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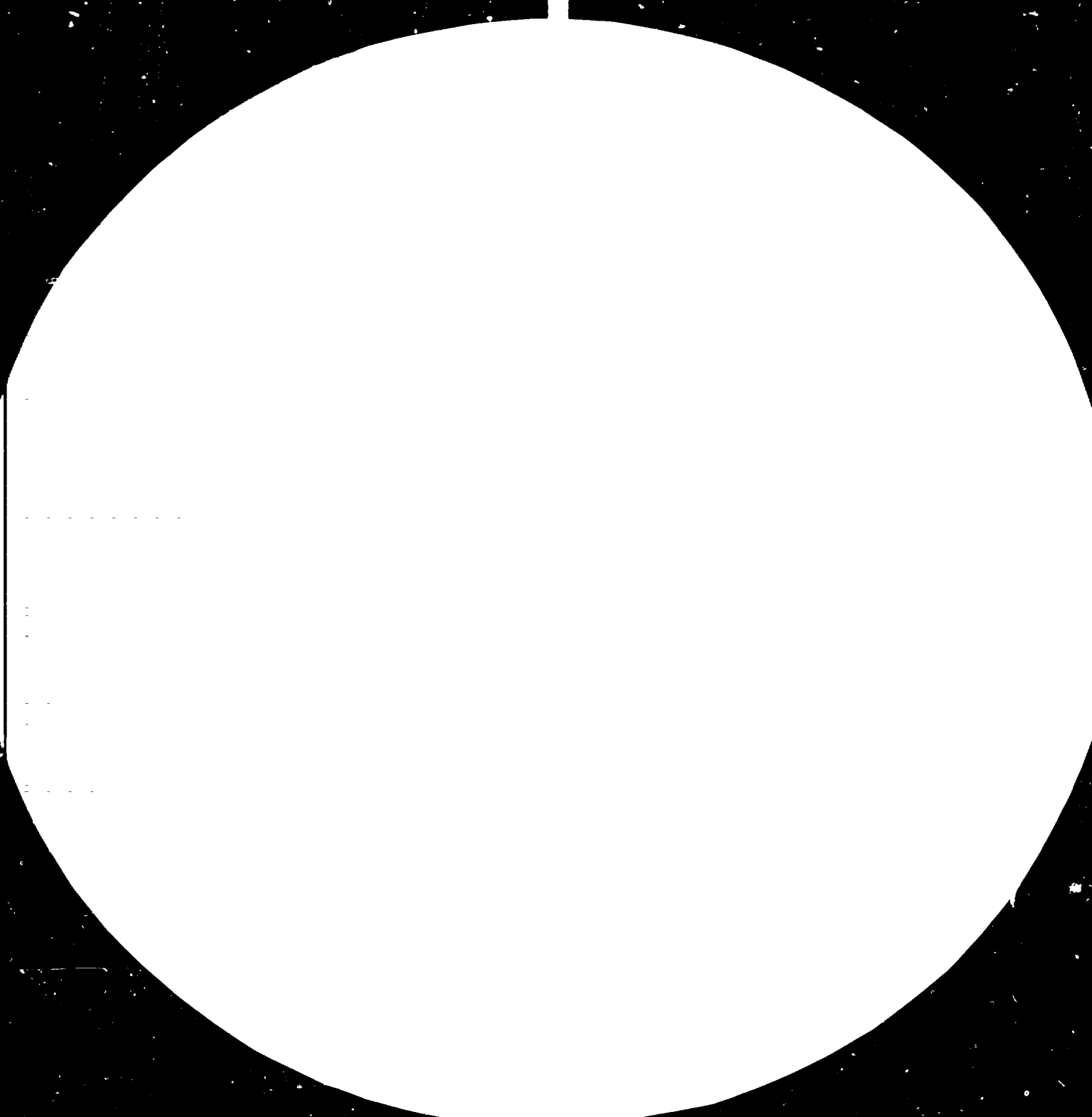
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GUIDELINES TO THE ESTABLISHMENT
OF A NATIONAL CENTRE FOR TECHNOLOGY IN SUDAN*

Prepared by
the UNIDO Secretariat

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BASIC CONSIDERATIONS RELATING TO
INDUSTRIAL TECHNOLOGY

Introduction

1. The application of industrial technology, as indeed of all technologies, is a means to an end, the end being the development goals of each country and, the acceleration of industrial development.

2. Industrial development, which has been described as a centre-piece of the development process, cannot be viewed only as the means of producing a large variety of goods and services by modern processes and techniques; it must result in adequate employment opportunities, greater income generation and distribution to poorer sections, and improvement in the conditions of life for the larger community in developing countries. The Lima target of the developing countries achieving a share of 25 per cent of the world industrial production by the year 2000 is thus not a mere quantitative target for it has qualitative implications as well.

3. To achieve over-all development goals including the fulfilment of basic needs and the redistribution of income, the pattern of industrial growth in developing countries may have 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 industrial technology can enable accelerated industrial growth of a nature consistent with over-all development goals and the achievement of the Lima target.

4. 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 integration of 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 only through such integration, both conceptually and in practical action, that the application of industrial technology can have the most fruitful results.

5. The application of technology has not only to be derived from the development goals, but has to match with other resources so as to effectively contribute to development. Technology is in fact not applied in isolation but as part of the performance of an economic activity that contributes to development. In such activity, say industrial development, technology is again applied not alone but matching with investment, skills resources and other related factors. In other words, the application of industrial technology cannot be divorced from the total process of industrial development.

6. There is also 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.

7. It is only within the framework of such basic considerations that industrial technology can be applied realistically and effectively. To promote such application of technology, three major elements have been identified for purposes 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 Government; 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 technology, and this involves, among other things, the building up of institutions and the training of manpower. The third element is the appropriate choice of technology, since inappropriate choice will be not only expensive but will distort the pattern of development.

Policies

8. A broad consensus will itself bring out the broad policy goals to be adopted. But they have to be incorporated in specific policy instruments which may be regulatory or promotional or of a short- or long-term nature. While some of these instruments have to be actually embodied in industrial, trade, fiscal and financial policies, there is a need for formulating a policy for technological development, drawing upon the consensus. If possible, a "Technology Policy Declaration" or Resolution could be adopted by the government.

9. In further discussing the policy instruments, it is convenient to revert to the classification of technological capabilities for selection, acquisition, adaptation, absorption and development of technology. Such capabilities can be fostered only if conditions are created in which these processes are facilitated. The policy measures to be taken should answer to this requirement also. Such measures could be general or selective for particular industries or services, as required. The cluster of policy instruments outlined in this paper have to be interpreted and applied according to the varying needs of the countries.

10. Policies to promote the selection of appropriate technology could include, for example:

- (a) Differential direct and indirect taxation (e.g. tax exemption or lower taxation for products/enterprises in the small-scale sector or utilizing newly developed or indigenous technologies: taxes on imported equipment or technologies);
- (b) Differential financial and credit policies (e.g., lower rates of interest and liberal credit for products/enterprises in the small-scale sector or utilizing newly developed or indigenous technologies);
- (c) Industrial policies concerning size of units and criteria for expansion (e.g. certain products could be reserved for manufacture in the small-scale sector; policies discouraging more assembly industries based on imported components);

- (d) Trade policies on import of capital goods or raw materials (e.g. 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 (e.g. discouraging turnkey contracts; not allowing foreign investment or import of technology in specified areas; associating local consultants or research and development institutions in selection).

All these will involve on the one hand an "infant industry" protection to indigenous technologies and technological capabilities and on the other, a compulsion to use them in preference to imported ones.

11. Developing countries may like to adopt, as about a dozen of them already have done, a policy for acquisition of foreign technology. This policy should not only cover technology per se, but equipment (which embodies technology) and foreign investment (which is a vehicle of technology and invariably predetermines it). Such a policy will obviate distortions in the pattern of industrial growth, besides avoiding an undue outflow of foreign exchange. It should have both regulatory and promotional aspects. It should protect indigenous technologies and technological capabilities where they are available and satisfy national requirements. It should encourage inflows where there are gaps in production, technologies or technological capabilities. Technologies which need to be protected and those which need to be encouraged to grow could be specified as a matter of policy. A mechanism for screening technology contracts will also be necessary. Such screening could ensure that the technological services required are clearly specified; technology packages are unpackaged wherever possible to admit contributions from indigenous technological capabilities; adequate provision should be made for the training of local technicians; there should be 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 promotion or regulation of foreign technology, the establishment of a screening mechanism will enable the continuous and systematic monitoring of foreign technology inflows which does not exist in many developing countries at present.

12. Policies could also promote adaptation. For example, adaptation to the satisfaction of a technical authority could be imposed as a condition in contracts for acquisition of foreign technology. Costs of adaptation could receive preferential treatment in taxation. Adaptation to local raw materials and components could be secured through a policy of phased programme of reduction of imported raw materials and components.

13. Absorption of technology in a narrow sense could be facilitated by policies which insist that foreign technology/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. The passing of a National Apprenticeship Act whereby each industrial unit is required to take a certain number of apprentices for training would also enlarge the pool of trained personnel. Free horizontal occupational mobility has also to be ensured. There are no known direct policy instruments for this purpose. However, general policies which do not unduly restrict the setting up of new units in the same industry may help incidentally. Policies for attracting the country's technical personnel resident abroad either for permanent settlement or for short-term guidance should also be formulated and implemented, as is already being attempted by a few developing countries.

14. Long-term policies for the absorption of technology should concentrate on human resource development so that the general level of technological capability may well be required in traditional societies. Policies that promote a greater involvement of scientists and technicians in the development problems of the country will be needed including the restructuring of their salaries and responsibilities wherever necessary.

Institutions

15. While policies and programmes require institutions or agencies to implement them, the role of institutions should not be overestimated as if they were a remedy for all ills by themselves. The value of institutions lies in that they provide a measure of continuity and collective interaction of experience and in due course become repositories of technological capabilities. At the same time they can be only as good as the policies and programmes they help to implement. Institution-building can be quite expensive and can also raise a host of co-ordination problems. On the one hand, the problems of developing technological capabilities are too numerous for a single institution to tackle, save by way of monitoring.

16. Developing countries have in fact a wide variety of institutional examples to choose from. They include ministries of science and technology, technology transfer centres, sectoral industry development centres, research institutions of various types, information centres, technology regulation agencies, etc. each performing one or more technological functions. A balanced approach to institution building will have to start from the functions, capabilities and services required and see how they can be provided effectively to entrepreneurs on the one hand and government officials and policy makers on the other.

Apart from institutions for technical education and training, at least three basic types of institutional functions may be required. One type relates to technology policy formulation and monitoring at the macro-level as well as technology screening and evaluation at the micro-level. These functions have to reside in a government department or agency, suitably located in the governmental set up to influence decision making. Another type of institutional function relates to technological information, evaluation and consultancy assistance to entrepreneurs. These may have to be performed by an agency, governmental or quasi-governmental, which is enabled to have effective relations with government, financial institutions and industry. The third type of function relates to technology development, adaptation and commercialization with facilities for consultancy and extension work. Such functions have to be exercised by research institutions or technology development centres, which may be single or multi-sectoral, depending on requirements.

17. Several of these functions have also to be injected into ostensibly non-technological institutions such as ministries of industry, planning, trade and finance, financial and banking institutions, etc. Sectoral industry centres have to function as technology adaptation and development centres as well. Technological diffusion, particularly in the rural areas, may require institutional innovations such as those adopted in India, viz. small industries centres, district industries centres and polytechnology clinics (i.e. extension and consultancy outposts of research institutes).

18. The practical steps which a developing country should take in institution building will then be as follows:

- (a) to examine whether adequate institutional arrangements exist for the technological functions described in the immediately preceding paragraphs;
- (b) to create new institutions and strengthen existing ones as necessary;
- (c) to ensure adequate linkages and co-ordination between the institutions, government and industry;
- (d) to provide the institutions with adequate manpower, material and financial resources;

19. Sudan does not lack in institutions. A Directory prepared by the National Council for Research a few years back lists no less than 30 institutions engaged in one form or the other of scientific and technological research. The number, most definitely, must have gone up. A survey and assessment of the technological institutions available, the functions performed by them and the potentialities of their development is essential. Technological institutions should not be construed in the narrow sense of industrial research institutions alone. The survey should cover 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, research institutes, etc. The reason for this is that their activities will impinge in some way or other on technological development. The institutions may be promotional, regulatory or service institutions. In this sense it may be better to think in terms of functions or services rather than institutions per se, since ultimately what is required is not the institutions themselves but the functions or services to be performed. The functions and services and the institutions should then be correlated. Voluntary agencies concerned with appropriate technology should also be covered. In assessing the institutions one should not only go by their numbers, the number of technical personnel employed and the expenditure incurred, but by their output. 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 governmental set up, 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. In regard to research institutes, their role in essential technological functions such as extension, pilot plant and commercialization of technologies should also be assessed.

Proposal for a Framework for a
National Centre for Technology in Sudan

Background

20. The need for a National Centre for Technology in the Democratic Republic of the Sudan was highlighted as far back as 1976 when a UNDP/UNESCO mission visited the country. As a consequence of the discussions that took place, it was concluded that there is opportunity and need for the establishment of a new establishment in Sudan which would have, as its primary purpose, the application of science and technology to the development of Sudanese industry and the Sudanese economy as a whole. The new establishment (later named as The National Centre for Technology) would also be responsible for the collection, evaluation and dissemination of software technology in its broadest terms. Basic research would be outside the scope of the Centre and would be directed to the universities and the research institutes. However, practical tests, applied research, adaptation and development work would be undertaken, as need be, for the demonstration, testing and application of a particular technology, machine, tools, equipment, etc. according to its competence.

21. The need for a National Centre for Technology received further stress during an Inter-Agency Mission on the Establishment of an African Regional Centre for Technology which visited a number of African countries, including the Sudan. The mission, which was made up of representatives from the various United Nations Agencies, including UNIDO, stressed that a provision for the African Regional Centre for Technology would necessarily be the creation of national centres which should assist any user of technology in selecting, acquiring and applying the most suitable and favourable technology in both technical and economic aspects.

22. It was felt, in particular, that the National Centre for Technology would not be a part of the formal vocational and technical education system of the country, and would not be a part of the research system of the country, either. Its task would be to apply and transplant technology developed or otherwise already known from research or from a research institute whenever the technology had been developed, or from other sources locally or abroad, to industry, with appropriate adaptation and/or modification.

23. Because of this central transmitting role and the inter-ministerial nature of technology application, the joint UNDP/UNESCO mission recommended the establishment of the National Centre for Technology as a Directorate under the Council for Scientific and Technological Research (CSTR), which is one of the four councils of the National Council for Research (NCR).

24. On the basis of strong endorsement by the Government of the Democratic Republic of Sudan, a request was submitted to the UNDP for UNIDO's assistance in the establishment of the National Centre for Technology. UNIDO's assistance will involve in part, the elaboration of a detailed and fully-costed Project Document for submission to the UNDP, the Interim Fund for Science and Technology for Development (IFSTD) or other bilateral funding organizations for financing of the proposed Centre.

25. It is hoped that this seminar and the results of the deliberations will provide valuable guidance to UNIDO during the elaboration of plans and proposals for the Centre. Such information would be particularly necessary in identifying the precise objectives and functions of the Centre. On the basis of clearly defined objectives and functions, UNIDO and the Government would then be in a position to formulate a functional organization chart that would reflect the desired staff inter-relationships as well as a scope and method of operation that would provide for the complex functions of the Centre.

26. The following paragraphs and the suggestions contained therein are meant to initiate discussions in the seminar rather than to provide any definitive suggestions of the actual functions and structure of the proposed Centre. The emphasis is more on functions rather than the structure. These have to be examined in the light of technological needs of the country.

Framework for the National Centre for Technology

27. The need has already been stressed, in the previous sections, for a critical examination of the existing institutional arrangements in Sudan. A preliminary assessment of their performance in meeting the technological needs of both Government and industry in specified priority industrial sectors should help in identifying the priority areas for the proposed Centre and strengthening of the existing institutions on the basis of identified institutional gaps and deficiencies. The institutional gaps and deficiencies could be identified more clearly by using a checklist based on the following commonly desired technological services:

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 and special requirements of Sudan
in promoting the utilization of natural resources
15. Pilot plant
16. Scaling up
17. Upgrading traditional technology
18. Commercialization
19. Extension

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

28. A cursory survey of the existing institutional arrangements in the country confirms that the Government has taken laudable steps in establishing several research-oriented organizations and institutions for the purpose of developing her natural resources and raw materials. Although most of these institutions are engaged only in basic research, there is none-the-less a sound basis for future developments. A major deficiency identified is that most of the research results are never applied; there is no systematic mechanism for commercializing the successful research results or making them available to the potential end users - particularly in the rural areas as well as to industrial users, especially small and medium-scale industrial enterprises. Some of the research activities also tend to be highly theoretical, unrealistic and with little or no practical applicability.

29. There is a definite need to bridge the gap between the R and D organizations in the country, the medium and small industrial enterprises and entrepreneurs as well as the rural population so that they can benefit from the research efforts and research results available from the R and D institutions. There is need for a technical service agency capable of assuming the role of a go-between for small and medium industries and R and D organizations. It is anticipated that the proposed Centre would assume this role and fill-in this institutional gap. The Centre would among other things, carry out the following:

- (i) act as a catalyst in the development and transfer of indigenous technology to the primary and secondary sectors of Sudan industry; in this regard the Centre would promote, co-ordinate and undertake applied scientific and industrial research which would benefit industrialization in Sudan; act as the governments' technical link to industry;
- (ii) provide "Production Support Services" such as

laboratory testing and analysis, quality control, metrology, training, and market research and analysis. In providing these services the Centre will perform a function different from that performed by existing research organizations and commercial companies, since it will emphasize the diffusion of manufacturing know-how aimed at building domestic managerial and technological capabilities. Thus, the Centre will provide them for only a short period of time followed by troubleshooting and backup support, particularly in the early stages of production. Easy access to these services in Sudan is expected to encourage small and medium-sized companies and entrepreneurs to enter into industrial activities.

- (iii) collect, integrate and disseminate the results of R and D activities which are carried out in the various research-related organizations/establishments within the country; act as a link between technology supplier and buyer and facilitate the commercialization of R and D results within the country; learn and practice R and D management and industrial management through production activities, and participate in evaluating and selecting foreign technologies to be transferred into Sudan from abroad;
- (iv) support the government in technology import business by advising about technology import policy from the industrial and technical points of view; make technological inputs to the elaboration of government technology policy;
- (v) provide technological assistance and services generally required by industry (especially small and medium-scale enterprises) in the following main categories:

- Testing, analyzing and evaluating raw materials and intermediate products;
- Testing and analyzing finished products for standardization, quality control and certification;
- Specific information on the current state of world knowledge in industrial, technological and techno-commercial areas
- Instrument repair, maintenance, and calibration;
- Designing equipment (e.g., simple ovens, kilns, mixers, and driers);
- Trouble-shooting in industrial plants;
- Technical investigations 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;
- Techno-economic studies;
- Engineering design and service work;
- Training of technical staff

(vi) act as the technical arm of national development banks and investment corporations such as the Sudan Industrial Bank and the Sudan Commercial Investment Bank providing them with technical and techno-economic inputs for their

consideration during the evaluation of industrial and development projects;

- (vii) make technical inputs during the evaluation, selection and acquisition of foreign technology; suggest alternative technologies; carry out the adaptation of imported technology and know-how as well as locally-developed technology; advise on the potential of an imported technology, thus preventing industry from buying obsolete technology, inappropriate technology, over-priced technology, or technology which is already available in the country.

Possible Functional Chart for the Proposed Centre

The attached table summarizes the direct and indirect functions of the Centre in the technology transfer process.

THE ROLE OF THE NATIONAL CENTRE FOR TECHNOLOGY IN THE TECHNOLOGY TRANSFER PROCESS

TECHNOLOGY TRANSFER STEP

ROLE OF CENTRE

A. Information on Selection of Technology:

- | | |
|---|---|
| (i) obtaining and providing information on desired technologies; | (i) major responsibility: must maintain up-to-date technological information service; |
| (ii) identification of alternate technological possibilities; | (ii) major responsibility: ties in with (i); |
| (iii) techno-economic and feasibility studies | (iii) depending on responsibilities and capabilities of the Centre; input can therefore be major or minor; |
| (iv) selection of the most desirable technology; | (iv) only technical and techno-economic inputs, ties in with (iii); legal and financial considerations are outside the Centre's responsibility; |
| (v) identification of alternate sources of the desired technology | (v) major role: ties in with (i); |

B. Obtaining and Introducing the Technology to be Transferred:

- | | |
|--|--|
| (vi) acquisition of rights to technology and obtaining technology know-how, including the formulation and closing of all types of technology transfer and licensing contracts; | (vi) this is not a responsibility of the Centre, except to provide technical information during negotiations; ties in with (i) and (iv); |
| (vii) establishing physical facilities and factories; | (vii) not the responsibility of the Centre |
| (viii) absorption of transferred technology, i.e., training of staff and personnel using technology; | (viii) a major responsibility of the Centre, one key function is the introduction of new technologies through the Centre's laboratories or pilot plants by demonstrating these to industry personnel, i.e., introduce the technology through training; |

C. Maintaining, Supporting, and Further Developing Transferred Technology:

- | | |
|---|--|
| (ix) providing technical services for the transferred technology; | (ix) a major responsibility of the Centre; |
| (x) carrying out applied R + D for improving and further developing the technology; | (x) a responsibility of the Centre; |
| (xi) continued training of industry staff and personnel; | (xi) a continuing responsibility, although not always carried out by the Centre; |
| (xii) maintain information surveillance in the field of transferred technology. | (xii) an important responsibility of the Centre. |

Broad Conclusions

30. In order that the Centre can successfully carry out its functions, the following guidelines would be recommended:

1. It should be an independent, non-profit organization that will provide requisite latitude for dedicated professional leadership and for flexibility in staffing and budget sufficient to attract and retain the best Sudanese scientists and engineers.
2. It should be grounded on secure financial support derived from the Sudan Government and private industrial sources. These arrangements should, however, not preclude support from other sources.
3. It should interact closely with industries in Sudan and should improve their efficiency and the utilization of natural resources. It should provide a foundation for new industrial activities by:
 - a) Knowing what the problems of Sudan's industry are;
 - b) Knowing enough about technology and economics to make sensible choices in planning programmes;
 - c) Establishing and maintaining management and working arrangements with industry to insure (a) above and to insure that new findings are put to use promptly.
4. It should be related intimately to the universities and other research institutions and should make use of university facilities, faculties and students as well as staff and facilities of the existing research institutions in its programmes.
5. The Centre should have a first-rate scientific and technical library, and provide information services.

