries is to be conceived neither as a substitute for nor a competitor to present bilateral and multilateral programmes. The overall objective, therefore, is to find means to expand the total resource flows, not simply change their proportions. Furthermore, the effort of the international community is being dedicated to the much needed improvement of information flow among developing countries and the tapping of unused resources for development activities. The resolutions adopted in the international fora, both inside and outside of the United Nations, as well as discussions in regional and international meetings, have brought out a number of points of consensus. The concept self-reliance is not an expression of a desire for isolation or autarchy, but an essential dimension of a new interrelated system of global relationships. Firstly, it provides greater opportunities for progress through co-operative efforts rather than through individual endeavours. Secondly, in view of the fact that the third world countries today are at different levels of development, are endowed with different natural and human resources, and have different productive capacities, opportunities for meaningful and mutually beneficial co-operation are vast. Thirdly, the United Nations system has been urged to promote such co-operation and provide effective assistance in strengthening co-operation at subregional and interregional levels. Fourthly, every effort has to be made to provide an operational content to the subject of co-operation among developing countries. Fifthly, specific programmes of action need to be developed towards this end and, more particularly, a mechanism established to foster and facilitate such co-operation.

6. The need for co-operation among the developing countries in the field of industrial technology is particularly essential in view of the similarity of the problems of technological development they face, and in view of the various constraints and limitations often posed by the acquisition of technologies from the developed countries. Furthermore, the technological

needs and experiences in developing countries have a close affinity and follow a similar pattern. Technological development in several developing countries has achieved a level, both in terms of indigenous processes and techniques and in the absorption and adaptation of foreign technology, where it can be effectively transferred to other developing countries. The capability to provide technological services, including engineering and consultancy services, also has grown considerably in many of these countries, and could be extended to other developing countries. Such co-operation would, on the one hand, enable the developing countries to learn from each others' successes, pitfalls and mistakes, and on the other hand, permit them to pool their resources for mutually beneficial programmes and projects, thereby avoiding wasteful duplication. It would, however, be necessary that the commercial transfer of technology between developing countries at the enterprise level, should be effected on terms and conditions which are suitable and appropriate for both parties.

7. The Round-Table Ministerial Meeting on Industrial and Technological Co-operation held at New Delhi, India, in January 1977, the Meeting of Senior Officials and Heads of National Technology Registries in Developing Countries held at Vienna, Austria, in March 1978, and the International Forum on Appropriate Industrial Technology held at New Delhi, in 1978, have all stressed the need for such co-operative action, and have defined and identified areas and specific action programmes for promoting technological co-operation among the developing countries. These include:

(a) Harmonization of policies and action to achieve the target set by Lima following redeployment of productive capacities from developed to developing countries and the creation of additional capacities;

(b) Co-operation in the field of industrial technology with a view to improving the identification and use of technologies already available in the developing countries, including technical know-how and skills, machinery and equipment, design, consulting and construction capabilities etc.;

(c) The creation of co-operative programmes concerning applied R and D activities in specific sectors, drawing heavily upon machinery and capabilities already available in the developing countries;

(d) The development of concrete plans for encouraging the use of engineering and consultancy capabilities available within the countries as viable alternatives to those offered by industrialized nations;

(e) Establishment and strengthening of the institutional framework at the national and regional levels to sustain industrial and technological development, and to promote joint investment projects;

(f) To promote collective action for negotiating and bargaining for technology acquisition by the developing countries;

(g) The development of joint programmes and projects for R and D in specific industrial sectors or products, including the exchange of expert personnel for training etc.

(h) Collection and dissemination of information among R and D institutions and production enterprises in developing countries regarding the development and/or existence of alternative technologies, techniques and processes which may be useful to other countries;

(i) Enhancement and development of national capabilities in the identification, evaluation and selection of foreign technologies, including the regulatory and promotional functions necessary in this regard;

(j) The promotion and development of indigenous technological capability, including appropriate indigenous processes and techniques technological service capability and the development of technological institutions engaged in industrial and technological R and D activities.

8. The objectives outlined above will have to rely on the political will and appropriate support from all governments concerned and on the introduction of adequate mechanisms for their implementation. UNIDO could play a central role in fostering and promoting such a programme and could provide as well analytical and direct assistance as needed. Moreover, it should be envisaged that the work and activities to be undertaken under this programme would have to rely upon adequate information and experience which is already available within the countries, but so far not properly utilized.

9. In an increasingly complex and inter-dependent economic society no group of countries can afford to cut itself off from the mainstream of international technological progress; however, developing countries cannot continue to be the recipients of production techniques that are often unsuitable, supplied at inflated prices and under restrictive conditions.

10. The Conference of Governmental Experts on Technical Co-operation Among African Countries held in Nairobi in May 1980 provided a good opportunity for the first systematic review and analysis of African experience in this field.[4/] It notes two encouraging signs. First that "the need for economic co-operation became imperative for the African countries as they reached independence", even though this "proved difficult only where the political will was lacking". It notes further that "progress has been made as regards political will ..... ideological differences are no longer an obstacle to the development of economic co-operation, which has thus moved ..... to more specialized sectors (meteorology, aridity, food, industry) or to operations in a specific field (training of rural engineers, solar energy research etc.)".

11. One of the particularly striking features of intra-African co-operation in fields related to technological development is the exchange of students for university education within Africa (see table).

4/ UNDP: African Experiences In Technical Co-operation Among Developing Countries, Conference of Governmental Experts on Technical Co-operation among African Countries, Nairobi, Kenya, 12-20 May 1980 (TCDC/AF/4).

Table - African students studying in African countries by field of study and host country in 1971 */

Field of study / Host country	Humanities Education Fine Arts	Law Social Sciences	Natural Sciences	Engineering	Medical Sciences	Agriculture	Not Specified	TOTAL
Congo	117	61	16	-	-	-	-	194
Ethiopia	10	-	6	4	4	21	13	58
Ghana	45	35	16	7	9	11	-	123
Ivory Coast	131	375	62	-	89	-	10	667
Lesotho	99	67	47	-	-	-	-	213
Libya	240	86	46	78	13	38	-	501
Malawi	2	4	4	-	-	1	-	11
Senegal	275	437	143	11	507	45	-	1 418
Sudan	153	553	15	2	7	4	-	734
Togo	163	266	68	-	-	-	-	497
Uganda	79	157	31	-	157	71	2	497
United Rep. of Cameroon	39	45	16	-	4	12	-	115
TOTAL	1 352	2 086	470	102	790	203	25	5 028

*/ Source: UNDP, African Experiences in Technical Co-operation among Developing Countries, Annex 3 (TCDC/AF/4).

However, one cannot help noting that the majority of these students are in the humanities, education, fine arts, law and social sciences and that some ten times the number studying in Africa are studying outside the continent.

12. Of twenty-one projects which could be analysed by UNDP[5/] only five could be said to relate to technological development. UNIDC has been active in promoting intra-African co-operation within its field of competence, with a number of ongoing programmes. Some five African countries are involved in UNIDO's Technological Information Exchange System (TIES) programme In-plant training courses for participants from several African nations have been organized in a number of industrial technology fields.

A FRAMEWORK FOR ACTION

13. Co-operation in science and technology has been identified as one of the three priority areas of technical co-operation among developing countries in Africa.[6/] It has been noted that technical co-operation between developing countries is more advanced at the conceptual, philosophical and political levels than it is in operational terms. The challenge is to translate the concept into meaningful action. It must be remembered, however, that experience in this area is very limited and there is as yet not much data on the problems facing the operationalisation of the concept. However, certain general principles seem to be clear. Joint action between countries is no substitute for determined action at the national level. In fact, unless national effort has reached a minimum threshold in its scope and intensity in some of the countries involved, together with a realization and a will to benefit from it in some others, such co-operation would be of little value, if not an outright dispersal of effort. One particularly important aspect of intra-Africa co-operation is the crucial importance

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5/ UNDP: African Experiences in Technical Co-operation among Developing Countries, Annex 1 (TCDC/AP/4).

6/ Ibid., para. 2

it has for the least developed, landlocked and island countries of Africa. It is difficult to exaggerate the value of co-operative measures in keeping these countries within the mainstream of technological development and saving them from lagging behind other countries in Africa. The identification of complementarities is almost the only basis of sound development planning and would make them less dependent on other countries.

14. The importance of political will has been cited on more than one occasion as a prerequisite for such co-operation. Without in any way belittling its importance, it should also be remembered that there is a whole spectrum of modes and activities in operationalizing co-operation in technological development. These range from the less committed exchange of personnel as students and trainees or as experts and consultants, through jointly organized meetings, symposia or conferences; multinational training courses; joint action in the processes of technology acquisition; co-operative research programmes or field studies; all the way up to jointly-owned production facilities.

15. Intra-African co-operaton in the functions of industrial technology should be viewed as the means to achieving collective technological self-reliance. It should be viewed as a dynamic approach to turning self-reliant concepts in technology fields into reality through actions that could start in a very modest way; but continue to develop in intensity and in quality as progress is achieved and new challenges and opportunities emerge in a continually changing world and African political climate.

16. Again, actions will be based on the three parameters: the functions of industrial technology; the sectors of industry in which these functions are to be exercised, and the instruments of exercising these functions. The functions and instruments have been dealt with in the other documents presented to the symposium, while the priority sectors have already been identified and approved by the African states.

17. In formulating a framework of action for technological co-operation in Africa, a number of specific issues will have to be considered. They reflect various degrees of co-operation as outlined in paragraph 14.

Amongst these are:7/

(a) The measures needed to collect and disseminate information on technology and product choices in other African countries. These would cover national and continental action and possibly by UNIDO as part of its functions in the Technological Information Exchange System and the Industrial and Technological Information Bank (INTIB). The problem here is partly caused by lack of knowledge regarding alternatives and partly by a continuing preference for more sophisticated technologies used in highly-industrialized countries. Closer contacts and greater sharing of knowledge and experience between African countries could help overcome this problem.

(b) The specific programmes that need to be carried out for the transfer of technology and know-how in the priority sectors, whether from the "flow" or "stock" streams. Unless positive measures are taken to encourage the flow of technology and know-how between African countries, enterprises will continue to seek technology from industrialized countries even where adapted technology has proved its appropriateness in another country.

(c) Measures for promoting greater utilization of technological services (for example, consultancy engineering, design offices, testing, calibration and standardization facilities) available in other countries. In an African context, such measures would guarantee a minimum workload for such nascent services that would make them economically viable and ensure their continuity, and the expansion and accumulation of experience and knowledge. The problem is also related to scarcity of information on the indigenous capabilities and the preference given to such services from abroad.

(d) Harmonized policy guidelines governing foreign technology inflow in the priority sectors. Such guidelines have been formulated by the Andean Pact countries in Latin America and their experience merits careful analysis.

7/ UNIDO: Technological Co-operation Between Developing Countries ID/WG.275/5.

(e) Joint acquisition of technology and know-how through collective bargaining, particularly for some of the priority sectors involving complicated and costly technologies which are likely to be used by more than one country.

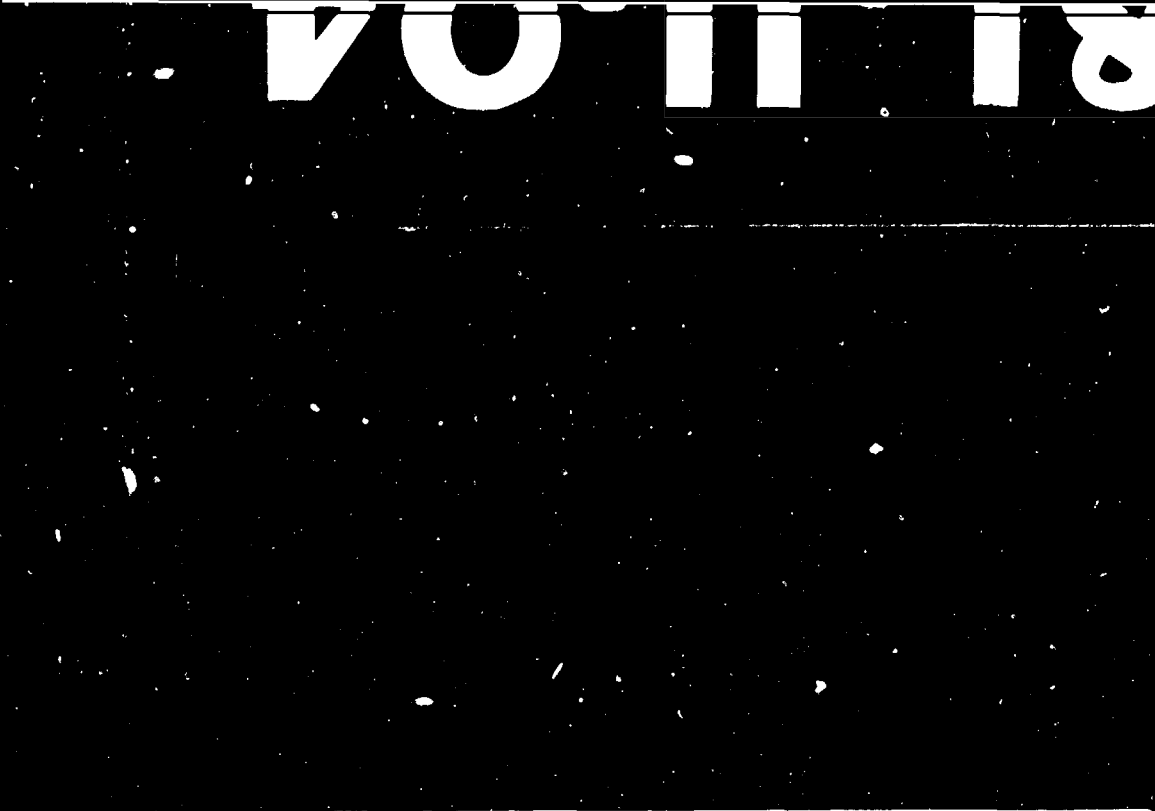
(f) Jointly-owned production units meeting the demand in more than one country. This presumes perhaps the most advanced stage of co-operation. It is of particular importance in some strategic industries or where there is complementarity of endowments.

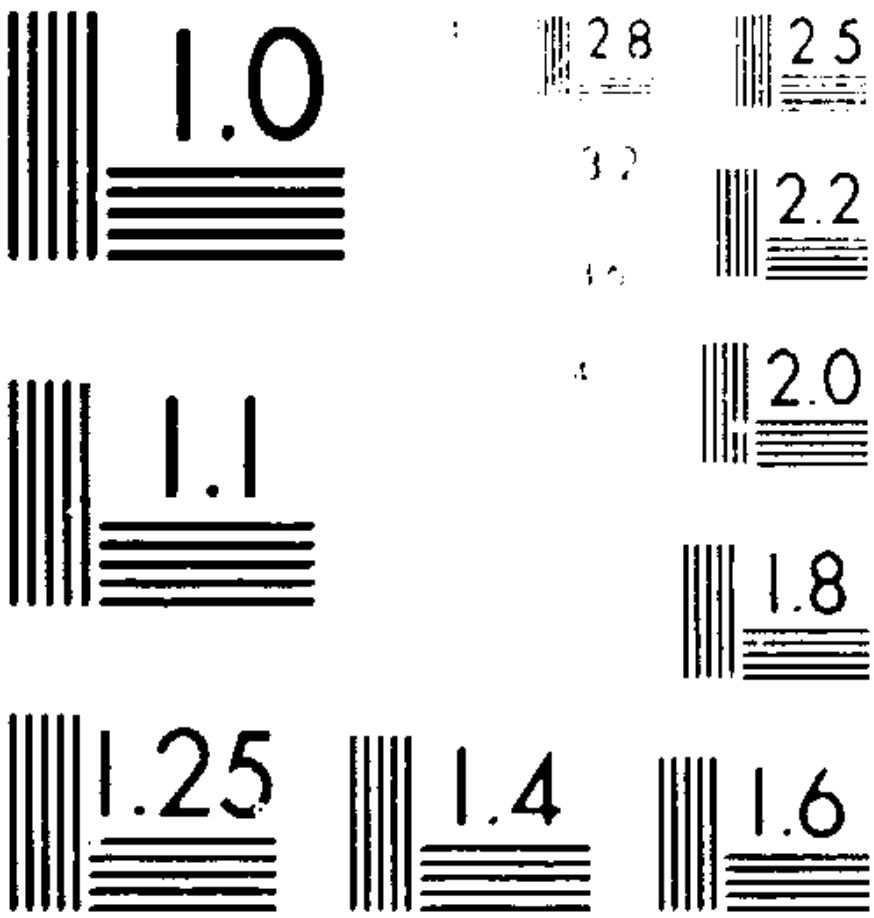
(g) Co-operative R and D programmes. Apart from the obvious advantages of linking existing manpower and institutions in joint research programmes in the priority sectors; of the exercise of the technology functions; the encouragement of indigenous creativity and the development of the stock stream of technology, joint effort is the only way for meaningful work in some of the fields of advanced and non-conventional technology. Thus a very wide range extending from agro-industry or leather to electronics, chemical industry and pharmaceuticals would be covered in the most effective manner.

18. The starting point for dealing with these issues and devising feasible programmes is a thorough survey of the supply side and an in-depth investigation, revealing the full potentialities and complementarities of existing institutions and resources. Various indicative actions in this connection have been presented at the end of each of the Symposium documents which could lead beyond the mere compilation of data on what is in existence to the identification of possibilities and enhancement of existing facilities in relatively short periods of time and without unduly large expenditures through careful consideration of some of the issues raised and discussed in the previous paragraph. 8/ Having identified the available base for co-operative activities the endeavour should be to strengthen and enlarge the base itself by specific well-directed actions. Thus, collective technological self-reliance would become an African reality in the acquisition of foreign

8/ UNIDO has compiled a directory of industrial information centres and is carrying out surveys of R and D, as well as training institutions in Africa. These activities will provide a valuable data base for planning and implementating co-operative activites.

technology and in developing endogenous technologies through a dynamic approach that anticipates challenges and exploits opportunities as they arise.

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INTRA-AFRICAN CO-OPERATION ON TECHNOLOGY AND THE ROLE OF THE OAU

Background

1. The significant and crucial role which industrial technology can play in social and economic development of Africa has been underscored in several fora. Workshops, seminars, symposia and conferences have been held in Africa to underline the various contributions which industrial technology can make to African development. The need to create and foster national, regional and sub-regional technological policies, programmes and institutions has been stressed at these meetings. Several documents from some of the meetings reflect these aspirations. The "Addis Ababa Declaration of Industrial Development" in Africa, (August 1970 and May 1973); the Cairo Declaration on "Industrialization in Africa" - Principles and Guidelines for Co-operation and Development", and the OAU Resolution CM/Res. 569 (XXIX) on Industrial and Technological Activities in Africa- adopted by the OAU Council of Ministers, at its 29th Regular Session held in Libreville, 23rd June to 3rd July, 1977, are some of the most important statements made on the subject by the OAU in the 1970's. They express the interest and aspirations of African leadership for technological development of the continent.

2. Recently, this concern for technological progress has received a renewed emphasis. The Monrovia Declaration of July, 1979, underscored the need for establishing measures and guidelines for national and collective self-reliance in African technological development. The Lagos Plan of Action for the Implementation of the Monrovia Strategy for the Economic Development of Africa adopted by the Assembly of the OAU Heads of State and Government, at its Second Extra-Ordinary Session held in Lagos, Nigeria, from 28th to 29th April, 1980, is yet another clear testimony to the commitment by the African governments to promote the continent's technological progress. The Lagos Plan devotes two chapters to issues dealing with technology: Chapter V, which is the longest one in the document, is devoted to discussion of Science and Technology for African Development, while Chapter VIII discusses measures to build up and strengthen economic and technical co-operation among African countries.

3. Apart from the above, the OAU, in co-operation with the ECA, has been active in the creation of institutions to carry out the wishes of the African governments regarding technological development. A number of regional institutions have been established. The African Regional Centre for Science and Technology has been instituted to provide assistance in formulating and promoting technological policies and programmes for Africa. The African Regional Centre for Engineering Design and Manufacturing has also been established; this is expected to provide African countries with capabilities for engineering design and project implementation. Recently, the Association of African Industrial Technology Organization (AAITO) has been formed in order to facilitate technological progress in the continent. The African countries have been actively involved in the formation and functioning of the United Nations Conference on Science and Technology. The OAU has been a party to the fostering of the idea that the 1980's be declared as the Industrial Development Decade for Africa, with all the incorporated and concommitant technological aspects. Prior to and during UNIDO III in New Delhi, 1980, the OAU took an active role in discussing issues pertaining to the subject. Currently, the OAU is deeply involved in the formation of the African Regional Organization for Standardization Centre and of the African Higher Training and Research.

4. The foregoing narrative illustrates the extent of commitment of the African countries to promoting African technological development, both in words and deeds.

5. Despite these statements of aspirations for technological progress and the practical steps taken to concretize these intentions, a wide gap still exists between the expressed desires and their attainment. This situation does not auger well for us. Africa remains the least technologically developed of all the continents. By all major indicators of technological progress, Africa fares badly. Calculations undertaken by UNIDO[1/] show that the African share of industrial development - an indication of technological progress - remained virtually constant at 0.7

1/ Recent Industrial Development in Africa (UNIDO/ICIS.117).

percent in the manufacturing sector during the period 1960 - 1972 and then rose to 0.8 percent between 1973 and 1975. The share of African countries in exports of manufactures fell from an average of 1.12 percent in 1970 - 1971 to an average of 0.6 percent in 1975 - 1976. The African region's share of the world output of metal and engineering products remained constant at 0.2 percent in 15 years from 1955 to 1970. Between 1970 and 1976, the growth rate of heavy industries progressed at only 4.1 percent annually.

6. Furthermore, the institutions established to promote technological progress have remained weak. They have not received the necessary political and material support to enable them to prosper and function effectively.

7. Under these circumstances, it would have been expected that the way to progress would be through strong multinational co-operative efforts. But this has not been the case. Efforts have been made by a number of OAU Member States to undertake multinational ventures but these have been confined largely to the areas of transport and communications. The co-operative efforts have not been extended to the development of industrial technology.

8. There are a number of prohibiting factors to intra-African co-operation on industrial technological development. The first and foremost is perhaps lack of adequate information to African Governments concerning the dire need for these co-operative ventures. This factor is complicated by the existence of uncertainties about sharing of benefits in multinational schemes. Secondly, the multinational institutions that have been established to deal with the promotion of these enterprises have been weak and have therefore been unable to carry out their mandated functions. Thirdly, there has been an unnecessarily large number of non-tariff barriers which have hindered free flow of ideas and persons from one state to another, thereby prohibiting the flow of technological knowledge.

What should be done to promote African co-operation on technology

9. Technology is a process which involved the entire fabric of society and it involves the processes of production, distribution, consumption and skill-formation. Hence, in their efforts to promote technological advancement, African countries must tackle the issue from two vantage points: from the indigenous as well as from the endogenous sources. While the former aspect deals largely with the traditional and age-born techniques, the latter is a mixture of the traditional and the foreign. The African countries should aim at promoting both. The blending of both would provide Africa with a strong starting base for further technological advance.

10. The Lagos Plan of Action, as already noted, provides for a large and elaborate scheme of thought and a list of programmes of work on how to promote technological progress. These programmes need no repetition here. What needs to be noted are a few ideas that do not receive any, or sufficient attention in the Plan of Action. We venture the following ideas in the hope that Member States, working in a spirit of co-operation, can supplement the concepts and specifications of the Plan with the following ones.

11. There are two processes of acquiring technological knowledge, as mentioned above.

(a) Local means of technological promotion:

(i) Some African countries have tradional ways and means of doing certain things. In a spirit of brotherhood and mutual friendship, these methods should be shared by other Member States which may wish to use them. In this way, African countries can share their technological knowledge with others. It is also quite possible that the traditional methods can be strengthened and dynamized as they are exposed to other countries; they may be modified, adapted, or revolutionized in the process of transformation from one place to another.

(ii) A number of co-operative ventures involving more than one Member State could be undertaken on a multinational basis, using traditional technologies. One example is pot-making. African countries in a given region can undertake to do co-operative research on the kinds of soils suitable for pottery. The results of this research can be translated into a co-operative productive venture which, using the traditional technologies, can produce quality goods which can effectively replace the imported items. For Member States which have lakes and rivers as common borders, this proposition is quite viable.

(b) External acquisition:

(i) Immediate measures should be taken by groups of Member States, acting jointly, to hire services of some eminent and independent experts from industrial nations to assist them in the production of specific industrial goods required to solve their problems. Co-operative action in this score can ward off the prohibitive costs that would expectedly be involved and which may be too much for one Member State to bear. The services and professional expertise of such persons would be imparted directly to the nationals of these states and at the points of production. In this way, one expert can train, on the spot of production, a large number of nationals in the area.

(ii) There is need to establish operational centers for manufacturing and designing of specific industrial products where measures outlined above can be undertaken. These should be centres of actual production. The Member States have already established the African Regional Centre for Engineering Design and Manufacturing. But what is being suggested here is different. The proposed centre(s) would be operational and may take ideas from the Regional Centre. Furthermore, the proposed centre need not be continental; a group of Member States can decide to set up their collective centre and produce only one or two products in order

to spearhead their technological development. Finally, the means of production, at the very basic level, should be accentuated.

(c) Other measures to promote technological co-operation:

(i) African countries should take immediate measures to remove non-tariff barriers so as to allow for free flow of ideas, materials and personnel among the Member States. This step will promote acquisition of technological information and learning from what others in the continent are doing. Already, such a step is being progressively taken by the ECOWAS. Other African regions should follow suit until the whole continent is free from these barriers.

(ii) Member States should make co-operative efforts to allow for the movement of professional technicians from a country that has a surplus to those that have a scarcity of such professions; this exchange of technicians would enhance the dissemination of technological knowledge among Member States.

The Role of the OAU in Co-Ordinating Intra-African Co-Operation on Technology

12. The objectives of the OAU are clearly set in its charter. These include co-ordination and harmonization of policies and programmes of the Member States; mobilization of political will of Member States to undertake co-operative ventures; taking of initiatives to promote co-operative development and development projects involving more than one Member State and monitoring and assisting in the implementation of policies and priorities in economic fields. These are some of the noble objectives envisioned by the Organization and which provide it with the necessary mandate to undertake major actions involved in industrial technology and technology transfer.

13. The Lagos Plan of Action specifies what plans and programmes Africa should undertake in order to promote technological development at the

national, sub-regional and regional and international levels. There is no need to re-enumerate these programmes here, since the Plan of Action is readily available. What needs to be emphasized now is the carrying out of various co-operative plans and programmes which is the clearest way of demonstrating the political will expressed in the Lagos Plan of Action.

14. The role of the OAU, as already mentioned, is to co-ordinate and harmonize policies and programmes of Member States at the regional, sub-regional and continent-wide levels. Having made a collective political expression in Lagos, Member States are now best placed to achieve the desired collective goals for technology. Similarly, the role of the OAU is to promote co-operative ventures involving more than one Member State. The Organization has made efforts to this end. It now remains for the Member States to exercise their political will in order to see that the aims of acquiring and promoting technological progress are attained.

15. The OAU has played, with great determination, a major and extremely important role in ridding the continent of political domination. The same determination is now required to rid Africa of technological dependence. Indeed, Africa is best placed to do this. It has its strength from its political unity and has had experience in exploiting this unity in political emancipation. The Assembly of African Heads of State emphasized the need for political will in promoting economic development during the Special Summit in Lagos, April, 1980, when they said: "Our success in exploiting our political unity should encourage us to exploit the strength inherent in our economic unity. We, therefore, resolve, in the context of our Organization, to unite our efforts in the economic field".

16. Given the commitment and the political will, the OAU will, for its part, intensify its efforts on the technology development front. It will undertake to co-ordinate all activities related to science and technology at the regional, sub-regional, and international levels. It will also organize scientific and technology conferences, seminars and workshops on the subject. It will co-operate with other international organizations

concerned with science and technology in order to promote technological progress for Africa. It will ensure that training facilities for technological manpower are intensified. Finally, it will strengthen the institutions concerned with the dissemination of technology.

17. In order to promote efficiently the co-ordination role of the OAU, it is important that the Organization be associated, in one way or another, with external aid for projects and programmes of common interest to Member States. This function would ensure co-ordination of policies and coherence of objectives among its members. It would also enable the Organization to monitor activities in Africa which are related to science and technology and can thus undertake to evaluate the performance of Member States in this area.

Other OAU Initiatives to Promote Technological Progress

18. The OAU, given the mandate and enthusiasm from the Lagos Summit, is prepared to take new initiatives in order to promote, not only the spread of technology among Member States, but also to ensure its continued advance. Accordingly, the following measures are envisaged:

(i) The role of the professional will be emphasized. This means that individuals engaged to render their management skills should de-emphasize their political affiliations in managing top-level international posts. This posture will greatly enhance their professional efficiency and will enable them to concentrate more on their work. The Member States can help the OAU in this respect.

(ii) The role of periodic and continual retraining of managers, at all levels, in new and proven industrial technology management, will recieve renewed impetus in the OAU scheme of work. Technological progress is a continuous process. New ways of doing the same things are part and parcel of technological advance. Hence, the role of the OAU is to emphasize retraining of personnel in industrial technology positions. Accordingly, the emphasis will be placed on the organization of seminars, panel

discussions, workshops and conferences, in order to exchange technological management ideas.

(iii) The OAU, in an effort to acquire first-hand information in technology matters, is to embark on field-work using its officers. This will enable the officers to prepare relevant policies and programmes. This posture is a new one for the Organization, and should prove to be extremely beneficial as the Organization makes efforts to implement the Lagos Plan of Action.

MOBILIZATION FOR INTRA-AFRICAN TECHNICAL CO-OPERATION FOR SELF-RELIANCE*

Introduction

1. The legendary story of the father who was explaining to his sons the merits of cooperation by asking them in turn to break one spear, and then a bundle of spears, must have been told thousands of times in African schools. So it was not out of context that the Lagos Plan of Action speaks so much about intra-regional cooperation. The Monrovia Strategy also bases African self-reliance on strong ties of collective solidarity. For Africa, the mother of about 50 sons, some infants, some toddlers and some geographically disabled, the fatherly OAU cannot but preach for more and more cooperation and solidarity amongst his sons.

2. The new element in the Monrovia Declaration and the Lagos Plan of Action however, is not cooperation; because cooperation activities are well known in many areas both at the regional and sub-regional level. Recently the UNDP meeting in Nairobi, in May 1980, on Technical Cooperation among African countries, revealed that more than one hundred institutions and two hundred treaties are dealing with such cooperation. The new element, brought forth in Monrovia and Lagos, is collective solidarity for self-reliance. This is what needs more thought and requires new approaches. Because twenty years after most African countries obtained what is supposed to be political independence, Africa is now more dependent than ever in every aspect. A fact that makes political independence only a misnomer.

3. Africa does not lack the natural resources for real independence and for self-reliance. It does not lack the potential manpower. What it lacks is a strategy, a plan of action and eventually the action itself.

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* Professor A.A.R. Elagib, Executive Director, African Regional Centre for Technology, BP 2435, Dakar, Senegal.

The Monrovia Declaration has pin-pointed the strategy. The Lagos Plan of Action has indicated the priority areas for action. What is now needed is more insight into the action itself, more belief and confidence in the feasibility, more conception of the implementation plan and more political will for the execution.

4. These aspirations are not that easy to achieve. The adverse forces of resistance are too powerful and inhibitive. In the old days, self-reliance was inevitable and is dictated by the physical limitations of distances, hazards, etc...African communities used to master it even within one tribe or village in their own ways. But African communities like other less developed communities, slowly lost their independence during the foreign occupation. After that, they became helpless addicts of foreign habits and induced needs, with no commensurate induced abilities or self-confidence to generate such abilities. Experience shows also that the political will tends to be less compatible with the restraint that self-reliance imposes on these communities.

5. These shortcomings will seriously undermine the very strategy of self-reliance unless they are seriously looked up and combated. They are impediments as formidable as the Jungles of Africa, only fires can combat and sweep through them. This paper is a modest attempt to show the need for starting these jungle fires within well planned fire-lines: it is an attempt to start mobilization for collective combat of these shortcomings and impediments, and mobilization for triggering awareness of the vast potentialities for real achievements and eventually for a breakthrough.

6. The paper will discuss concepts, modalities and possible areas of co-operation, and will give concrete ideas and outlines of priority programmes, with some reference to those embarked upon by the Executive Board of African Regional Centre for Technology. The paper will also discuss the optimization of international assistance and technical cooperation in Technology transfer and industrialization.

7. These subjects will be treated under the following headings:

- Introduction.
- Concepts, constraints and new modalities.

- Mobilization for mass awareness and self-confidence.
- Mobilization for strengthening and unleashing the political will.
- Optimization of International Assistance and Technical Cooperation.
- Priority areas of cooperation for achieving the strategy of self-reliance.
- Conclusion: Working for the breakthrough.

Concepts, Constraints and New Modalities

8. Before going further into the details of the subject, one important aspect of the concept of self-reliance needs to be emphasized: the strategy of self-reliance is not at all intended to mean isolation; on the contrary as much as it means obviating or reducing dependence, it also means obviating the possibility that Africa becomes a burden on world economy. Furthermore, it aims at building endogenous capabilities so that Africa can play a more important role allienating world shortages by efficient utilization of its vast indigenous resources.

9. This genuine objective of self-reliance does seem very appealing and the prospects look as the French say "Tout en rose".
Indeed it is not the case. The strategy comes head to head with strong traditional centres of interest. These are not only the genuine trade dealers but also the ruthless commission agents of international profiteering and international power axis. The forces of resistance actually multiply geometrically the faster the new strategy is implemented or intended to be implemented. The strategy actually comes on as a new religion comes to the clergy who had already spent money and sweat to build their own idols for the masses to worship and were looking forward to reeping the profits or at least restore the expenses. It goes without saying that the influence of the clergy is strong not only on the masses but also on the rulers. Hence, to wield the political will will not be as easy at the time of implementation as it looked in Monrovia or in Lagos.

10. Many refer to the pre-independence era in Africa as the "colonial era". In the strict sense it should be called the "occupation or alienation era". Colonization is actually what happened and is happening in

North America, South America and Australia, because the native population there has been pushed aside or exterminated and the new invaders colonized the land. In Africa the native population, short of extermination, was alienated from its environment and traditions during occupation, through a slow process of brain-washing, partly through mass media and partly through the new foreign education system and language. The master's complex then caused the eternal damage: the elite, through the desire of imitation, were detracted totally from their environment and they developed more expectations and consumer habits than capabilities or reproducer skills. In many countries, the misoriented education system produced elements who were more liabilities on these countries' economies than saviours. The elements that achieved political independence have thus not been succeeded by the right elements for achieving economic independence. The rest of the population are helpless, are bewildered by the might of foreign technologies, harassed by the negligence and inefficient handling of their affairs by their compatriots and have finally lost confidence and faith in any salvage by people of their skin.

11. In old days, stronger communities could not influence other communities drastically, unless they moved into them and mixed with them; hence although new habits would be developed, yet new experience would be learned from the invader. Today, however, advanced communities through their mass media: telecommunication, radio, television, press and cinema can influence other communities without moving into them. Unfortunately, these media inculcate into the less developed communities more expectations and consumer habits than experiences or skills. Consequently the brain washing and the domination continued even after independence, through remote control. It is under such odds and constraints that the Monrovia Strategy of self-reliance is to be achieved and the Lagos Plan of Action is to be implemented. Many, however, may tend to overlook the newly introduced element or concept of self-reliance and forget that the Lagos Plan of Action has to be built on a strong foundation of this concept. This requires deep excavation into the indigenous wealth of Africa through the endogenous capabilities of its people. Thus, the modalities which are applicable up to now, made Africa more dependent than twenty years ago and indeed more dependent than

two thousand years ago, when the rest of the world used to look for inspiration from Africa. Such modalities will be far from suitable for implementation of the plan under the new concept.

12. If training is to be conducted in the same old fashion instead of revolutionizing the system, if energy is to be imported instead of indigenous resources being harnessed and if transfer of technology is an ultimate objective rather than a short term means for a long term objective of building up endogenous capabilities for innovation and development, then the Lagos Plan of Action will miss its real target. Also, the new strategy of self-reliance will remain only a belief in the heart of those who wrote it and a paper declaration of those who signed it unless it is followed by mobilization of mass-awareness, self-confidence in its feasibility and of solemn political will for its support.

Mobilization for Mass Awareness and Self-Confidence

13. Self-confidence is an important pre-requisite for self-reliance. If people do not believe in themselves and in their capabilities, they will think it is a risk to untie the strings of dependence and venture into the insecurity of self-reliance. People who are not aware of the potentialities of their countries, who do not know their heritage and who are totally ignorant of their past achievements, cannot easily develop self-confidence. Africans who grew up from a childhood when they were made to read about the "discovery" of Africa will not believe that they had roots going below the surface soil that was ploughed by the foreign discoverer. Consequently, they will not easily believe that they can stand up to the winds of self-reliance. They will not believe that their mother Africa had anything to offer them below that loose soil which the foreigner ploughed and fertilized. Hence, it is not easy to convince them to embark on the deep ploughing process which is needed for self-reliance. To change the phychology of such people, extensive intra-continent mobilisation is needed. This should be the first post-Lagos task, i.e. the first preparatory activity for the implementation of the Lagos Plan of Action. In civil engineering terms this is called "preparation of the site", an operation which usually involved a great deal of obstacle clearing.

14. This chapter of the paper will deal with the mobilization for mass-awareness and self-confidence. Here, the target of the mobilization will be the masses. The following chapter will deal with mobilisation for strengthening and unleashing the political will and will deal with mobilising the politicians and the policy and decision makers. The mobilization activities envisaged will need all hands. They will require involvement of: extension and publicity workers, historians, archaeologists, social scientists, economists, geographers, pedagogists and psychologists, as well well as scientists and technologists.

15. The mobilization for mass-awareness and self-confidence will be directed at bringing forward to the knowledge of the people the natural resources and historic heritages of Africa. Africa has to be now discovered by its own people, after many others claimed that they had discovered it. Each country will be asked that, within a specific period of time, it makes a stock-taking of its past heritages and/or potentialities for the future. Even countries with no natural resources will have potentialities, e.g. for providing labour, which will be trained for specific activities in the prospected African Economic Community. The catalytic factor for mobilization will be the sense of intra-continental competition and the zest for national prestige in such a competition.

16. The natural resources and potentialities survey should include manpower, food and agricultural potentialities, mineral resources and industrial potentialities, energy resources, and possible routes and facilities for transport and communications. Such a stock-taking or survey might have been made before but the new elements in this exercise are that (a) it has to be done mainly by African expertise and (b) that the information must receive vertical wide dissemination to the public.

17. The exercise on historic heritage is not as conventional as that on natural resources. It is aimed at retrieving knowledge about the many civilizations that flourished in Africa hundreds or thousands of years ago. Such civilizations must have been based on novel economic, technological, military or social activities that made their people tower above their contemporaries. A great deal has been done on identifying and publicizing ancient cultures and arts. Surprisingly, very little was done on

ancient technologies or economic activities. Recent historic and archaeological discoveries proved that those civilizations were actually built on ancient technologies, e.g. irrigation systems, architecture, metal smelting and metal industries. Because these civilizations were very old and grew in the slow traditional manner unaided by the development of mass education or mass dissemination, they did not have the publicity or continuity of the European Renaissance or Industrial Revolution; even though they were not less glamorous.

18. Intra-continental operations may be launched, e.g. operation Memphis, operation Meroe, operation Benin, operation Axum, operation Zimbabwe, operation Ghana, operation Kairawan. These operations will aim at bringing forward to the public how the people of these civilizations attained self-reliance and even superiority with the meagre physical means they had at the time which, by no means, were better than what the African people have now. Such material should be the basis of our school history and should replace the bulk of the material about the discovery and conquest of Africa which is ironically now taught to African children and which is instilling into them defeatist attitudes.

19. The main objective of the two exercises about natural resources and historic heritage is the mobilization for building up mass-awareness of the indigenous potentialities, and for restoring confidence in the endogenous capabilities to shoulder the responsibility of self-reliance and even of a breakthrough.

Mobilization for Strengthening and Unleashing of Political Will

20. To convince the masses of the feasibility of self-reliance and to seed into them self-confidence, it is essential to make them aware of past heritage and availability and abundance of natural resources. To convince the political leaders, however, it is more essential to prove to them the feasibility of building up endogenous capabilities to exploit these resources within the country or within the countries which have alliance or community ties with them. This is why it is more appropriate to think of the realization of the self-reliance strategy within intra-regional cooperation. It is also the reason for the timely planning and establishment of intra-regional

institutions like the African Economic Community, the African Regional Centre for Technology, and other allied institutions for technical co-operation in the region. Naturally, self-reliance is more feasible within a region than within a single country.

21. It goes without saying that the prospected African Economic Community Technical Cooperation and Technological Complementality will be of foremost importance, more than in the case of other communities, e.g. The European Economic Community, where individual countries have great technological capabilities. The main worry of the policy and decision makers or political leaders is the lack of compatible scientific and technological capability to shoulder the responsibility of self-reliance. This is why their political will buckles. Intra-regional technological complementarity alleviates, to some extent, the fears of the rulers, but is there enough guarantee for them of availability of the necessary expertise within the country or within the region?

22. Here the element of mobilization is necessary. Just as the masses needed boosting of awareness of indegenous resources and heritages, the political leaders need to know and to be assured of the science and technology potential of their countries. For many years in most countries, unfortunately, there existed a dichotomy and rift between the scientific and technological communities and the policy-makers, especially the politicians. At best, there is hidden suspicion or lack of trust, but certain hypocricy exists. The rulers pay lip-service towards the scientific and technological community and the scientists and technologists pay the necessary respect but keep at a distance or adopt passiveness, i.e. they involve themselves only in body but not in soul. Many countries have actually already lost all souls and bodies of their cadres in the continuous plague of the Brain Drain.

23. Mobilization is needed to bring these two factors of the society together. The politicians have no problem in making their role known. It remains for the scientists and technologists to make their role known. It is true that this is not compatible with their professional character. However, the ignorance of the policy and decision makers or the rulers of the capability of their national scientific and technological communities

will be the main impediment to confidence in the feasibility of the self-reliance strategy and hence to the development of political will. If this state of affairs continues, then it means that the very rightful and ideal soldiers for this epoch of self-reliant development, namely the scientist and technologists, will be out of the scene.

24. The mobilization operations envisaged to combat this shortcoming are annual national gatherings to be held between the political leaders, planners, production forces and the scientific and technological community in each country. The meetings may be instigated continent wide by OAU and the African Regional Centre for Technology through the Governments and the learned societies in the respective countries. There will be fora for each group to explain its role, expectations and demands and also fora for assessing the capabilities for self-reliance and for application of the Lagos Plan of Action. Representatives of neighbouring countries and other regional institutions may be invited. The experience of the Erkowit conference in the Sudan and other similar conferences has proved before that such gatherings greatly enhance the relation and understanding between the various factions. They enlighten the political leadership about the endogenous capabilities and allay their fears which otherwise could greatly restrain the political will and impede any venturing into the policy of self-reliance and of optimal utilization of the indigenous expertise. It is emphasized here that if rhetoric capabilities and armed fight were the elements of politics in the pre-independence era, science and technology should have been and must be the rightful elements of politics for achieving self-reliant development in the post-independence era.

Organization of International Assistance and Technical Cooperation

25. It is obvious that in the light of the Monrovia Strategy of Self-Reliance, the modalities of international assistance and technical co-operation must be revised. The two issues (of self-reliance and call for assistance) need to be compromised because they may contradict. Careful sifting and optimisation is necessary. Assistance which will result in continuity of dependence or which will cause addiction or loss of sensitivity to the challengers of self-reliance, must be eliminated or re-oriented.

26. Transfer of technology is one of the most common modalities presently sought by developing countries to build their capabilities. It is also one of the popular areas of assistance: however, it is controversial and even a hazardous area if not approached scrupulously and discriminately when a strategy of self-reliance is to be achieved. Careful vetting and unpacking must be made by local consultants or through their participation with international consultants of neutral origins.

27. The transfer of technology must be made a short term means for developing capability to regenerate in the long term the capacity for local development or substitution by indogenous innovation. If technology transfer is contracted only as transfer of hardware with no extensive training programmes for local people to handle its operation and maintenance, the country becomes permanently dependent on the supplies.

28. Permanent dependency also is developed when a country sells itself completely to donors of strategic commodities, e.g. basic food and energy supplies without a plan for progressively building endogenous capability to develop substitutes or to harness and to tap indegenous resources. There are basic elements, of self-reliant development which every country must include in its development plan. They are also some of the areas cited below for intra-regional cooperation.

29. Recently a great deal has been advocated about tripartite formats of cooperation between the industrially advanced countries, the oil rich countries and the raw materials producers. In some international fora the term "partners for progress" was initiated. This is a viable arrangement provided that intention of equity prevails and exploitation is denounced. If Africa is to enter into this tripartite venture, certain conditions must be observed. Firstly, an intra-regional collective approach must as far as possible be adopted to increase the bargaining power. Secondly, the self-reliance strategy should always be observed by allowing dependency only to the extent the other parties are dependent on Africa for commodity supplies or for other political or moral support. Thirdly, it must be clear that Africa's requirements are not money and hardware alone in the bare sense, but also building a regenerative capability to improve its share of

the deal by exchange of know-how and expertise to boost productivity in both quality and quantity of its products. Fourthly, the improvement of infrastructure in Africa must be part of the tripartite deal.

30. The Africans as well as the other parties or partners must realize that it is not out of charity that Africa asks for equity in the partnership, but because of real need for development of the vast potential resources of Africa and for boosting productivity both in quantity and quality. This is the only hope for alleviating the world's shortages and hence curb the world-wide escalation of prices.

Priority Areas of Cooperation for achieving the strategy of Self-Reliance

31. To determine priority areas, an extensive academic analysis may be done. However, the result will be the same if one takes a trip around Africa and asks the common man. He will say food and energy. A more sophisticated African will add industrialization, transport, communication and training. Best indication and emphasis is given in item 2.4 of Appendix 4 about the Monrovia Declaration. Appendix 3 shows specific areas of Science and Technology approved by the Executive Board of the African Regional Centre for Technology (ARCT) as priority components of the Centre's 5 year programme (1981-1985). These areas are derived from the Lagos Plan of Action for realization of the Monrovia strategy. They conform with the fore-cited priorities.

32. Appendices 1 and 2 show the objectives and the institutional functions of the Centre as approved by the plenipotentiaries of 28 African countries who signed the Centre's Constitution in Kaduna, Nigeria, 1977. The concept of the Centre itself is a major feat of recognition of the need for technical cooperation. It is governed by a Council composed of the ministers responsible for technology in the African member states.

33. The best drill or exercise to be done from time to time by African countries to assess or evaluate the extent to which they are realizing individually or collectively, the strategy of self-reliance, is to imagine a hypothetical case of embargo or cut of external supplies due to a major hostility action, e.g. a World War III. At present of course, the degree

of susceptibility of most African countries if not all is maximum for crisis in food and energy. Ironically, these are the areas where Africa has greatest indigenous resources but through neglect, they are now the most vulnerable areas.

34. As an example, Africa was self-sufficient in basic food crops like sorghum, millet, yam, cassave, maize even within the village or tribe. They are indigenous crops which people relied upon for their feeding due to the suitability of the climatic conditions for their growth. Some of them grow in rainy seasons as short as 70 days and of few millimetres. For many reasons, the production of these crops decreased and the degree of self-sufficiency dwindled as Tables 1, 2 and 3 show. The reasons are numerous, e.g. the massive emigration of working hands from production areas to towns, the resort of women who were the main factor in the processing to more lucrative jobs outside home and the lack of efforts for promoting indigenous techniques.

35. The main reason, however, was bad planning and sometimes the easy foreign aid. Wheat imported as foreign aid, for example, did eternal damage. Most of the population shifted to wheat specially in the congested urban areas. Here, there are ready bakeries and even ready technologies for the production of bread from wheat. The indigenous crops need special processing for development or adaptation for mass production. When the wheat aid is lifted, some countries even have to subsidize the price of imported wheat to avoid the crisis. Wheat or rice importation is now forming one of the major roles on balance of payments in many countries. Very few countries in Africa have the optimum condition for growing wheat, and yet dependency on it is being allowed to increase. For realizing self-reliance, an advanced priority has to be given to cooperation for improvement of the indigenous food production, processing and storage techniques.

36. Tables 3 and 4 show the great potentialities of Africa in Energy resources. A safari through Africa in fact reveals even greater potentialities: it reveals the coal abundance in South and Central Africa; oil in West Africa, North Africa and East Africa, gas in North and Red

Sea Areas; potential geothermal energy in most of the areas of the Rift Valley from the Central Lakes to the Red Sea; hydropower from many rivers including three of the largest rivers in the world (Nile, Congo and Zambezi); and vast uranium resources in Central and West Africa. Renewable sources of energy are also in abundance in Africa: forest and agricultural waste in the vast areas with suitable rainfall; wind on the coasts and solar energy in the desert areas. In fact, Africa has the greatest land traverse of vertical sunshine amongst all continents. This is only awaiting a breakthrough in solar energy technology.

37. In its five year programme, ARCT is evolving a simple approach for cooperation. This is based on the new concept of R, D and D, i.e. Research, Development and Dissemination instead of the conventional combination of R + D. The Centre, however, is not going to do laboratory research at this stage. It is going to assess on-going research programmes in Africa and supplement any existing deficiencies in the areas of priority in its programme to make those researches bear fruit. The main emphasis in its programme, which is expected to be supported by the Interim Fund for Science and Technology for Development (IFSTD/UNDP), is on surveying and assessing international relevant models of technology as well as indigenous models. Viable models are then selected for implementation in Africa. Pilot schemes will be contracted to local institutions in sub-regions of Africa for adaptation and further evaluation and/or for hosting dissemination and training programmes. Plans for pilot schemes for institutional framework models and energy models for rural development are also envisaged.

38. Surveys of training needs, and documentation of science and technology activities in Africa in the form of a register are also some of the priority tasks decided by the member states. Such a register will help the Centre and other regional organizations to avoid duplication of effort and to identify areas of deficiency for regional supplementation, especially in training.

39. Interesting industrial technology models are quoted from UNIDO's profiles on small industries for use as pilot-schemes for training and demonstrations for entrepreneurs (Ref. 9).

Conclusion: Working for the Breakthrough

40. Self-reliance is a major step towards a breakthrough and towards making Africa occupy a leading position amongst advanced continents because if one is not able to rely on himself, one cannot impress the others to rely on him. One hopes that enough Africans realize the great potentiality for a breakthrough and for Africa to lead. As mentioned before, Africa did lead thousands of years ago. One hopes that after the mobilisation exercise, more self-confidence will be inculcated. Self-reliance realisation will then be the crucial turning point. The breakthrough occurs when other continents depend more on Africa than Africa needs to depend on them. This situation is semi-attained when Africa starts to export commodities with more and more added value due to processing and industrialization even through borrowed technologies. Full attainment of a leading position is finally possible when Africa starts to contribute to world progress by innovating and developing its own technologies. Study of development of technology in other countries gives remarkable examples for guidance.

41. The most interesting is the example of Japan. It is not intended here to refer to some of the tales about Japan immitating other technologies, because everybody may start with that modality. One forgotten strategy which Japan followed was that Japan decided to select a technology which was just in the craddle before patents or commercial rights made its exchange impossible. Electronics in the 1920's and 1930's was in its infancy. Japan embarked on it as a viable optimum technology. Ship-builders and heavy industries promoters were joking and skeptic about any possibility of a light industry like electronics to have any future compared with their own industries. Today, Japan actually leads because it now employs electronics and micro processers not only to lead and control world trade in electronic products but to control all the processes of its heavy industries and hence has wrested leadership also in that area.

42. Africa should now embark on technologies of the future for which it can offer an optimum host. I venture to select the soft technologies microbiology and solar energy. Solar energy has drawn a great deal of attention.

Microbiology, however, did not have the same glamour but in reality, the more one thinks about it, the more one is overwhelmed by the potentialities for Africa. Europe and America have built their civilizations mostly on metals and energy-intensive physical and chemical processes. Africa has strategic reserves of both metals and energies to bargain co-existence until it develops its own modality of the break through. The next civilization may well be based on organisms to perform most of the industrial processes through less intensive-energy biological processes.

43. This civilization may need 50 or 100 years to trigger off but the race for it starts now. Africa has the climate for breeding organisms and training them. In this regard, it is not a joke to say that parapsychology and witchcraft needed no less formidable talents but these are only recognized as technologies when they are imported back as hypnotism.

44. "Mobilization for the breakthrough", however, will be the subject of the following paper.

Table 1 - Growth of Food Production in Africa 1/

Subregion	Average Annual Growth Rate			
	Total Food Production		Per caput Food Production	
	1961 - 70	1970 - 77	1961 - 70	1970 - 77
	Percent			
North Africa	3.0	2.1	0.7	-0.7
Western Africa 2/	2.1	1.1	-0.3	-1.5
Central Africa	2.6	1.0	0.1	-1.3
Eastern & Southern Africa	2.8	1.9	0.4	-0.9
AFRICA	2.7	1.3	0.03	-1.4
MSA in Africa	2.7	1.2	0.4	-1.4

1/ based on FAO Indices of Food Production ; 2/Includes Sahel

Reference FAO/ARC/78/5 July 1978 Food Plan for Africa.

Table 2 - Self-sufficiency Ratios for the Major Food Commodity Groups in the African subregions : 1962 - 64 and 1972 - 74

Commodity	Northern		Sahel		Western		Central		East & Sth		Africa total	
	1962 1964	1972 1974	1962 1964	1972 1974	1962 1964	1972 1974	1962 1964	1972 1974	1962 1964	1972 1974	1962 1964	1972 1974
	percent											
Cereals	91	74	97	79	101	86	90	73	97	95	96	83
Rootcrops	102	102	98	97	100	100	101	100	110	101	101	100
Pulses	133	118	109	99	98	97	100	107	109	109	110	107
Meat	98	98	102	136	99	89	97	93	98	116	98	105
Milk	94	87	96	75	76	49	84	62	95	94	93	85
Sugar	30	53	0	5	0	18	159	104	163	205	93	93
Oilseeds	81	80	287	267	132	147	250	155	95	118	131	129
Fish	118	116	143	143	59	86	90	95	89	98	92	102

Table 3 - Levels of Self-sufficiency in Basic Foods 1/ 1962-64 and 1972-74

Subregions	1962 - 1964		1972 - 1974	
	Deficits 2/	SSR	Deficits	SSR
	mt	%	'000mt	%
Northern Africa	- 1 146	94	- 5 798	78
Sahel	-79	99	- 1 000	83
Western Africa	-12	100	- 1 921	94
Central Africa	-54	99	-506	94
Eastern & Southern Africa	- 269	99	-597	98
TOTAL AFRICA	- 1 560	98	- 9 822	90

1/ Cereals, roots and tubers, pulses, meat and fish.
2/ In wheat equivalent calculated on the basis of calories,

Reference FAO/ARC/78/5 July 1978 Food Plan for Africa.

ANNUAL HYDRAULIC POTENTIALS

Region	theoretical potential 10^{12} kWh	technical usable potential 10^{12} kWh	operating potential 10^{12} kWh	potential under construction 10^{12} kWh	planned potential 10^{12} kWh
Africa	10.118	3.14	0.151	0.047	0.201
America (North)	6.15	3.12	1.129	0.303	0.342
America (Latin)	5.67	3.78	0.299	0.355	0.809
Asia (excluded USSR)	16.486	5.34	0.465	0.080	0.368
Oceania	1.5	0.39	0.059	0.020	0.032
Europe	4.36	1.43	0.842	0.094	0.197
USSR	3.94	2.19	0.265	0.191	0.17 estimated
TOTAL	44.28	19.39	3.207	1.090	2.12

TABLE 4: Annual hydraulic potentials
Potential annuel en energie hydraulique
Jährliches Potential an hydraulischer Energie

World Energy Conference 1980

TABLE 5 : The reserves and resources of oil and natural gas liquids (1.1.1979)

Crude Oil	Proved recoverable reserves		Additional resources in place	Estimated additional resources		
				in place		rec.
	10^6t	%	10^6t	10^6t	%	10^6t
Africa	8040	9	2180	85000	16	34 000
North America	4480	5	42100	60000	11	24 000
Latin America	7770	9	15800	30000	6	12 000
Far East/Pacific	2390	3	7740	30000	6	12 000
Middle East	51040	57	600	130000	24	52 000
Western Europe	2710	3	7770	25000	5	10 000
USSR, China, Eastern Europe	12700	14		160000	30	64 000
Antarctic				10000	2	4 000
TOTAL	89140	100		530000	100	212 000

Natural gas liquids	Proved recoverable reserves		Additional resources in place	Estimated proved rec. reserves		Estimated add. rec. resources	
	10^6t	%	10^6t	10^6t	%	10^6t	%
Africa	494	33		470	7	450	4
North America	510	34	1980	690	10	1100	10
Latin America	382	25	133	390	6	250	2
Far East/Pacific	110	7	577	310	5	850	7
Middle East				1890	29	2100	18
Western Europe	9	1	12	360	5	550	5
USSR, China, Eastern Europe				2470	38	6300	54
TOTAL	1505	100		6580	100	11600	100

TABLE 6: Summary table of world reasonably assured resources of uranium (WOOA-countries) (in thousands of tonnes of uranium)

	World Region	Recovery Costs Up to $ 80/ Kg U	Recovery Costs $ 80-130/ Kg U	Refer. Date	Source
1.	NORTH AMERICA	746.0	197.0	1/1/79	
	Canada	215.0	20.0	1/1/79	1
	United States	530.0	178.0	1/1/79	1
2.	WESTERN EUROPE	68.3	355.0		1
	Austria	0	0.5	1/1/79	1
	Denmark (Greenland)	0	27.0	1/1/79	1
	Finland	0	1.8	8/1/79	1
	France	39.6	15.7	1/1/79	2
	Germany F.R.	4.0	0.5	1/1/79	1
	Italy	0	1.2	1/1/79	1
	Portugal	6.7	1.5	1/1/79	1
	Spain	12.5	3.9	3/12/80	1
	Sweden	1.7	300.0	6/5/79	1
	Yugoslavia	4.5	2.0	1/1/79	2
3.	AUSTRALIA + JAPAN	297.7	9.0		
	Australia	290.0	9.0	1/1/79	1
	Japan	7.7	0	7/2/79	1
4.	LATIN AMERICA	104.8	5.1		
	Argentina	23.0	5.1	1/1/79	1
	Brazil	73.5	0	Feb. 79	1
	Mexico	8.3	0	May 79	1
5.	MIDDLE EAST AND NORTH AFRICA	32.3	0		
	Algeria	28.0	0	1/1/79	2
	Turkey	4.3	0	1/1/79	2
6.	AFRICA SOUTH OF SAHARA	580.0	164.6		
	C.A.R.	18.0	0	1/1/79	2
	Gabon	37.0	0	1/1/79	2
	Niger	160.0	0	1/1/79	2
	Namibia	117.0	16.0	1/1/79	2
	Somalia	0	6.6	1/1/79	2
	South Africa	247.0	144.0	1/1/79	1
	Zaire	1.8	0	1/1/77	3
7.	EAST ASIA	0.3	0		
	Korea	0	4.4		
	Philippines	0.3	0	1/1/77	3
8.	SOUTH ASIA	29.8	0		
	India	29.8	0	1/1/77	1
	TOTAL (rounded)	1860	737		

TABLE 7 : AFRICA'S SHARE OF WORLD PRODUCTION OF KEY MINERALS

1,000 metric tons (1976)

Country	Chief producing Countries in Africa	World	Africa	(1) %	(2) %
Diamonds (carats)	Zaire, South Africa	40	29	72	97
Gold (in tons)	S.A.R., Zimbabwe, Ghana	1 240	760	61	57
Cobalt	Zaire, Zambia, Morocco	26	14	54	42
Platinum (in tons)	S.A.R., Ethiopie	186	84	45	83
Vanadium	S.A.R., Namibia	24	11	45	49
Chromium ore	S.A.R., Zimbabwe	8 611	3 017	35	96
Manganese ore	S.A.R., Gabon	24 759	8 194	33	53
Uranium ore	S.A.R., Niger, Gabon	27	7	25	—
Phosphate rock	Morocco, Tunisia	106 931	25 781	24	—
Copper	S.A.R., Zambia, Zimbabwe, Zaire	7 921	1 477	19	14
Antimony	Morocco, S.A.R.	69	12	18	5
Bauxite	Guinea, Ghana	80 492	12 251	15	50
Mercury	Algeria	8	1	13	—
Asbestos	Zimbabwe, S.A.R.	5 055	578	11	8
Tantal (in tons)	Zaire, Zimbabwe, Ruanda	390	43	11	67
Oil	Nigeria, Libya	2 925 815	268 423	9	—
Iron ore	Liberia, Mauritania, SAR	878 000	71 300	8	—
Nickel	S.A.R., Botswana	779	51	7	74
Beryllium (in tons)	Zambia, Zimbabwe, Ruanda	2 800	177	6	—
Tin	Zaire, Nigeria, S.A.R.	212	13	6	—
Zinc	Zaire, Namibia, Zambia, S.A.R.	6 025	292	5	—
Lead	Morocco, Namibia, Zambia, Tunisia	3 520	142	4	—
Natural gas (bio m^3)	Algeria, Libya	1 372	15	1	—

(1) Africa's % of World Production

(2) Africa's % of World Reserves

Ref . Industrialisation of Africa
Fusion Energy Foundation

Appendix 1

Objectives of the Centre

The objectives of the Centre shall be to:

(a) Contribute to the development and use of technology within its member states;

(b) Stimulate the awareness of technological development in member states;

(c) Strengthen the technological capability of its member states;

(d) Promote the use of such technology as is suitable for the development objectives of its member states;

(e) Assist within its member states in the formulation of technology policies as an integral part of planned scientific, technological and socio-economic development;

(f) Encourage research and training in the methodologies of technology planning;

(g) Improve for the benefit of its member states, the terms and conditions under which technology is imported;

(h) Promote within its member states the diffusion and dissemination of technology and also the collection and encouragement of the use of technological information;

(i) Promote co-operation among countries of the African region, particularly amongst its member states; and

(j) Assess the social implications of the development, transfer, and adaptation of technology and promote the understanding of such implications.

Appendix 2

Functions of the Centre

For the purpose of achieving any of the objectives set out in Article 2 of this Constitution, the Centre shall perform any or a combination of the following functions; that is to say to:

(a) On requests from Governments of its member states or institutions of technology within such member states, assist in the establishment of national institutions for the development, transfer and adaptation of technology;

(b) Advise national institutions of its member states on the choice of technology;

(c) On request from Governments of its member states, identify and supply consultants to advise on matters relating to technology;

(d) Promote through national institutions effective links between producers and users of technology at the national level within its member states;

(e) Compile and maintain registers in the field of technology of:

(i) African research institutions, their programmes and achievements,

(ii) Institutions outside Africa which are concerned with technologies relevant to the needs of its member states, and

(iii) Available specialists in the various fields of technology within the Centre and elsewhere;

(f) Organize training seminars and workshops on various aspects and problems in the field of technology;

(g) Promote the exchange of technical, managerial and research personnel amongst its member states;

(h) Assist in the training of technical and managerial personnel at various levels and in various sectors;

(i) Identify and provide information on specific opportunities for training in the various fields of technology;

(j) Promote and encourage as appropriate the orientation of education, training and curricula towards the technological needs of its member states;

(k) Establish and maintain active relations with:

(i) National technology centres in Africa,

(ii) Regional centres outside Africa which are engaged in activities similar to those of the Centre,

(iii) Specialized regional or sub-regional organizations whose activities are relevant to those of the Centre,

(iv) Relevant organs of the United Nations and other International agencies,

(v) Development financing institutions;

(l) On request from Governments of its member states assist them in identifying alternate sources of technology in various fields;

(m) Assist in the training of specialist personnel in the:

(i) Unpackaging of technology,

(ii) Evaluation and assessment of technology,

(iii) Negotiation of contracts and arrangements relating to the development, transfer and adaptation of technology, and

(iv) Problems connected with industrial property rights;

(n) Provide for its member states information and documentation services on the various fields of technology, in particular on:

(i) Alternative technologies, and

(ii) Alternative sources of technologies;

(o) Co-operate with intergovernmental, public or private institutions engaged in development of methods to be applied in a unified approach to development planning;

(p) Sponsor, promote and encourage original research in the forecasting, assessment and planning of technology;

(q) Encourage the inclusion of courses in the methodology of technology planning in the education and training of development planners;

(r) Assist its member states in the effective use of the international code of conduct for the transfer of technology and other relevant international agreements; and

(s) Take such other steps as are related or incidental to the functions of the Centre or as may promote the attainment of the objectives of the Centre.

Appendix 3

African Regional Centre for Technology

Project Titles

* 1. The indigenous Technologies of Africa.
2. National Science and Technology for development conferences (Erkowit type of conference).
3. Science and Technology policy studies and training programmes.
* 4. Supplementation of training programmes in the region, 3, 8, 16, 17, 20.
* 5. Register of Africa's resources in Science and Technology.
* 6. Documentation of technological information relevant to development objectives of the African Region.
* 7. Development of technological consulting services.
8. Localization of professional training in Engineering.
9. Africa Journal of Technology.
10. Programme for the popularisation of Science.
11. Pilot Schemes and supplementation of Research and Development Programme.
* 12. Promotion of indigenous technologies of food production.
13. Climatological trends and economic growth in Africa.
14. Mechanization with forward linkages for increased employment opportunities (A Boiler Tractor Project).
15. Development of Energy models for Africa.
16. Pilot projects on the informal training of technicians.
17. Relevant technologies for the future.
18. ARCT Laureates.
19. ARCT Nobel Laureates Lectures.
20. Establishment of ARCT Chairs on technology acquisition and development issues.
* 21. The establishment of national technology centres.
* 22. Promotion of technologies for Rural Development. 11, 14, 15.
* 23. Development of appropriate technologies for women.
24. Appropriate technologies for health and shelter.
25. Appropriate building technologies.
* 26. Evaluation of social impact of transfer of technology.
* 27. Evaluation of environmental impact of technological installations.

* Projects identified by the Executive Board for 1981 - 85.

Appendix 4

Monrovia Declaration

1. In Monrovia the OAU Heads of State and Government adopted the "Monrovia Declaration of Committment of the Heads of State and Government of the OAU on the guidelines and measures for national and collective self-reliance in economic and social development for the establishment of a new international economic order".

2. In adopting the Declaration the Heads of State and Government "recognizing the need to take urgent action to provide the political support necessary for the success of the measures to achieve the goals of rapid self-reliance and self-sustaining development and economic growth", declared as follows:

2.1. "We commit ourselves individually and collectively, on behalf of our governments and peoples, to promote the economic and social development and integration of our economies with a view to achieving an increasing measure of self-sufficiency and self-sustainment".

2.2. "We commit ourselves, individually and collectively, on behalf of our governments and peoples, to promote the economic integration of the African region in order to facilitate and reinforce social and economic inter-course".

2.3. "We commit ourselves, individually and collectively, on behalf of our governments and peoples, to establish national, sub-regional and regional institutions which will facilitate the attainment of objectives of self-reliance and self-sustainment".

2.4. "More specifically, we commit ourselves, individually and collectively, on behalf of our governments and peoples, to:

(a) Give an important place to the field of human resources development by starting to eliminate illiteracy,

(b) Put science and technology in the service of development by reinforcing the autonomous capacity of our countries in this field,

(c) Achieve self-sufficiency in food production and supply,

(d) Implement completely the programmes for the United Nations Transport and Communications Decade for Africa,

(e) Realize the sub-regional and regional internally located industrial development,

(f) Co-operate in the field of natural resources control, exploration, extraction and use for the development of our economies for the benefit of our peoples and to set up the appropriate institutions to achieve these purposes,

(g) Develop indigenous entrepreneurial, technical manpower and technological abilities to enable our peoples to assume greater responsibility for the achievement of our individual and collective development goals,

(h) Co-operate in the preservation, protection and improvement of the natural environment,

(i) Ensure that our development policies reflect adequately our socio-cultural values in order to reinforce our cultural identity, and

(j) Take into account the dimension of the future in the elaboration of our development plans including studies and measures aimed at achieving a rapid socio-economic transformation of our states".

2.5. "We hold firmly to the view that these commitments will lead to the creation at the national, sub-regional and regional levels, of a dynamic interdependent African economy and will thereby pave the way for the eventual establishment of an African Common Market leading to an African Economic Community".

2.6. "Resolving to give special attention to the discussion of economic issues at each annual Session of our Assembly, we hereby call on the Secretary-General, in collaboration with the Executive Secretary of the United Nations Economic Commission for Africa, to draw up annually specific programmes and measures

for economic co-operation on sub-regional, regional and continental basis in Africa".

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EXTERNAL ASSISTANCE OPERATIONS

1. This document is primarily concerned with the role of external assistance in the development of technological capabilities in Africa. As such, it does not deal with the wide variety of external assistance for other specific or general purposes. However, it will be necessary to touch upon some fundamental issues in the planning and execution of external assistance programmes, as well as to look into the industrial technology component or implications of external assistance programmes not explicitly meant for this purpose.

2. Unlike technology- and capital-transfer operations which have been extensively analysed and debated by both sides of such transactions, external assistance has yet to be analysed in depth and the positive and negative aspects of its operations revealed particularly in regard to its impact on technological development. On the donor side, routine evaluation has been carried out by several donors for some time past. Furthermore, there is a growing interest among some donor countries for carrying out a deeper and more thorough analysis of past experience in external assistance operations. On the recipient side, some developing countries, including one or two African countries, are beginning to look into the matter and are co-operating in such in-depth evaluation exercises. Yet, on the whole it may be true to say that most recipients have yet to assess their experience with external assistance.

3. It is hoped that a discussion of the role of external assistance will be the prelude to intensive analyses in Africa of the manner in which these operations have been conducted in the past, and to the formulation of a clear strategy by each African country in negotiating and implementing external assistance programmes, particularly in the field of industrial technology.

4. The sources of external assistance are well-known. It comes inter alia from international agencies; regional groupings of donors, for example the European Economic Community; donor countries; private sources (firms, voluntary agencies) as well as from non-governmental organizations. Africa today receives external assistance from a large number of such sources. There is no well-documented record of the amount of such assistance over a specific period of time, or of its types, objectives or sectors

for which it was given. Whatever information which can be pieced together comes from the donors, for example, UN agencies, programmes and funds; organizations such as the Organization for Economic Co-operation and Development and the European Economic Community, governments or non-governmental organizations. It is, however, true to say that external assistance has played an important role in the overall development of African countries and has helped progress in a number of areas and that more assistance is needed.

5. The modes of providing external assistance need not be dwelt upon in great detail here, since they too are now well-known. It would, however, be useful to distinguish between the three main types which reflect the asymmetry between the donor and the recipient and which broadly cover the whole spectrum of current operations. At one end of the scale, there is the straightforward grant which meets an immediate need and which entails the minimal involvement of the recipient in implementation. At the other extreme, there are the co-operative programmes in which two partners share the responsibility for implementation and where disparities between their involvement are not pronounced. In between, there is the assistance programme where the input from the donor helps to energize or enhance indigenous capability which has reached a minimum threshold of viability.

6. In discussing the role of technical assistance in strengthening industrial technology capabilities in a recipient country, the impact of other financial or technological transactions involving an "aid" component, tied or untied, grant, soft loan, credit facilities etc. on indigenous technological capabilities will have to be taken into consideration. These are important components in the recipient country's "implicit" technology policy and could well inhibit, even though un-intentionally, the development of national technological capabilities.[1/]

7. Finally, there is sometimes a marked failure on the part of the recipient country to assess accurately the total cost it is incurring in the implementation of external assistance in any of the three main categories outlined in para. 5. There is a rather naïve assumption in this case that there is "something for nothing". It is now becoming more and more realized that this is far from being the case and that the real cost to the recipient is by no means insignificant. This does not in any way

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1/ See Action in the Field of Technology and Planning in Africa prepared for this Symposium.

belittle the contribution or need for external assistance. It is a reminder that unless the cost is reckoned by the recipient, external assistance will not fulfill its objectives and might even have an adverse effect.

AFRICAN EXPERIENCE WITH EXTERNAL ASSISTANCE

8. When colonial rule ended in Africa, most countries had a minimal cadre of educated Africans who could take over the main administration and technical responsibilities of an independent national government.[2/] The first wave of technical assistance took the form of hastily-prepared "technical aid programmes" which entailed sending African nationals for education and training in the ex-colonial countries. These were, by necessity, service-oriented arrangements that had little to do with the productive sector of the economy. As the administrative and service sector expanded from the capital to the rural periphery, the need for more administrative cadres became even more pressing. Thus, educational facilities were expanded at the primary and secondary levels and universities were established. These followed the established patterns set during the colonial period and were modelled on their educational establishments. In particular, most university curricula seem to have been designed to educate the élite of the administrative and political establishment. Over two thirds of university students in Africa were studying law and the humanities.[3/] The few scientists and engineers were increasingly deployed in the service and administrative sector of the economy. Thus technological capability in most African countries was not developed to a great extent. This has, no doubt contributed significantly to the problem of technological dependence in Africa.

9. External assistance in Africa has also gone into other fields and sectors of the economies of the African countries, for example in building infrastructures, in agriculture, health and education. Recently most donors have tended to adopt a policy based on a "basic needs" approach and to order the priorities of their assistance to African countries on this basis. Naural disasters, particularly severe drought, have diverted

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2/ See Industrial Technology Manpower in Africa prepared for this Symposium.

3/ Ibid.

considerable resources to the alleviation of immediate large-scale sufferings and dangers. While such assistance has been valuable, limited external assistance in developing technological capabilities ranged from the construction of buildings, to the supply of equipment and books, the granting of scholarships and the services of experts. Although the number of people with local and overseas training continues to rise over the years and several science and technology institutions have been set up with external assistance components, this does not seem to have contributed significantly, so far, in the key areas of industrial technology. 4/ A variety of factors have contributed to this state of affairs. Some of these relate to the manner in which the role of external assistance has been conceived, either by the donor or the recipient, while others relate to the development strategy of the country as a whole and the role envisaged for technology imports from the industrialized countries. There are as yet not many examples in Africa of analyses of the impact of external assistance on developing the technological capabilities of the recipient country. The general impression, based on evaluations of donor countries and on the present clearer understanding of the problem of building indigenous technological capabilities, is that external assistance has mainly concentrated on "transferring" rather than on "developing" technology. This is understandable and in no way denigrates its role. But in doing so, emphasis has been placed on the transfer of embodied technology, in the form of plant and equipment, rather than technological software and know-how. The equipment and products involved were, by necessity, those of the donor country and not those best suited to the needs of the recipient. In general, the technology transferred and its products has not always been appropriate. This has no doubt produced quick results from the point of view of socio-economic improvement and growth. It has also meant that the benefits of external assistance were rather short-lived and have not been of a cumulative character. Failure to maintain plant and equipment in working order; shortages of spare parts and raw materials and difficulties of adaptation to local working conditions are well-known causes of reduced benefits.

10. Another essential aspect of external assistance in Africa seems to be that identification of the area and nature of external assistance has been carried out mainly by the donors, rather than by the recipients.

4/ See document Industrial Technology Institutions prepared for this Symposium.

Although the role of foreign expertise in working out the details of an assistance programme should not be underestimated, it is possible, or even likely, that the donor may not be the best judge of the national goals or orders of priority. In many cases, recipient countries have accepted, just as much as sought, external assistance programmes. While this must have been of some value, the absence of a clear order of national priorities in seeking and accepting external assistance could lead to less than optimum results.

11. External assistance seems to be accepted in some cases in a rather haphazard manner depending on the initiatives of some donors or individuals in recipient countries, rather than on a national policy. In many cases assistance programmes are not well co-ordinated at the national level. Assistance programmes from different donors have been known to overlap and to contradict. Few African countries channel all assistance through a central mechanism which co-ordinates it and allocates the human and material resources called for as a counterpart contribution from the recipient.

12. As mentioned earlier there has been in Africa, as in many other parts of the world, no systematic effort to analyse external assistance operations, to monitor them effectively or to assess, with reasonable accuracy, their total cost to the recipient country and to provide resources for the purpose. This is particularly important in Africa in relation to the operations of private donors, whose activities have sometimes reflected a rather static and limited view of appropriateness of technology.

13. There seems to have been very limited recourse in Africa to external assistance from other African or third world countries, either in the hardware or the software form. While it may be understandable in the former, the full potentialities of the latter do not seem to have been fully utilized. Education and training of personnel in other developing countries, as well as the exchange of information on technological development, in general, and the role of external assistance, in particular, could bring immediate benefits to Africa in building its technological capabilities.

A FRAMEWORK FOR ACTION

14. In outlining a suitable framework for action by the African countries for defining the role of external assistance in developing industrial technology it should always be remembered that one of the declared objectives of Africa is to achieve collective self-reliance in the field of industrial technology. The basic criterion for judging a specific programme of external assistance should thus be its contribution to the fulfillment of this goal. Within this general orientation, more specific and detailed criteria have to be developed.

A. Evaluation of Past Experience with External Assistance

15. It is high time African countries carried out a comprehensive and systematic analysis of their own experience with external assistance as a whole and in the field of technological development in particular. It is clear that assistance in building up a country's own capability to develop and prosper utilizing its own resources, and those from outside, in an optimum manner is far more important in the long run than satisfying an urgent need mainly from foreign resources and in a non-recurrent manner. In-depth analysis of past experience could be carried out in co-operation with some donor countries. UNIDO, and other international and regional organizations, have an important role to play here and may be called upon to support such thorough evaluation in their fields of competence. One particular type of assistance which requires particular attention here is that from private or voluntary sources.

16. Evaluation is best carried out mainly by organizations and individuals not involved in previous or current assistance programmes. What is needed is a fresh outlook and a broad national view of the role of external assistance in national development, unfettered by current practices or accepted views. The experience and views of those involved in assistance operations are of course essential and valuable inputs in such an exercise.

B. Clear Identification of Needs from External Assistance

17. The areas, types and modes of external assistance are by necessity subject to negotiation and approval by both donor and recipient. Effective external assistance necessitates that the recipient have a clearly formulated development strategy, national objectives, policies and plans for implementation

which identify the gaps where external assistance of one form or the other is needed as well as the order of priority for such assistance. It is essential for accomplishing the aims of external assistance that this order of priority is adhered to. Accepting assistance in a low priority area before filling the gaps in the higher priority area cannot contribute to national goals and objectives.

18. The low level in identifying needs that will produce optimum economic, social and technological benefits from external assistance is a reflection of low technological capability. Attempts must be made by African countries to identify priority areas for technological development and to consider the ways in which they can develop abilities to assimilate, adapt and improve technologies of interest to their economic and social progress. The priority sectors have already been identified and approved by the African countries. The priority actions and programmes in developing technological capabilities have been discussed in the working documents. There should now emerge a clear picture of the needs in this field and of their order of priority. With needs identified on the basis of their maximum contribution to national development, sources and forms of external assistance that best match the needs can be approached and programmes negotiated on terms that are mutually beneficial to the recipient as well as the donor. In other words, a country must first and foremost be fully aware of its needs based on a realistic assessment of the internal situation and shop for assistance beneficial to the country on this basis. In the past, projects conceived and implemented on the initiative of donors have tended to run into difficulties in the end. Local participation in project conceptualisation, planning and execution will definately increase capabilities in recipient nations.

C. Improved Negotiating Capacity in Defining the Terms and Conditions

19. External assistance has been considered a windfall by some recipients in developing countries. Thus the details of offers were not analysed carefully and no serious attempt to negotiate conditions was made. Aid that ties all procurements in the donor country irrespective of their cost competitiveness or external assistance that allocates a significant portion to foreign consultancy and advisors to the exclusion of national expertise may not be in the recipient's best interest. It may prove possible to obtain the advisory and consultancy services from a third world country having adequate experience in the type of work being undertaken. Such arrangements will increase local capacities and help build stronger capabilities in the third world country whose advisors and consultants have been hired to do

involving local consultants and R and D institutions in the design, implementation and development of technology assistance packages. There are already some pioneering examples of joint research and development activities involving individuals and institutions in the donor and recipient countries in co-operative elements of assistance programmes. This could well be a very effective means of developing local expertise and institutions and in linking them in an interactive manner with technological development and production.

F. Co-operation between Third World Countries

22. There is need for countries and institutions in the third world to join forces in order to strengthen their bargaining power and develop their autonomous scientific and technological capabilities and capacities in a spirit of collective self-reliance. Already in some countries co-operation between third world countries has produced very encouraging results. Textile mills, farm implement plants, sugar and bicycle factories designed and fabricated in third world countries have been built in other third world countries. These operations have involved intensive training at the management as well as at medium and low levels of technical skills. Results achieved in foundry and other metal working processes have been particularly impressive. Such co-operative activities need to be promoted.

Concluding Remarks

23. External assistance has played and will continue to play an important role in the technological development of Africa. The interest and determination recently manifested in basing further development on clear and integrated industrial technology policies and plans, the actions and programmes in developing African manpower, institutions and information systems in industrial technology on the basis of at least major policy guidelines and a minimum of integrated technology programmes should lead to a much clearer definition of the needs and priority areas and modes for external assistance.

24. In the absence of carefully documented analysis on external assistance operations in strengthening African technological capabilities, the above comments can only be of a tentative nature. With inputs based on the experience and views of the participants, the Symposium will be taking an important step in formulating a well-defined and positive African strategy in optimizing the benefits of external assistance for technological development and in integrating it effectively with national and regional endeavours in this field.

the job. Negotiating skills are in themselves not enough if the direction and purpose of technology activities are unclear and are stated in broad terms as has been the case in many countries. It has often been argued that building technological capabilities is a slow and sometimes painful process. Thus the willingness of the donor to participate in the acquisition of skills and "know-how", besides hardware, foreign expertise, or the mere expansion of capacity should be deeply investigated. It is to the mutual advantage of both donor and recipient that the assistance programmes include elements for close monitoring of the performance of acquired plant, equipment and products, for keeping them in good working order and adapting them, if necessary, to suit local conditions or supplies of raw materials. This enhances the image and credibility of the donor at an extra minimal cost, while maximising the benefits to the recipient over the largest possible period of time.

D. Detailed Information on the Donor's Motivations, Strengths and Limitations

20. Sound external assistance should be based on a clear appreciation of the motivations and objectives of the donor. This would define the scope and nature of assistance that could be expected from a donor and that would be in line with the goals and objectives of the recipient. More specifically, the recipient's ability to make a comparative assessment of technologies implies also greater access to information about technologies available from the donor, their strengths and limitations. This is the only sound basis for an effective negotiating capacity on the donor's side. It calls, both for greater flows of information on the political, social, economic, trade and technological standing of the donor country and an ability to analyse this information and to utilize it effectively in negotiating the most mutually advantageous assistance package.5/ Needless to say here, that knowledge of and information about the recipient country, which is unfortunately not always comprehensive or up-to-date, is a basic requirement for negotiating good assistance programmes.

E. Increased Emphasis on Software Components

21. The importance of transferring skills and "know-how" has already been emphasized on several occasions. Attempts should be made to extend the scope of external assistance programmes beyond adequate training of nationals to

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5/ See Action in the Field of Industrial and Technological Information in Africa prepared for this Symposium.

THE ROLE OF UNIDO IN INDUSTRIAL TECHNOLOGY

BACKGROUND

1. A detailed document describing UNIDO's past activities and directions for future work in the field of strengthening the technological capabilities of developing countries was presented to the Third General Conference of UNIDO, 21 January - 9 February 1980.[1/] This document provides information on the range and scope of UNIDO's involvement in the field of industrial technology.

2. The document proposed that, in addition to continuing the important programmes already initiated, directions of future UNIDO work should be devoted primarily to:

(a) Generating a widespread movement designed to create awareness and mobilize interest and effort;
(b) Providing assistance to developing countries in planning and implementing the elements of a framework for national action;
(c) Development of human resources;
(d) Development of technology, including both processes and equipment.

3. The deliberations of the Third General Conference showed uniform recognition of the need to expand activities aimed at strengthening the technological capabilities of the developing countries. The recommendations of that Conference and of the Industrial Development Board, which considered the follow-up to that Conference at its Fourteenth Session, have provided a basis for action by UNIDO which reflects a more comprehensive approach to technology.

4. UNIDO has been active in several developing countries in the African region, both in regard to technical assistance and promotional activities: for example, in the United Republic of Cameroon, Ghana, Nigeria and the United Republic of Tanzania in the field of technology policy and planning; in Algeria and Egypt concerning technology acquisition; and in a number of countries in regard to institution building and training.[2/] Programmes for the promotion of metal production development units are under way in several least developed countries of Africa and a programme for co-operation in the

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1/ Strengthening of Technological Capabilities of Developing Countries: The Role of UNIDO (ID/CONF.4/7).

2/ UNIDO's technical assistance to Africa amounted to $ 17.3 million in 1979 and is anticipated to be $ 19.4 million in 1980.

field of small-scale industry has been initiated in Egypt and Kenya. In addition, UNIDO has assisted emerging regional organizations such as the African Association of Industrial Technology Organizations (AAITO), and the African Regional Centre for Technology (ARCT).

5. In keeping with this trend of assistance to the African region and in the light of the importance attached by the UNIDO secretariat to the African Development Decade, many of the activities which will be undertaken by the secretariat in future are envisaged to be specifically relevant to African countries and conditions.

6. Directions of future action

(a) Further activities under the Co-operative Programme of Action on Appropriate Industrial Technology, including the mobilization of interest and effort and the organization of further meetings like the International Forum on Appropriate Industrial Technology, New Delhi;

(b) Further activities under INTIB[3/], to the extent resources permit;

(c) Programmes for strengthening the technological capabilities of the developing countries, in particular capabilities related to the negotiation and acquisition of technology;

(d) Programmes of assistance to, and co-operation with, regional centres for technology transfer, in order that those centres might provide, at the regional level, natural links for INTIB and other UNIDO activities in the field of industrial technology;

(e) Programmes of technical assistance, to be rendered at the request of the countries concerned, to support national action for industrial technology, special attention being given to the least developed countries;

(f) Programmes for the identification and greater use of the technologies, as well as the technological expertise and capabilities, of developing countries;

(g) Further promotion of technological co-operation among developing countries, keeping particularly in view the recommendations of the Round Table Ministerial Meeting of the Ministers of Industry, held at New Delhi in January 1977, and the Istanbul Declaration;

(h) Promotion of, and assistance to "centres of excellence" or specialized centres for technological co-operation;

(i) Promotion of networking and co-operation among industrial and technological institutions at national, regional and interregional levels;

3/ See ID/B/241

(j) Preparation of technology perspectives in important industrial sectors and monitoring of technological breakthroughs for the benefit of the developing countries;

(k) Preparation of portfolios of R and D projects and the promotion of the implementation of those projects;

(l) Support on technological aspects to follow-up activities of the meetings organized by the System of Consultations;

(m) Preparatory work for a global consultation on industrial technology.4/

(n) Promotion of technology transfer in the redeployment process, and the further development of technology so transferred;

(o) Promotion of research and dissemination of information on energy-related technologies;

(p) Participation in the formulation and implementation of projects financed from the United Nations Interim Fund for Science and Technology for Development;

(q) Strengthening UNIDO as an executing agency in the field of industrial technology and its co-ordinating role within the United Nations system in this field.

7. In a few cases, the programmes basically call for further development of ongoing activities, while others call for new initiatives.5/ Implementation of these programmes involves the mobilization of interest and effort in a substained manner, at the international, regional and national levels. UNIDO intends to pursue systematically further avenues for effective co-co-operation not only with national governments, but also with regional organizations and other United Nations agencies, as well as public and private enterprises, governmental and non-governmental organizations.

4/ See New Delhi Plan of Action, ID/CONF.4/CRP 16/Add.1, Section III, C.(f).

5/ As regards actions taken since the Third General Conference of UNIDO, see Follow-up of the Decisions and Recommendations of the Third General Conference of UNIDO (ID/B/C.3/100/Add.1).

8. The issue and tasks involved in strengthening the technological capabilities of developing countries have by now been well recognized. A stage has been reached where integrated programmes of action of sufficient scope to make a decisive impact on the technological development of the African countries must be drawn up and carried out. This calls for a programme-oriented approach. The Symposium may wish to provide guidance on the future course of UNIDO programmes as outlined in this document and in ID/CONF.4/7 with particular reference to African needs.

9. Resources both from existing national and international sources, and from the Interim Fund for Science and Technology will be needed. Just as developing countries will have to devote a larger percentage of their GNP to the development of their technological capabilities, so also a larger percentage of the resources of the United Nations system and the international community, including those arising from other bilateral and multilateral arrangements, will have to be devoted to the task of strengthening national technological capabilities of developing countries.

10. UNIDO has co-operated in the past with many African countries in several programmes in industrial technology. It has maintained close relations with the Economic Commission for Africa (ECA), including the ECA/UNIDO Industry Division. It has kept close relations with the African Regional Technology Centre (ARTC), provided expert assistance to it and will continue to support its work. UNIDO works also in close co-operation with the Organization of African Unity (OAU) within the framework of the Memorandum of Understanding signed in Monrovia during the Sixteenth Assembly of OAU Heads of State and Governments. The action programmes recommended by the Joint OAU/UNIDO Symposium on Industrial Technology for Africa will further enhance UNIDO's role in supporting the efforts of Africa in developing capabilities in the field of industrial technology.

Annex I

LIST OF PARTICIPANTS

ANGOLA

Mr. Jose Pedro Morais, Junior
Chief, International Relations
Ministry of Industry
P. O. Box 594
Luanda, Angola

BENIN

Mr. Ernest Godonou
Directeur d'Etudes et de la Planification
Ministere d'Industrie, des Mines et de l'Energie
Cotonou, Benin

BOTSWANA

Mr. Joseph Rokabane Monametsi
Director
Botswana Enterprises Development Unit
Private Bag 0014
Gaborone, Botswana

Mr. Vincent Kakanyo Selato
Commercial Officer
Ministry of Commerce
Private Bag 004
Gaborone, Botswana

CENTRAL AFRICAN REPUBLIC

Mr. Mathias Allendi
Ingenieur Chimiste Technologue
Chef de Service des Etudes et de la Planification Industrielle

CAMEROON

Mr. Gaston Payom
Sous-Directeur de la Programmation
Delegation Generale a la Recherche Scientifique et Technique et
Secretaire du Comite National de Transfert des Technologies
DGRST, BP 1457
Yaounde, Republique Unie du Cameroun

CONGO

Mr. Georges Bolondo
Economiste Industriel
Chef de Service de la Planification Industrielle
Direction Generale de l'Industrie
B.P. 211
Brazzaville
Congo

DJIBOUTI

Mr. Ali Ahmed Ali
Economiste Industriel,
Conseiller du Ministre de l'Industrie
Djibouti

Mr. Abdi Miganeh
Technician au Ministere de l'Industrie
Djibouti

EGYPT

Mr. Awaad Ahmed
Manager, Egyptian Inst. Industries
P. O. Box 1960
Cairo, Egypt

Mr. Yousef Morsi Hussein
Head, Science Policy Research Unit
Academy of Scientific Research and Technology
101 KASR Al-Eini Street, Cairo

EQUATORIAL GUINEA

Mr. Severino Obiang Bengono
Director
Ministry of Industry, Mines and Energy
Malabo, Republic of Equatorial Guinea

ETHIOPIA

Mr. Hailu Sebsibe
Team Leader
Development Projects Study Agency
P. O. Box 3433
Addis Ababa, Ethiopia

GHANA

Mr. Francis Acquah
Deputy Minister of Industries, Science and Technology
Ministry of Industries, Science and Technology
P. O. Box M39
Accra, Ghana

Mr. Joseph Konadu-Boaten
Director of Trade Fairs
Ministry of Trade and Tourism
Accra, Ghana

Mr. Boatey Eric
Manufacturer
Ministry of Trade and Tourism
Accra, Ghana

GUINEA

Mr. Salim Sissoko
Ambassador of Guinea to Cairo and Khartoum

GUINEA-BISSAU

Mr. Aristides Minezes
Conseiller Economique du Ministere de Commerce et
de l'Industrie
Guinea-Bissau

IVORY COAST

Mr. Bogui Timothee Aka
Charge de la Propriete Industrielle et de la Technologie
Ministere de l'Economie, des Finances et du Plan (DGAI)
B.P. V65
Abidjan, Cote D'Ivoire

KENYA

Mr. Robert Okelo Arunga
Director
Kenya Industrial Research and Development Institute

Mr. Indetie E. Jared
Industrial Development Officer
B.P. 30413
Nairobi, Kenya

Mr. Peter Cakera Kimani
Projects Officer
B.P. 30418
Nairobi, Kenya

Mr. Dismas Lurus Ochieng
Principal, K.I.T.I.
P.O. Box 280, Nakuru, Kenya

LESOTHO

Mr. Thabo Ephraim Ntlhakana
Ambassador
Lesotho Embassy, Nairobi

Ms. Ntsepeng Mothepane Hlaoli
Investment Promotion Officer
Ministry of Commerce and Industry
P. O. Box 747
Maseru, Lesotho

MADAGASCAR

Mrs. Ramenoelina Bodolalao
Conseiller Technique
Ministere de l'Economie et du Commerce
Antananarivo, Madagascar

MALI

Mr. Seydou Doumbia
Directeur du Centre d'Etudes et de Promotion Industrielles
B.P. 1980
Bamako, Mali

Mr. Bounafou Toure
Chef, Division Etudes et Echanges Commerciaux au Centre
Malien du Commerce Exterieur
B.P. 1996
Bamako, Mali

MAURITIUS

Mr. Sathiamoorthy Sunassee
Secretary for Foreign Trade
Ministry of Commerce and Industry
Port Louis, Mauritius

MOROCCO

Mr. Mohamed Bejiloli
Chief, Department Electromecanique
Bureau de Developpement Industriele

NIGER

Mr. Dan Tonka Maazou
Directeur de Stand
Direction du Commerce Exterieur
Ministere des Affaires Economiques
Niamey, Niger

NIGERIA

Mr. T.E. Atiwurcha
Honourable Commissioner for Trade and Industry
Ministry of Trade and Industry
Yola, Gongola State, Nigeria

Mr. Bassey J. Etuk
Chief Commercial Officer, State Government (CRS)
Government of Nigeria, Lagos, Nigeria

Mr. Niyo Henry
Senior Commercial Officer
Ministry of Trade and Industry
Yola, Nigeria

Mr. Tunde Abolaji
Chief Trade Promotion Officer
Nigerian Export Promotion Council
103, Lewis Street, Lagos, Nigeria

RWANDA

Mr. Fabien Rutazihana
Chef de la Division Industrie
Ministere du Plan
B.P. 46, Kigali, Rwanda

Mr. Louis Kwihangana
Directeur au Ministere de l'Economie et du Commerce
Kigali, Rwnada

SENEGAL

Mr. Sidy Lamine Ba
Directeur de l'Industrie
Ministere du Developpement Industriel et de l'Artisanat
B.P. 3179
Dakar, Senegal

Mr. Papa Sekou Sonko
Adjoint au Directeur du Commerce Exterieur
Direction du Commerce Exterieur
1, Rue Mosckry
Dakar, Senegal

SIERRA LEONE

Mr. Raymond Abisodu Benjamin Johnson
Senior Industrial Planning Officer
Ministry of Development and Economic Planning
Freetown, Sierra Leone

SOMALIA

Mr. Ali Hersi Osman
Industrial Officer
Ministry of Industry
P. O. Box 928
Mogadishu, Somalia

SUDAN

Mr. Abdel Rahman Ahmed El Agib
Director
National Council for Scientific and Technological Research
P. O. Box 2404
Khartoum, Sudan

Mr. Elgasim Ali Elgasim
Research Scientist
Food Research Centre
P. O. Box 213
Khartoum, Sudan

Mr. Ibrahim Elrufai Abu El Hassan
Assistant Director
National Council for Research

Mr. Bakhiet Zakaria Abdel Nabi
Head, Standardization and Quality Control Department
Industrial Research and Consultancy Institute
P. O. Box 268
Khartoum, Sudan

Mr. Mohamed Osman Abdella
Manager, Engineering Department
Sudan Industrial Research and Consultancy Institute
P. O. Box 268
Khartoum, Sudan

SWAZILAND

Mr. Vincent Mfanyana Khathwane
Managing Director (SEDCO)
P. Box A186
Mbabane, Swaziland

TANZANIA

Mr. Gilman Rutihinda
Commissioner for Foreign Trade
Ministry of Trade
Dar-es-Salaam, Tanzania

Mr. Ahmed S. Hamad
Senior Scientific Officer
Tanzania National Scientific Research Council
P. Box 4302
Dar-es-Salaam

TOGO

Mr. Ayite Konko D'Almeida
Administrateur Civil
Direction Plan
B.P. 1667
Lome, Togo

TUNISIA

Mr. Habib Laroussi
Directeur, Ministere Economie Nationale
Tunisia

UGANDA

Ms. Hadijah Nasozi Gava
Senior Economist
Ministry of Planning and Economic Development
P. Box 7086
Kampala, Uganda

UPPER VOLTA

Mr. Abdoul Diallo
Conseiller des Affaires Economiques-
Direction du Developpement Industriel et
de l'Artisanat
Ouagadougou

Mr. Placide Some
Conseiller des Affairs Economiques
Office National du Commerce Exterieur/Ministere du Commerce
du Developpement Industriel et Mines
Ouagadougou

ZAIRE

Mr. Monkoy Molende Tansia
Chef de Service des Analyse Sectorial (Industrie)
Commissariat du Plan/Presidence de la Republique
Kinshasa, Zaire

ZIMBABWE

Mr. Webber Chinyadza
Senior Planner
Ministry of Economic Planning and Development
Salisbury, Zimbabwe

OBSERVERS

ARCT

Mr. A.A.R. Elagib
Executive Director
African Regional Centre for Technology
Dakar, Senegal

BDEAC

Mr. Mamadou Baba Diop
Economiste (BDEAC) (Banque de developpement des Etats de l'Afrique Centrale)
B. P. 1177
Brazzaville, Congo

SUDAN

Mr. Farouk Eltayeb Elhadi
Director, Industrial Research and Consultancy Institute
P. O. Box 268
Khartoum, Sudan

Mr. Mohamed Ahmed Mohamed Elhali
Assistant Director
General Petroleum Corporation
P. O. Box 2986
Khartoum, Sudan

Mr. Elsadig Elzubeir
Physicist
Ministry of Energy and Mining
Khartoum, Sudan

Mr. Ahmed Babiker Hussein
Lecturer
Mechanical Eng. Dept.
Faculty of Engineering and Architecture
University of Khartoum
Khartoum, Sudan

Mr. Mustafa M. El Mepkawi
Managing Director, the Star-Knitwear Co., Ltd.
P. O. Box 2428
Khartoum, Sudan

Mr. Ahmed Elzein Elhassan
Head of Petroleum Studies,
National Energy Administration
Ministry of Energy and Mining
Khartoum, Sudan

Mr. Isam Elamir
Petroleum General Corporation
Ministry of Energy and Mining
Khartoum, Sudan

Mr. Ahmed M. El-Din Ahmed
Civil Engineer
Ministry of Energy and Mining
Khartoum, Sudan

Mr. Barri Osman Hamed
Mechanical Engineer
Ministry of Energy and Mining
Khartoum, Sudan

Mr. Mukhtar Mohamed Elamin
General Manager
National Energy Administration
Ministry of Energy and Mining

Mr. Mohamed Nasr Eldin
Chemist
Ministry of Energy and Mining

Mr. Maha Mohamed Ahmed
Chemist
Ministry of Energy and Mining

Mr. Awad Yassin Ali
Research Scientist
Food Research Centre
P. O. Box 213, Khartoum (North)

Mr. Abdel Halim Rahana Ahmed
Scientist
Food Research Centre
P. O. Box 213, Khartoum (North)

Mr. Abdel Fattah Taha
Research Scientist
Agricultural Research Corporation of Sudan
P. O. Box 30,Khartoum (North)

Mr. Osman Hassan Farah
Director
Sudan Mint.

Mr. Mohaed Salih Abdallah
Director, Spinning and Weaving Corporation
P. O. Box 765, Khartoum

Mr. Ali Magzoub Haseeb
Research Assistant
CSTR, National Council for Research

Mr. Abbas Y. Ahmed
Technical Manager
Spinning and Weaving Corporation
P. O. Box 765, Khartoum

Mr. Abdalla Babiker
Sudan Gezira Board

UNCTAD

Mr. Osman Hassan
UNCTAD
Geneva

UNDP

Mr. Christian T. Atchou
Head, UNDP Liaison Office with ECA and OAU
Addis Ababa, Ethiopia

Mr. Yves G. Biry
Chief Technical Adviser
State Industries Project
c/o UNDP, Khartoum

Mr. A.M. El Amin
UNDP/Khartoum

WIPO

Mr. Ibrahim Thiam
Director
External Relations Division
WIPO, 1211 Geneva

OAU SECRETARIAT

Mr. Paul Etiang
Assistant Secretary-General in charge of
Economic Development and Co-operation
P. O. Box 3243
Addis Ababa, Ethiopia

Mr. Getachew Paulos
Economist
c/o OAU, P.O. Box 3243
Addis Ababa, Ethiopia

OAU TECHNICAL STAFF

Mr. Malick Sy
French Translator/Interpreter
OAU Regional Office in Geneva

Mr. Kwame Amoah-Kusi
English Translator/Interpreter
c/o OAU, P. O. Box 3243, Addis Ababa

Mr. Mohamed Moustafa
English Translator
c/o OAU, P.O. Box 3243, Addis Ababa

Mr. Alovor Young
French Translator
c/o OAU, P. O. Box 3243, Addis Ababa

Mr. Cheikh Malikite
French Translator (Freelance)

Mrs. Meseret Gizaw
English Secretary
c/o OAU, P. O. Box 3243, Addis Ababa

Mrs. Seble Gebru
English Secretary
c/o OAU, P.O. Box 3243, Addis Ababa

Miss Roman Bezu
Bilingual Secretary
c/o OAU, P.O. Box 3243, Addis Ababa

Miss Harriet Kyasimire
Bilingual Secretary
c/o OAU, P.O. Box 3243, Addis Ababa

Mr. Berhane Libanos
Machine Operator
c/o OAU, P.O. Box 3243, Addis Ababa

UNIDO SECRETARIAT

Mr. G.S. Gouri
Senior Technical Adviser i/c
Technology Programme

Mr. K. Venkataraman
Special Technical Adviser

Mr. E. Aguilar
Chief
Section for Economic Co-operation Among Developing Countries

Mr. S. Ndam
Technical Assistant to the Deputy Executive Director

Mr. R. Lafond
Industrial Information Officer

Mr. G. Tabah
Associate Industrial Development Officer

Dr. O. El Kholy
UNIDO Consultant

Mr. S. Ahmed Hamad
UNIDO Consultant

Miss Eileen Reilly
Technology Programme