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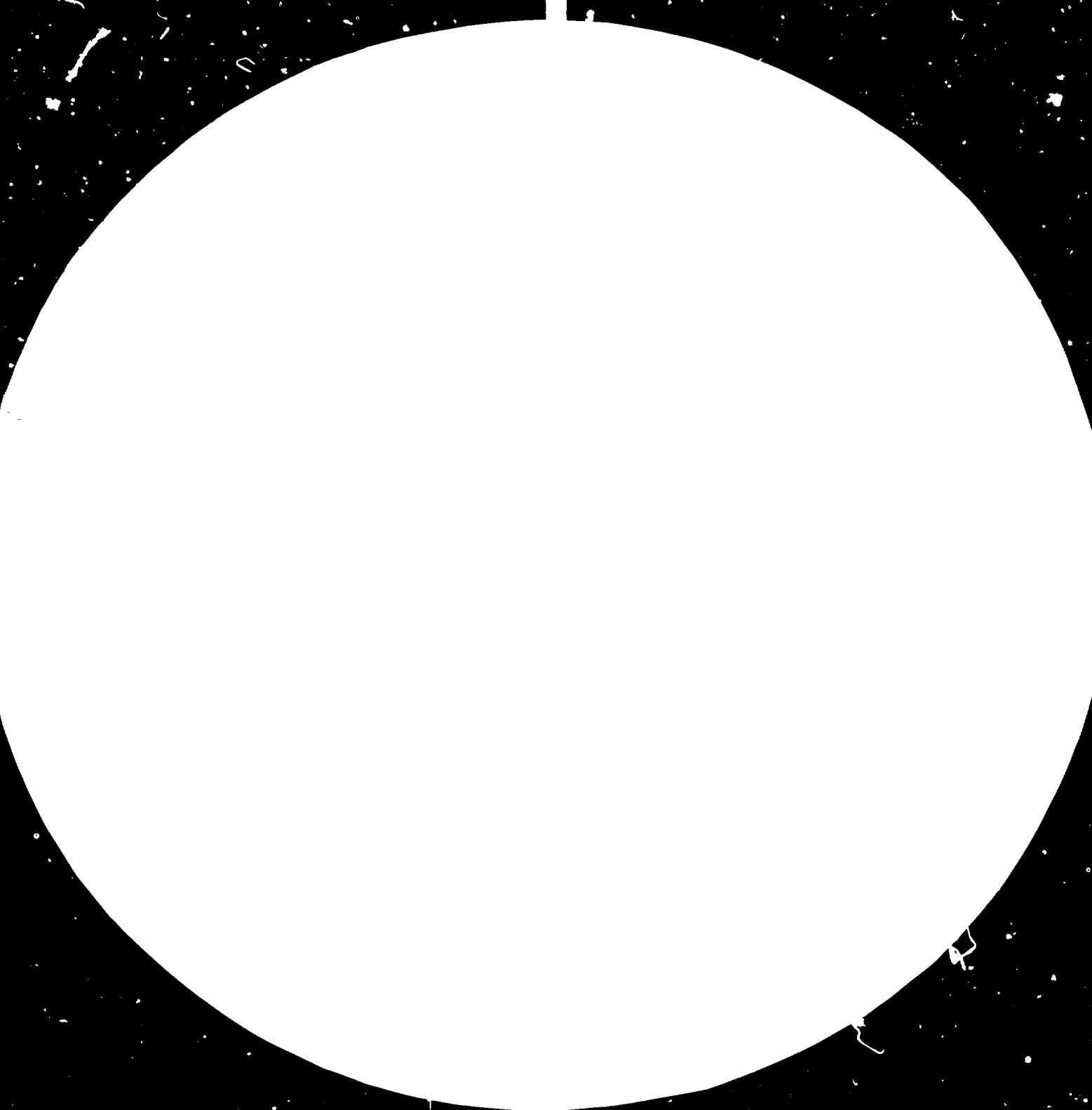

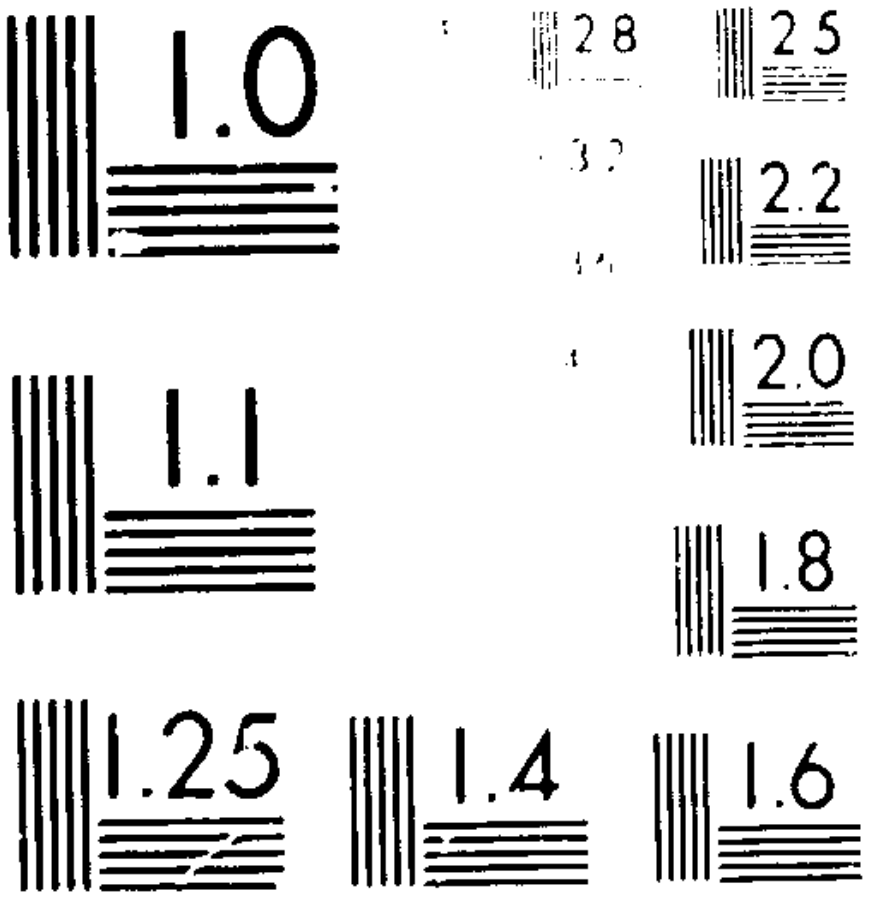
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ACTION IN THE FIELD OF TECHNOLOGY POLICY AND PLANNING IN AFRICA *

prepared by

the UNIDO secretariat

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CONTENTS

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 enviromential 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 '<u>flow stream</u>', with its emphasis on the selection and acquisition of foreign technology and its subsequent adaptation, absorption and diffusion; and the '<u>stock stream</u>', 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.[3/] 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 technological 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 positior of regional industrial units in respect of technology acquisition and the development of regional technological capability.

(b) Assessment of 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 utilization 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 services, 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

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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 exhange. 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.

63. 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.

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.