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WORKING GROUP ON CONCEPTUAL AND POLICY FRAMEWORK FOR APPROPRIATE INDUSTRIAL TECHNOLOGY

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CONCEPTUAL AND POLICY FRAMEWORK FOR
APPROPRIATE INDUSTRIAL TECHNOLOGY IN DEVELOPING COUNTRIES

~~Discussion Paper~~

Conceptual and Policy Framework for Appropriate
Industrial Technology in Developing Countries *

Issues and Considerations

Note prepared by the secretariat of UNIDO

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CONCEPTUAL AND POLICY FRAMEWORK FOR APPROPRIATE
INDUSTRIAL TECHNOLOGY IN DEVELOPING COUNTRIES*

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* This paper, prepared by the Secretariat of UNIDO has been partly based on the recommendations of the First and Second Consultative Meetings on Appropriate Technology convened by UNIDO. The reports of these meetings have been circulated as background documents. The paper has also taken into account other background documentation circulated on the subject.

Introduction

1. The basic developmental objectives in developing countries are to achieve optimum utilization of factor resources, increased incomes and employment and significant improvement in conditions and standards of living. The process of industrialization, which must play a critical role in development strategy, must be geared to the fulfillment of these and other basic socio-economic objectives through production of various goods and services, and the application of suitable processes and techniques.

2. There has undoubtedly been significant industrial development in several developing countries. Considerable import substitution has taken place, together with growing technological absorption by industrial enterprises. Export capability in respect of non-traditional export products has also grown significantly in a number of countries. Despite such developments, the pattern and experience of industrial growth indicates that broader socio-economic objectives have often not been adequately achieved. Industrial production has largely been based on manufacture of products and use of technologies and production techniques utilized in industrially-advanced countries, with continuing dependence on foreign technology, equipment and participation. Industrial policies, geared principally towards import substitution, have tended to result in high production costs, requiring protection through high tariffs and import restrictions. There has been increased concentration of industrial ownership, either by subsidiaries or affiliates of transnational corporations or by domestic industrial groups operating under sheltered and near-monopolistic conditions. Industrial growth has also been largely concentrated in a few metropolitan and urban centres, where the pressures of industrialization have greatly aggravated urban problems.

3. The overall impact of industrial growth in most developing countries has been restricted to small sections and enclaves in most of these countries and there has been little percolation of industrial and technological development to the economy as a whole. The majority of the population have neither benefitted significantly nor been actively involved in the process of industrialization. Little linkage has taken place between 'organized-urban' industry and semi-urban and rural communities, which continue to be

largely dependent on subsistence agricultural pursuits. There has been little upgrading of local skills nor the provision of basic infrastructure facilities, except in areas of industrial concentration. In several countries, poverty and unemployment have tended to increase, and basic socio-economic needs, particularly income and employment opportunities, remain largely unfulfilled.

4. There is growing recognition of the need for significant reorientation in industrial strategy, both to achieve better utilization of national resources and to meet basic socio-economic needs to a greater extent. The Second Conference of UNIDO in Lima in March 1975, while setting a quantitative target of 25 per cent of global industrial production originating in developing countries by the year 2000, also defined essential qualitative objectives as being the fulfillment of basic needs, maximum development of human resources and greater social justice through more equitable income distribution. The close interrelationship between industrialization and technological development necessitates that reorientation of industrial strategy must be effectively dovetailed with technological progress and increased technological self-reliance in these countries. The application, adaptation and development of appropriate industrial processes and techniques most consistent with broader socio-economic objectives should constitute an essential element of a reoriented industrial strategy.

Reorientation in industrial strategy^{1/}

5. A reoriented industrial strategy should aim, firstly, at rapid expansion of basic and potential growth sectors related to domestic factor resources and, secondly, be directed towards more broad-based industrialization through significant extension of the industrial base to the rural sector in each economy. Both these aspects require the growth of technological capability at various levels as the structure and pattern of industrial growth is largely determined by the form of technological application in various sectors.

6. Sectoral industrial growth patterns would inevitably vary for different countries depending on natural and investible resources, development of skills and entrepreneurial capability and overall levels of development. Countries such as Argentina, Brazil, India and Mexico, with large internal markets and considerable growth of industrial skills, may have different

^{1/} Reference is invited to the UNIDO secretariat paper, Reorientation of Industrial Strategy in Developing Countries and Selection and Application of Appropriate Industrial Technology - ID/WG.279/4.

sectoral growth trends than other developing nations at varying stages of development. Several countries such as the island economies of Hong Kong, the Republic of Korea and Singapore, among others, have achieved a high level of exports of manufactured products. A number of countries have had to concentrate on substitution of essential imports, because of foreign exchange constraints. In several countries, very little industrial development has taken place at all. The growth pattern of oil-exporting countries may also be significantly different, with variations in country situations because of other factors, particularly human resources. National policies towards external investment also vary considerably, ranging from a liberal approach towards such investments to varying degrees of regulatory control on foreign capital ownership in various sectors.

7. The pattern of growth in large developing countries, with adequate natural resources and sizable internal markets, may include such basic industries such as steel, aluminium, fertilizers, chemicals and the like. In smaller countries also, there may be potential for certain heavy industries, though greater emphasis may need to be given to medium and small-scale production, particularly in countries with limited investment resources and in an early stage of industrial growth. In countries where a significant industrial base has been established in the organized-urban sector, this will need to be strengthened through greater technological adaptations and innovations.

The organized-urban sector must continue to expand rapidly, with better exploitation of natural resources, growth of human skills and technological progress. The fuller utilization of existing industrial capacity, together with the establishment of new units and expansion of existing enterprises, which may often need to be based on sophisticated modern techniques and processes, should be channelled towards rapid growth of production in the organized-urban sector, both to meet growing internal demand of basic production inputs and to develop export capability in various fields. The manufacture of certain products such as steel, fertilizers, chemicals and the like may also need to be undertaken in the large-scale sector though techniques and processes utilized should, as far as possible, be consistent with broader objectives, particularly that of providing greater employment.

8. Apart from channelling investible resources into the growth of basic industries related to specific factor conditions in particular countries, attention needs to be particularly concentrated in two important production sectors. Firstly, since most developing countries are emerging from primarily agricultural economies, the development of agriculture and the growth of agro-based industries is of special significance. Greater emphasis needs to be given to improved agricultural storage, increased local processing of agricultural products through agro-industrial units, greater domestic manufacture of agricultural equipment and other inputs and optimal utilization of agricultural products and by-products. Secondly, greater attention needs to be given to the growth of skills and capability in the use of modern tools and equipment and the production of a wide range of engineering goods. These can range from relatively small-scale production of simple machined products to the growth of capital-goods production, covering the manufacture of machinery and equipment of various categories. Obviously, the production of more sophisticated machinery and equipment must be related to potential demand and available resources and be phased over a period of time to cover growth of skills and capability. Nevertheless, most developing countries need to extend their production capability for various engineering goods, including parts and components. The growth of the engineering-goods sector, and the development of skills in the use of modern tools and equipment, should be viewed as an important infrastructure requirement related directly to technological development at various stages of industrial growth. It should be possible to map out a fairly significant level of engineering-goods production and manufacture of various types of equipment, parts and components, even in less industrially-advanced economies, both because market conditions would usually sustain such growth and because this would, in turn, result in significant development of skilled operations and production and management skills.

9. A significant aspect of reorientation in industrial strategy would be the diversification and extension of the industrial base so as to extend industrial growth to rural areas and sections of the population where there has been little impact so far. Such dispersal could initially be related to the production of a large variety of goods and commodities primarily required

in semi-urban and rural areas, such as processed food and agricultural products, dairy products, agricultural implements and other agricultural inputs, building materials, certain drugs and pharmaceuticals and a wide range of consumer items. The greater the extent of dispersal, the greater would be the participation and involvement of a wider section of population in the industrialization process, apart from the direct impact of increased employment and income over a broader base. The potential for industrial dispersal would obviously be different for each country and region and would depend on local factor endowments, the provision of infrastructure and other facilities, growth of human skills, gradual increase in purchasing power and the extent to which an overall industrial policy package directed towards industrial dispersal could be effectively implemented.

Relationship with technology

10. The existing industrial structure in most developing countries has been largely determined by the pattern of foreign investment and technological inflow. With growth of modern technology concentrated almost exclusively in industrialized economies, developing countries using such processes and techniques have become increasingly dependent on the flow of technology, capital goods and technological services from developed economies. Though the percentage of total trade in technology between developed and developing countries is relatively small, the volume of payments of technology royalties and fees rose from US\$400 million in 1965 to over US\$1100 million by 1975. As the pattern of technological development in industrialized countries has increasingly been towards greater capital intensity and larger scales of production, the application of such processes and techniques has often proved unsuitable and inconsistent with the objectives and needs of developing countries. The use of technologies and scales of production have necessitated high capital outlays and continuing imports of materials components expertise for long periods. In several instances, the use of capital-intensive technologies has not met the basic objective of greater employment and growth of skills. While the use of advanced technologies may be essential in certain industrial branches, it is necessary for developing countries to consider various technological alternatives that may be available and which may be more appropriate to their circumstances at various stages of development.

11. In view of the close relationship between industrial growth and technological capability, a reoriented industrial strategy would necessitate a more broad-based programme for technological development. Such a programme would need to be coordinated with other essential components of industrial growth, particularly the flow of investible resources. However, the growth of technological skills and capability could provide the initial and essential base for a more diversified programme of industrialization.

12. The existing pattern of growth of skills in individual enterprises, primarily based on foreign technology, needs to be replaced by a more comprehensive programme of technological development and self-generating technological growth from the grass-roots upwards, which could provide adequate momentum for an effective technological development and application system over a period of time. The technological needs of various sectors need to be defined and met through gradual growth of domestic technological capability. Foreign technology inflow will undoubtedly continue to be necessary and is likely to increase at successive stages of industrial growth, as the manufactured products of the developing countries are required increasingly to compete in international markets. At the same time, domestic capability must be increased rapidly, not only for faster absorption of foreign technology and adaptations and innovations, but for the growth of indigenous processes and techniques directly related to local factor situations.

13. The technology 'mix' in a country must be related to the pattern of industrial growth and sectoral investments. In certain production sectors, such as petrochemicals and the like, sophisticated capital-intensive techniques may be utilized in large-scale production, though alternative processes and techniques can be applied at various stages of production and in ancillary activities. To the extent that such production stages and allied industrial activities can be undertaken through more labour-intensive techniques, these would be more appropriate in countries having a large surplus of labour. On the other hand, capital-intensive techniques may be more appropriate in countries where such surplus labour is marginal and can be deployed in other industries. Various alternatives are available, even in industrial sectors where highly capital-intensive techniques are used by developed country enterprises, and considerable choice can be exercised with regard to scales of production and related processes and techniques in several sectors. Production of pulp and paper, for example, which is increasingly being undertaken

in large-size pulp and paper units in developed countries can be undertaken on smaller scales of production in countries with limited markets, resources and raw-material availability. Cement and cementitious materials can also be produced on different scales of production, often involving different technological application. In respect of heavy industries also, such as steel and fertilizers, considerable technological choice can be exercised in the determination of suitable scales of production and appropriate processes and techniques linked to such production sizes.

14. The selection of suitable technology for production sectors which lend themselves more to industrial dispersal would require a greater flow of alternative techniques and processes and generally smaller scales of production. While large-scale production, using labour-intensive techniques, may also be quite appropriate, the technical needs of dispersed industries would generally be related to techniques and processes which are more labour-intensive and geared to small-scale production, with intensive use of local resources and locally available skills. These criteria cannot, however, be applied in all cases and certain small-scale manufacturing units, as in the case of precision instruments, may well require fairly capital-intensive techniques.

Conceptual framework for appropriate industrial technology^{2/}

15. The selection and application of appropriate industrial processes and techniques must be effected within the framework of the objectives and needs of developing countries. In recent years, the concept of appropriate technology has assumed considerable importance in the context of technological choice and application. The concept has generally been viewed in terms of labour-intensive techniques primarily employed in small-scale production. It has often been related to marginal improvements in traditional indigenous techniques used in developing countries. Alternative scales of production have equal relevance in both developing and developed countries. There has, however, been greater conceptual emphasis on the use of such techniques in developing countries.

^{2/} This concept has been further elaborated in the UNIDO secretariat paper, Reorientation of Industrial Strategy in Developing Countries and Selection and Application of Appropriate Industrial Technology, ID/WG.279/4.

16. It is necessary to view the concept of appropriate technology in its proper perspective, particularly in respect of technological needs of developing countries. Most of these economies are undertaking ambitious programmes of industrialization. Such programmes cannot be confined to the use of any one technological approach. **Technologies** need to be selected and applied in these countries as are consistent with local resource endowments and conditions of application in different country situations. In certain conditions and in particular production sectors, the use of capital-intensive techniques may well be wholly appropriate. Even in **these** sectors, however, the structure of production can be considered in different stages and technological alternatives can be taken into account. Similarly, large-scale production may also be fully appropriate in certain sectors in developing countries, particularly if labour-intensive techniques are utilized in particular production stages to the extent practicable from a techno-economic viewpoint. At the same time, more labour-intensive techniques and smaller scales of production could certainly be more appropriate in a large number of instances in developing countries. Greater decentralization and dispersal of industry would undoubtedly necessitate consideration of such alternatives in view of the different situations and factor circumstances involved. The concept of appropriate technology, while considered within the framework of developmental objectives, must be related to specific resource circumstances and conditions of application in particular situations. The determining factor is the suitability of particular techniques and processes in a given set of circumstances. Such circumstances would also inevitably change over a period of time and the use of industrial processes and techniques must be dynamic and wholly responsive to such changes.

Technological alternatives

17. The critical element in the determination and selection of appropriate technology is the exercise of choice between several technological alternatives. The market for technology is imperfect, the degree of imperfection varying in different sectors. Nevertheless, considerable technological choice does exist in most industrial branches and such choice is often closely related to the **selection of products and the structure of the production enterprise.**

18. As part of the exercise of identifying more appropriate technologies, certain sectors^{3/} have been analysed where choice between various alternatives may necessitate re-structuring of production, particularly in respect of new production capacities. These sectors have been selected to highlight the extent of technological choice that can be exercised, particularly in the context of greater industrial dispersal to semi-urban and rural areas. An attempt has been made to define policy aspects and the institutional infrastructure necessary to enable such choice to be effectively exercised.

19. The sectors selected for discussions at the International Forum on Appropriate Industrial Technology which should be considered as illustrative of the issues of technological choice in sectors of greater relevance for industrial dispersal, are food storage and processing, production of agriculture implements, sugar, oils and fats, textiles, cement and building materials, paper and pulp, and drugs and pharmaceuticals, apart from infrastructure needs of the rural sector in terms of energy and transport, and workshops/industrial centres designed to produce light-engineering goods. The issues of technological choice in heavy industries such as steel, capital goods, fertilizers and chemicals also need to be considered. Several background papers relating to these sectors have been prepared for discussions at the Forum which not only deal with the technological alternatives but the policy and institutional implications of selection and application of more appropriate techniques. Sectoral Working Groups of the Forum, comprising of experts in each sector are expected to examine the issues and implications of technological choice in the various production branches and to recommend the policy and institutional infrastructure necessary for implementation of various alternatives. The policy and institutional implications can obviously only be applied in the context of specific country situations. It is nevertheless considered that certain broad parameters can be defined for consideration by policy and decision-making authorities in each developing country.

20. It is also necessary to examine the broad implications of appropriate technological usage in respect of certain categories of heavy industries, often basic to the needs of developing countries. Technological problems obviously vary considerably from industry to industry but certain general issues and considerations can be identified in respect of the heavy-industry sector, where large financial outlays are generally required and where technological dependence is even greater than in most other sectors.

^{3/} This refers to the background papers on specific production sectors which will be considered by the sectoral Working Groups in the International Forum on Appropriate Industrial Technology in New Delhi (20-25 November 1973).

Production efficiency

21. In considering various technological alternatives, it is necessary to deal with the question of production efficiency. The use of particular processes and techniques, selected on the basis of socio-economic considerations, should normally be cost efficient in terms of production costs and pricing of end-products. The use of selected techniques should not result in higher production costs which would be reflected in higher prices that consumers in the developing countries would be required to pay. In certain instances, some differences in costs may need to be allowed for but only for a certain period of time during which requisite technological efficiency can be achieved. In such cases, the trade-off between these costs and broader socio-economic objectives, such as greater employment, must be taken into account. Special facilities and incentives may also be necessary, together with protection from competition from the domestic large-scale sector for a specified period. By and large, however, the use of particular processes and techniques in smaller scales of production, that may be more appropriate for dispersed industrial units, should ensure competitive capability with similar products produced in large-scale units using capital-intensive techniques.

22. Competitive efficiency also needs to be viewed against long-term objectives and impact. It was noted that certain capital-intensive techniques, such as the use of mechanization in arid or semi-arid zones, may increase productivity for a short period but may tend to have adverse environmental and other effects over a longer span of time. Efficiency over a period of time may also be related to the availability of adequate maintenance and repair facilities. The use of mechanized agricultural equipment, for example, can bring short-term advantages to agriculturists, which are more than set off by periods when such equipment cannot be used because the facilities for its maintenance and repair are lacking.

Sectoral linkages

23. Though, for convenience of discussion, a distinction has been made in this paper between the organized-urban and dispersed sectors, no line of demarcation should be drawn between the two and both should be considered as integral elements of a process of industrialization.

Close sectoral linkages and interrelationships must be maintained between large-scale and small-scale enterprises, either in urban or semi-urban and rural areas. Small-scale production activities should be integrated as feeder ancillary production units to large-scale plants, particularly in the engineering-goods sector. This would require not only closely-knit industrial operations but also financial and technological linkages. Such linkages have been effectively established in industrially-advanced economies and it is essential that similar interrelationships in production activities, including sub-contracting, must emerge and grow in developing countries. The trend towards a greater degree of vertical integration which is common in several developing countries, needs to be modified to a more effective system of horizontal integration between a much broader number of production enterprises. Similarly, close integration and inter-linkages must be maintained with the agricultural sector development and the processing of agricultural products, as dynamic agricultural development would provide a strong base for industrialization in most developing countries.

National technological development

24. As stated earlier, the use of more appropriate technology in developing countries requires the formulation and implementation of an overall programme for technological development and application. It is only within the framework of such an overall programme that sectoral technological needs and growth patterns can be identified and developed to meet basic socio-economic objectives. An important feature of such a technology development programme is the creation of a comprehensive technological base extending to various sectors and regions in the economy. It is necessary that manpower resources, which have remained largely untapped and are available in abundance in most developing countries, must be activated and brought within the framework of industrial growth. This requires not only the provision of essential infrastructure facilities in semi-urban and rural areas, but the necessary technological infrastructure in terms of growth of skills and technical capability.

25. It is necessary that basic infrastructure facilities such as energy and transport should be adequately expanded, particularly in rural regions. Energy and transport planning in developing countries has largely concentrated on metropolitan and urban areas, because of lack of resources and other constraints.

It is necessary that alternative technological patterns be considered to meet essential infrastructure requirements which are designed to a greater extent, on local availability of materials and skills. In the energy sector, consideration has to be given to the provision of energy for various rural needs, possibly through the establishment of small decentralized local networks using alternative non-conventional sources of energy. While rural energy planning may be integrated into a national energy plan, it should not be made contingent on, or consequential to, the implementation of a centralized programme of rural electrification which may well extend over several decades in several countries. The necessary technological options need to be examined both in respect of non-conventional energy sources and in terms of the availability of hard ware and possibilities for domestic fabrication, operation, and maintenance and repair. The substitutability and related advantages to end-users of alternative energy supplies vis-à-vis conventional electrification programmes need to be broadly determined and necessary parameters identified in this regard. Similarly, in respect of rural transportation, it is necessary to consider various alternatives in respect of non-motorized and motorized vehicles, rather than depend solely on automotive vehicles of traditional design. The production of automotive equipment, which has been undertaken in several developing countries by way of assembly or semi-assembly of various models of automobiles, buses and trucks, needs to be reviewed in the context of other alternatives that may exist or may need to be developed to meet the needs of transportation in rural areas.

26. Apart from energy and transport, the necessary technological infrastructure also needs to be created in various sectors and regions, together with institutional and other facilities essential to the growth of local skills and capability. It is considered that rural workshops/industrial centres could provide the necessary technological base for the spread of knowledge of industrial operations and use of modern tools and equipment, as well as producing a wide range of goods and the upgrading of local techniques. Such workshops/centres could provide the basic institutional infrastructure for the growth of rural industries geared to local requirements and factor endowments. The facilities thus provided would need to be integrated to

adequate industrial extension services covering surveys of local industrial potential; assistance in identifying viable projects; provision of technological information and expertise; assistance in securing financial credit and machinery and equipment; assistance in ensuring a regular supply of materials and in the marketing and distribution of end-products. Rural industrial estates would also need to be set up to provide necessary facilities to potential local entrepreneurs. A comprehensive policy package would also need to be formulated and implemented for effective industrial dispersal and growth of technological skills in the country as a whole. Such a package should include the provision of adequate credit facilities through field branches of banking and credit institutions; financial incentives similar to, if not greater than those provided to organized-urban industry; an assured supply of processed industrial materials; preferential purchase of products by government agencies and institutions; and possible reservation of production capacity for industrial units located in rural areas for specified periods of time.

27. The extension of technological knowledge and skills to semi-urban and rural areas would need to be closely interlinked with programmes of technical and vocational education. While programmes of technical and vocational education have been undertaken in most countries, these have often not been adequately integrated with knowledge and application of industrial processes and techniques.

Foreign technology

28. While technological knowledge must be spread and developed through various geographical regions and industrial sectors, it is necessary that the technology needs of the organized-urban sector in each economy are adequately met. This necessitates (i) careful selection of technology and know-how, which may have to be acquired from external sources; (ii) determination of suitable terms and conditions; (iii) disaggregation of the technology package acquired; (iv) adequate absorption of such technology and (v) consequent adaptation and innovative development.

29. The choice of foreign technology requires careful assessment of various alternatives. In most industrial branches, technology and know-how can be acquired from different sources, except in cases where the technology is protected by patents or other industrial property rights. Developing-country institutions and enterprises must have adequate knowledge of such alternatives and must assess such alternatives in the light of their requirements.

The most modern and sophisticated production techniques may

not be the most suitable for conditions in developing countries and the various criteria discussed above should be applied. The choice of the licensor is also of considerable importance. A considerable body of technological knowhow is available from a number of sources in both developed and developing countries and recipient enterprises must make a careful assessment in this regard.

30. The contractual terms and conditions in technology agreements have been the subject of considerable discussions in various fora. National regulatory institutions in several developing countries have defined broad guidelines which, in most cases, do not permit unduly restrictive conditions on production and sales and tie-in arrangements of various types. In some countries, the duration of agreements is also limited to a maximum period. The trends in developing countries in respect of regulation of foreign technology in developing countries have been discussed in greater detail in two of the background papers^{4/}, together with the need for disaggregation of the technology package.

31. The acquisition of foreign technology must be accompanied by rapid and adequate absorption in recipient enterprises. There is often a tendency to continue licensing arrangements for unduly long periods. Technological absorption needs to be pre-planned and necessary training programmes implemented well in time. Recipient enterprises must also be in a position to adapt and innovate new techniques, based on local skills and capability. This necessitates adequate facilities for research and development on the part of recipient enterprises.

32. Foreign technology inflow is, in most developing countries, closely linked to private foreign investment. The pattern of joint ventures has emerged as a popular corporate arrangement in several countries, particularly where national policies impose restrictions on foreign capital ownership. Experience in this regard has been mixed, though several successful joint ventures have been undertaken in most countries. With the growth of domestic entrepreneurial capability, there is an increasing trend towards licensing arrangements for technology and know-how, without

^{4/} 'Basic Considerations for the Evaluation of Technology Contracts in Developing Countries', No. ID/WG.275/6, prepared by the Secretariat of UNIDO; and 'The Role and Functions of Technology Regulatory Agencies in Technological Development', No. ID/WG.275/7, prepared by the Secretariat of UNIDO.

foreign participation. The growth of state enterprises in several countries has also accentuated this trend, though several state enterprises have also entered into joint venture arrangements.

32. It is necessary for developing countries to evolve policy guidelines in respect of foreign technology. Such inflow as is essential in particular industrial sectors needs to be obtained on suitable terms and conditions and rapidly absorbed and adapted to local conditions and circumstances. While the responsibility for this rests primarily with user enterprises, state-owned or in the private sector, governments can and need to play a significant role in ensuring that such inflow takes place in production branches where foreign technology is necessary and that it is acquired under suitable terms and conditions consistent with national policies and objectives. Institutional agencies in these countries must discharge important functions in this regard.

Institutional facilities

33. The growth of technological capability whether through absorption and adaptation of foreign technology and know-how or through innovative developments of indigenous processes and techniques necessitates the development of adequate institutional facilities and linkages in respect of (i) technological information; (ii) domestic technological services; (iii) regulation of foreign technology inflow; (iv) monitoring of technological changes; and (v) development of institutions for technological development based on domestic needs.

34. An essential aspect of domestic technological growth is the creation and development of an adequate information network, providing a flow of data and material regarding alternative sources of technology, both indigenous and external in various sectors. Such an information network should be closely related to the technological needs of both the organized-urban and the dispersed industrial sectors. The flow of information to small enterprises in the latter sector needs to be particularly ensured.

35. 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, construction

and installation and plant commissioning, start-up and operations. The dependence on foreign agencies in respect of such technological services has been an important determinant in the planning and implementation of most industrial projects. This has also made disaggregation of imported technology packages extremely difficult and left a critical infrastructure gap, resulting in undue dependence on foreign designs and engineering services with a consequential impact on investment patterns, capital goods needs, and plant operations and management. The deficiencies in technological service capability for various industrial branches need to be identified and indigenous service capability should be adequately encouraged and developed to overcome these shortcomings. It is necessary to ensure that domestic capability in technological services is utilized to the maximum extent possible, as such capability can only grow through a deliberate policy of utilizing such capability, as is nationally available, to the maximum extent.

36. In several developing countries, national regulatory institutions have been set up to screen proposals relating to foreign technology, and to ensure that the inflow of such techniques is within the framework of certain guidelines. Such screening has, however, been largely confined to the terms and conditions of technology agreements. Since the ultimate decision and responsibility for choice of technology rests with user enterprises, there has been a marked preference to use technologies considered most modern, together with popular brand names which can command greater sales. The institutional regulation of foreign technology should extend beyond the consideration of contractual terms and conditions, and should be closely related to the identification of processes and techniques which can be appropriately utilized in various sectors. Such institutions can provide valuable guidelines to user enterprises in the selection of more appropriate techniques and processes.

37. It is important that the incidence of technological change, both in respect of foreign technology inflow and the growth of domestic technological capability is regularly monitored, so that there is constant feedback regarding the impact of foreign technology or domestic technological progress and so that changes in technological needs and developments can be assessed from time to time. The absorption of foreign techniques and processes and their suitability to the changing technological environment

of particular countries also needs to be assessed periodically. Such monitoring would facilitate the identification of these industrial sectors where adequate domestic technological capability has been developed -- either through indigenous research and development or through absorption and adaptation of foreign techniques and processes -- which could be utilized by other manufacturing units. The results of such monitoring should be imported in policies relating to technology regulation in various sectors.

38. It is vital that the wide range of institutions dealing with technological investigations and R and D are closely linked with industrial growth at the enterprise level in various sectors. Apart from close linkage with industry, such institutions should serve as centres of excellence or, rather, as centres of relevance, particularly for the dispersed sector, which has hitherto received little attention from most such institutions.

National Centers for Appropriate Technology

39. While most of the above-mentioned institutional functions need to be performed for overall technological development, specific institutional responsibility for appropriate technology also needs to be specifically defined at the national level. The selection and application of appropriate techniques extends to all industrial sectors and must be exercised by the enterprises and institutions concerned. It would nevertheless be desirable for each country to set up a National Centre for Appropriate Technology, which would perform primarily coordinating functions, which would include (a) identification of technological alternatives more suited to domestic factor circumstances that may exist in various industrial branches; (b) coordination of R and D programmes for appropriate technology through various domestic institutions and enterprises; and (c) recommendations as to policy and other measures to promote the use of more appropriate techniques in particular sectors. Such National Centres should be closely integrated with the governmental agencies at the policy level dealing with the selection of technology and the development of national technological capability.

40. It is necessary that developing countries should allocate adequate resources for R and D in the adoption and development of more appropriate processes and techniques. Research and development activities in this field have generally been very limited and specific research programmes should be undertaken, which could be coordinated by the National Centers for Appropriate Technology. It would also be necessary to consider financial incentives, including subsidies and tax benefits to industrial enterprises undertaking research and development in the adoption and use of more appropriate techniques.

Framework of technology policy

41. The role of governments in developing countries is crucial in implementing a reoriented industrial strategy based on greater diversification and dispersal, together with rapid growth of technological capability at various levels and the use of more appropriate industrial techniques and processes. To the extent that state enterprises have been set up in several developing countries, the objectives and policies, if suitably defined, can be directly implemented through such enterprises. This would be particularly so in sectors such as machine-building, where state-owned enterprises have been established but would also be applicable in other sectors of manufacture and distribution of processed industrial materials and products. In respect of private-sector industries in market and mixed-economy countries, governments would need to define and implement a comprehensive policy package for the achievement of such objectives and a wide range of policy instruments would need to be effectively used.

42. It will be necessary to set up a suitable administrative mechanism at the policy and decision-making level to ensure that national technological development and the application and development of appropriate technologies receive adequate policy orientation. While National Centres for Appropriate Technology or similar institutions can assess various technological alternatives and recommend possible courses of action, decision-making authority and support at a higher level will be necessary for the adoption and implementation of policy decisions. Such functions could be discharged by central planning bodies or a specific department or agency directly responsible for technological development,

which would have both a coordinating function and be closely associated with policy decisions in this regard and their implementation.

43. National policies should be announced regarding the role of private foreign investment and the extent of foreign capital ownership permissible in various sectors. Such policies have been defined in several countries and have also been embodied in specific legislative measures in some countries. Similar policy announcements should be made in respect of foreign technology. Legislation has been passed, particularly in certain Latin American countries in this regard while, in other countries, regulatory control of foreign technology inflow is exercised through executive measures. A well-defined policy, which is adjusted from time to time to changing conditions, could greatly facilitate technology flow in production branches where this is considered necessary and provide suitable encouragement and incentive for growth of domestic technologies in branches where such inflow may not be necessary. Governmental decisions on such an issue are apt to be criticized as constituting undue interference with the market mechanism. The situation in most developing countries, however, makes it difficult to rely on market forces alone, if continuing technological dependence is to be avoided. It is, however, essential for the regulatory mechanism to be adequately responsive to technological needs, including foreign technology, in various branches. The example of Japan, over the last two decades, exemplifies how effective, and yet how responsive, a regulatory mechanism needs to be, in changing technological situations.

44. It is necessary that institutional mechanisms, apart from technology regulation agencies, should be set up for providing an adequate technological information network and to ensure technological support and assistance through research and development programmes and monitoring activities. Such institutional agencies must be closely linked with the production activities and problems both of the organized-urban sector and of small-scale enterprises and industrial units set up in rural areas. Adequate resource allocations for such institutional functions must be provided and periodic review should be made of their impact and responsiveness.

45. Specific policies need to be evolved and implemented for the growth of technological service capability, including maximum use of domestic technological services even when foreign technology is used. In some developing countries, consultancy organizations have been successfully set up in the state sector while, in others, special incentives and policy support is provided for greater utilization of domestic consultancy and engineering services.

46. It may be necessary to identify these specific fields of production suitable for small-scale units. In certain branches, only small-scale units should be entitled to certain financial and tax incentives and concessions. It may also be considered whether certain products should be 'reserved' for production through small-scale units or for units located in rural areas. In both such cases, however, the size of the enterprises in terms of capital assets and number of workers employed, would need to be identified. If production activities are related to particular locations, the locational criteria will need to be suitably defined.

47. A specific programme of financial and tax incentives will need to be provided for growth of the dispersed sector and for small-scale industries.

The present structure of incentives tends, in several countries, to favour the growth of large-scale units in the organized-urban sector. This needs to be modified to provide greater incentives and concessions such as tax holidays, tariff rebates, supply of scarce raw materials to small-scale enterprises and industrial units in the rural sector. In the case of the latter, a system of capital grants, bearing a relationship to the extent of capital investment, may also be considered. A comprehensive system of credit on easy terms and using liberal criteria for 'creditworthiness' should be adopted by banking and investment credit agencies, with adequate extension of such agencies to semi-urban and rural areas. Unless cheap and adequate credit is easily available in rural areas, it would be difficult to provide the necessary financial stimulus to rural industrial growth. Financial assistance should also be available for purchase of machinery and equipment for small-scale and rural industries, including hire-purchase arrangements which have been implemented in some countries.

48. It is necessary that adequate resources are channelled into infrastructure development in semi-urban and rural areas, besides areas of industrial concentration. Several programmes requiring state funding, will need to be implemented for providing greater facilities to rural energy and transportation programmes. Apart from the promotion of smaller energy systems or investments in rural road construction, financial assistance and support must be provided by state agencies for the production of the necessary hardware, such as energy equipment or appropriate non-motorized and motorized vehicles for rural needs. It will also be necessary for state agencies to undertake, or financially assist, the establishment of rural workshops/industrial centres, together with rural industrial estates in selected locations.

49. The application and development of more appropriate technology in various production sectors also necessitates consideration of specific policy measures in each branch. A number of branches to be discussed by the sectoral Working Groups are directly related to agriculture, such as food storage and processing, manufacture of agricultural implements, and the production of sugar, and oils and fats. While policies related to overall agricultural development will have an important impact on sectoral growth and technological choice in these branches, certain specific policy measures will need to be implemented if more appropriate techniques are to be adopted. In food storage, for example, financial assistance must be provided by state agencies for construction of warehouses and grain storage facilities in rural locations and market centers. Greater local processing of agricultural products will necessitate various policy measures for application of different technologies. The choice of appropriate sugar-production technology under different conditions, for instance, will also require specific policy measures for the use of particular technologies. These can range from restrictions on the installation of new capacities using a particular technology to differential systems of tax and excise levies on the resultant sugar produced by different technologies. In respect of alternative technologies for the production of cement, textiles and paper, which would often be related to different scales of production, policy measures such as differential excise and tax levies, price control, and pooled-price distribution arrangements, can significantly determine the nature and size of capital investments, technological choice and the extent of dispersal.

The local manufacture of certain essential drugs and pharmaceuticals in the dispersed sector would also require policy support in the distribution of such products through hospitals apart from financial assistance in the establishment of such facilities.

50. A more detailed consideration^{5/} of the range and implications of technological choice in the above-mentioned production branches should provide specific policy recommendations for the application and development of more appropriate technologies in each branch. There is little doubt, however, that a number of policy measures will need to be considered and implemented in the context of each country-situation if more appropriate techniques and processes are to be adopted and implemented in various production branches.

51. The policy framework for adequate technological development and the selection and application of more appropriate technologies should, therefore, be considered, both in terms of a comprehensive policy package for overall technological growth and the use of more appropriate technologies in particular production branches. The specific policy package will obviously differ from country to country but it is necessary to highlight the wide range of issues which need to be considered and determined, if effective technological development and rapid growth of technological capability is to be achieved.

International Technological Co-operation

52. The growing technological needs of developing countries necessitate much greater technological co-operation between developing countries and at the international level. While the volume of external technology inflow will be significantly enlarged with growing industrialization in these countries, the pattern and terms of such inflow may need considerable modification to meet the needs of developing countries in various production branches. With the increase in technological capability and availability of technology and know-how in several developing countries, there is also much

^{5/} This would be taken up by the sectoral Working Groups.

greater scope for technological co-operation between such countries because of the similarity in problems and constraints and in possible solutions. Technological development in several production branches, together with technological services and expertise has achieved a level in a number of developing countries when it can be effectively transferred to enterprises in other developing countries. In respect of all external technology inflow, however, whether from developed or developing-country enterprises, recipient institutions and enterprises must ensure that the criteria of suitability in relation to domestic objectives and factor circumstances is adequately met and that technology and know-how is acquired under acceptable terms and conditions, both from a national viewpoint and that of recipient enterprises.

Technological co-operation between developing countries

53. The need for greater industrial and technological co-operation between developing countries was stressed in the Round-table Ministerial Meeting held in New Delhi, India in January 1977. In this meeting, specific areas of co-operation were identified which included, inter-alia, co-operation in respect of industrial technology so as to improve the use of techniques already available; co-operation in respect of contracts and agreements already concluded to provide guidance to others; promotion and collective action for negotiating and bargaining for more equitable economic relationships and acquisition of technology; development of concrete programmes for using engineering and consultancy capabilities available in developing countries; and co-operation in the establishment of national regional technology institutions and for research and development in specific sectors.

54. The U.N. Conference on Technical Co-operation between Developing Countries held in Buenos Aires in September 1978 has further highlighted the essential need for such co-operation and adopted a plan of action for promoting and implementing such co-operation. The programme of action has identified several measures at the national level, including national programming for such co-operation, adoption of policies conducive to such co-operation, and promotion of greater technological self-reliance through multinational R and D centres and other forms of co-operative action. Action programmes at the sub-regional and regional levels have also been identified, together with actions and measures necessary at the global level.

55. Apart from increase in the number of joint industrial enterprises and greater flow of technology between developing countries, important measures for exchange of information and experience in respect of technology contracts have been initiated between national regulatory institutions in several developing countries. In order to facilitate such exchange of information and to enable effective analysis and dissemination, UNIDO has been entrusted with the responsibility of receiving, processing and distributing the information supplied by participating developing countries under this programme. The exchange of information on technology contracts should greatly strengthen the bargaining power of developing countries because of the greater knowledge and information at their disposal, apart from extending the area of technological choice. Since technology contracts are purely commercial arrangements and so long as proprietary or confidential technical information is not divulged, there is no legitimate objection to the sharing of information and experience between national regulatory institutions. Such exchange of information of commercial terms and conditions between national regulatory agencies would not affect the interests of licensors or licensees but would greatly assist regulatory agencies in taking decisions in the light of the wider experience of other developing countries.

56. Within the framework of the overall TCDC programme of action adopted at the Buenos Aires Conference, several specific measures can be undertaken to promote the growth of technological capability and the use and development of more appropriate technologies. Such programmes and measures can take the form of (i) collection and dissemination of information regarding the experience and availability of alternative technologies which may be more appropriate for developing countries; (ii) a specific programme for facilitating the flow of such alternative techniques and processes between enterprises in developing countries in certain production branches; (iii) greater utilization of technological services, including consultancy engineering facilities available in other developing countries, which may be more appropriate and oriented to local conditions; (iv) determination of norms and principles governing the transfer of such technologies and processes between enterprises and institutions in developing countries; (v) adoption of uniform policy guidelines governing foreign technology

inflow; (vi) consideration of arrangements for the joint acquisition of suitable technology and know-how; and (vii) the implementation of joint programmes between developing country institutions and enterprises for consultancy and engineering services, training of personnel and research and development, particularly in respect of more appropriate technologies.

57. There continues to be a lack of awareness regarding the availability of appropriate technology and know-how in other developing countries. Most prospective licensees from these countries continue to seek technology and know-how from transnational corporations in developed economies even in respect of relatively simple production processes, which are available in other developing countries. The problem is partly lack of information regarding such alternatives and partly a continuing preference for more sophisticated production techniques used in developed economies. The collection and dissemination of information and data regarding technologies which have proved useful and appropriate in a developing country, and which are available for commercial transfer to enterprises in other developing countries, would greatly facilitate greater technological co-operation between these countries^{6/}.

58. It may be necessary to undertake specific programmes for facilitating transfer of appropriate processes and techniques between enterprises in developing countries in selected production branches, both in the organized-urban and dispersed sectors, where appropriate technologies have been developed or are available. Such production branches could include not only the production of a wide range of consumer products through medium and small-scale industrial units but the manufacture of intermediates and machinery and equipment of various categories. Such a programme could be initiated through technology regulation agencies or other institutions dealing with technological development in these countries.

59. The greater utilization of technological services, including the preparation of feasibility studies, detailed engineering and project implementation from institutions and enterprises in other developing countries also offers considerable potential. Institutions and enterprises in developing countries, which have developed such skills, are likely to

^{6/} Draft Report of Second Consultative Group on Appropriate Industrial Technology, 26-29 June 1978 - ID/WG.279/12; Reorientation of Industrial Strategy in Developing Countries and Selection and Application of Appropriate Industrial Technology - ID/WG.279/4.

provide knowledge and facilities more appropriate to conditions in other developing countries and on more competitive terms and conditions. A specific programme for dissemination of information regarding availability of such technological services in developing countries would facilitate greater co-operation and joint programmes in this field.

60. In order to facilitate greater flow of appropriate technologies between enterprises in developing countries, it may be desirable to define suitable norms of conduct in technology-supply arrangements, which would be required to be followed by licensors and licensees in these countries. On most contractual aspects relating to technology transfer, such as the duration of agreement, tie-in provisions, restrictions on exports, guarantees, access to improvements and other contractual conditions, guidelines could be defined, based on a maximum degree of co-operative partnership. Model guidelines could be prepared by an international organization such as UNIDO, which could be considered by governments in developing countries.

61. It would also be desirable, in this context, for developing countries to adopt uniform policy guidelines governing the inflow of foreign technology. Considerable progress in this regard has already been achieved through regular meetings and exchange of views between representatives of technology regulation agencies in these countries. Such co-operation could be further extended, so as to ensure that a fairly uniform policy approach could be adopted in respect of selection and acquisition of appropriate technology and know-how.

62. The joint acquisition of technology and know-how for use in more than one project in developing countries may hold out considerable possibilities in the future. There is considerable commonality in industrial programming in countries at comparable stages of development, and projects in the same production sector may be undertaken in more than one developing country at around the same time. Such projects can range from large-scale industries such as steel, petroleum, fertilizers and chemicals, machine-building to medium-size plants for textiles, sugar, cement and agro-industries and small-scale units covering a wide range of intermediate and consumer products. In a number of these projects, the acquisition of

suitable technology and know-how on a collective basis for more than one project, can be considered. This would enable more detailed evaluation and consideration of technological alternatives and would reduce technology costs, apart from securing better contractual terms. Such an approach towards collective bargaining would have particular significance in countries geographically contiguous to one another, as in the case of the Andean group or regional country-groups in Asia and Africa. Significant collective action has not so far been initiated in acquisition of technology, primarily because this issue has been viewed in national terms and left to the initiative of individual enterprises. With growing realization of the interrelationships in technological growth, a joint or collective approach in technology acquisition has dynamic possibilities for developing countries in the future.

63. With the need for development of technological service capability, most developing countries need to set up certain domestic facilities in this regard. Greater technological co-operation among such countries can take place, both in the setting up of such facilities where they do not exist and in the development of such institutions and enterprises on the basis of a joint programme. There appears to be considerable scope for setting up joint consultancy and engineering services, particularly for the use of more appropriate technologies, either on a regional basis or between developing-country groups at a similar stage of industrial growth. More effective joint programmes for training of personnel in various sectors also needs to be initiated. Some training facilities have been provided in certain developing countries but the scope and coverage of such training programmes can be significantly enlarged. Joint programmes for research and development activities particularly in respect of more appropriate techniques also need to be undertaken to a much greater extent. The difficulties and constraints in respect of industrial research and application experienced in several developing countries emphasizes the need for greater sharing of experience and the implementation of joint research activities. Fields such as electronics, drugs and pharmaceuticals and non-conventional sources of energy represent possible areas of joint research, together with agro-industries, leather, chemicals, engineering products and several other sectors of special interest to a number of developing countries.

64. Technological co-operation between developing countries for the application and development of appropriate technologies can and needs to be extended over a fairly wide area. Technology regulation agencies, and other national institutions involved in technological policies and development should initiate and negotiate such programmes of co-operation. In certain fields, developing countries may need inter-governmental agreements specifying the nature and extent of mutual assistance and co-operation, within the framework of which bilateral or multi-lateral arrangements could be worked out.

Technological co-operation at international level

65. While there is great need and potential for technological co-operation among developing countries, enterprises in developed economies will continue to be major sources of industrial technology for some time to come. In recent years, there has been increasing recognition, in industrialized countries, of the necessity for more rapid industrial and technological growth in developing countries.

This needs to be translated in terms of concrete action-programmes by enterprises and governments in developed nations for more effective technological co-operation. While the adoption of a Code of Conduct in respect of technology transfer is still under negotiation at the inter-governmental level, it would be desirable for representative bodies of technology suppliers and licensors in developed countries to ensure the observance of certain guidelines in technology supply to developing-country enterprises. This would create a much better climate for greater technological co-operation at the enterprise level.

66. There is also need for greater flow of technology from a larger number of enterprises in developed countries. Hitherto, investment-cum-technological collaboration with developing-country enterprises has largely been concentrated in the hands of relatively few transnational companies having close trade or industrial links with one or other developing country. Technological knowledge and capability in various production branches is, however, available with a much larger number of enterprises in industrialized countries, particularly medium and small manufacturing units, and the field of technological choice would be considerably widened if such enterprises were also brought within the ambit of technological collaboration with developing-country enterprises.

67. Certain other policy and institutional measures may be considered by developed countries in the interest of greater technological collaboration with developing countries. For this purpose, appropriate agencies could be designated by individual developed economies to facilitate the transfer of suitable technologies to developing-country enterprises. Greater incentives could also be provided for flow of suitable technologies to developing countries. These could take the form of tax relief or subsidies in respect of incomes accruing from supply of technology or technical services to these countries. It is also necessary to facilitate greater technological co-operation by governmental and semi-governmental institutions dealing directly or indirectly with R and D in various production branches with corresponding institutions and enterprises in developing countries. It is also important that developed countries should participate financially in assisting the growth of technological capability in developing countries. Even if a small percentage of the income generated from technology licensing were set apart by these countries for financially assisting technological growth and development of technological infrastructure in developing countries, this would provide significant technological co-operation.

International institutional mechanism

68. The above measures for technological co-operation should be implemented with the overall objectives of selection, application and adaptation of more appropriate technologies in developing countries. It is essential that adequate attention is focussed at the international level on greater flow of suitable technology and know-how between countries and the implementation of specific measures designed to facilitate greater exchange, application and development of appropriate technologies. It may be desirable that an international mechanism be established in a developing country which could provide essential facilities for this purpose. Such a mechanism could take the form of an International Centre on Appropriate Technology (ICAT) under the auspices of an international organization such as UNIDO. The principal functions of such an International Centre would be to (a) collect, analyze and disseminate information and experience in the application and use of alternative technologies in various production sectors, with particular emphasis on technologies specifically developed or adapted to the needs of

developing countries in selected sectors; (b) facilitate contacts between enterprises and institutions possessing such technologies and enterprises in developing countries interested in acquiring such techniques; (c) assist in the process of transfer of such appropriate technologies in particular cases; (d) coordinate a programme of research and development undertaken in R and D institutions in both developing and developed countries, including allocation of financial assistance to such institutions; (e) assist in the adaptation of such technologies to suit conditions in particular countries.

69. A mechanism such as an International Centre on Appropriate Technology, while under the auspices of UNIDO, would need to be developed as an autonomous organization, with a governing body having representatives from both developing and developed countries.

70. Depending on the extent of resources that may be available, it should also be possible to finance specific research and development activities in appropriate technology undertaken in both developed and developing countries. It is principally through an extensive research and development programme that appropriate technological adaptations and innovations can take place, which would be designed primarily to meet the technological needs of developing countries.

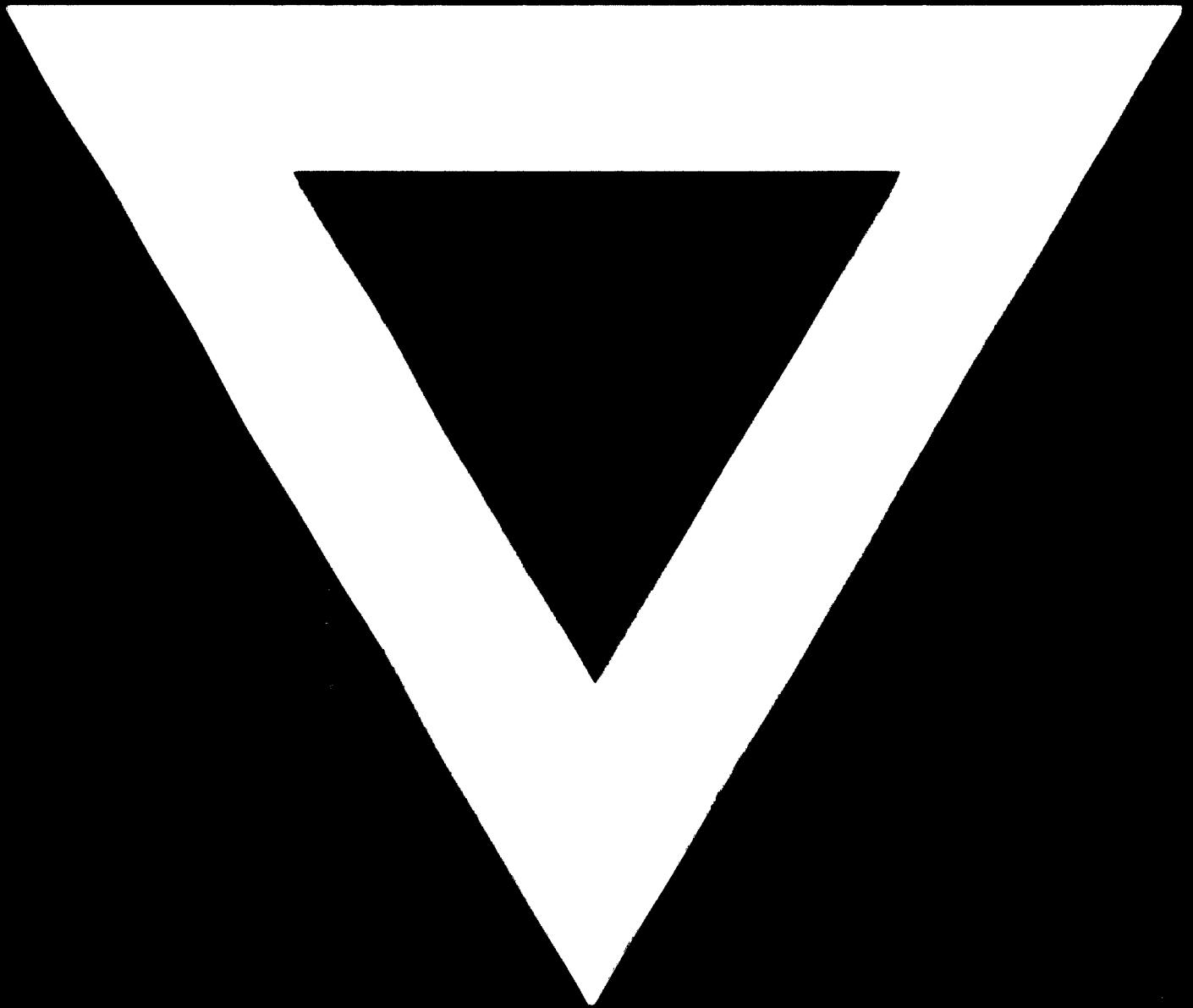
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The following background documents are being circulated:

Appropriate Technology in the Context of the Redirection of LDC Industrial Development Strategy: Concepts and Policies	ID/WG.279/2
Management of Appropriate Technology	ID/WG.282/3
Appropriate Industrial Technology: an Integrated Approach	ID/WG.279/6
Systematic Approaches to Appropriate Technology	ID/WG.282/88
Institutional Development of Appro- priate Industrial Technology in Developing Countries: R+D Policies and Programmes	ID/WG.282/90
An Approach to the Development of Appropriate Technology	ID/WG.282/101
Towards a Strategy for Industrial Growth and Appropriate Tech- nology	ID/WG.264/1
Final Report of the First Consultative Group on Appropriate Industrial Technology, 14-16 November 1977	ID/WG.264/4
Reorientation of Industrial Strategy in Developing Countries and Selection and Application of Appropriate Industrial Technology	ID/WG.279/4
Draft Report of the Second Consultative Group on Appropriate Industrial Technology, 26-29 June 1978	ID/WG.279/12
Industrial Development Strategies and Choice of Appropriate Technology in Developing Countries	ID/WG.282/113
Operational and Policy Choices for Technology and Industrialization in Developing Countries	



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