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WORKING GROUP ON CONCEPTUAL AND POLICY FRAMEWORK FOR APPROPRIATE INDUSTRIAL TECHNOLOGY

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INDUSTRIAL DEVELOPMENT STRATEGIES AND
CHOICE OF APPROPRIATE TECHNOLOGY IN DEVELOPING COUNTRIES,

~~Background Paper~~

Industrial Development Strategies and Choice
of Appropriate Technology
in Developing Countries*

Note prepared by the secretariat of UNIDO

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The concept

1. Appropriate technology is not an absolute concept. The Second Consultative Group on Appropriate Technology convened by UNIDO defined the term "appropriate technology" as technology that contributes the most to the economic, social and environmental objectives of development. It is relative to three sets of factors: development goals, resource endowments and the economic and social milieu for its application.
2. While seeking to achieve an aggregate growth of their economies, developing countries have set diversified goals for their development. Aggregate economic growth by itself is not enough. These countries have come to recognize that the economic progress they have achieved has not benefited the poorer sections of their communities, estimated to number around 40 per cent. The poor living in villages and shanty towns have remained largely without participation in production gains, have suffered from open or disguised unemployment and being with little or no incomes, the goods and services they need have either not been produced or, if produced, these have not reached them. Industry, the most dynamic element in economic growth seems to have passed them by. Redistribution of incomes, meeting the basic needs of the poor and provision of employment have, therefore, been added to economic growth among the more urgent goals for development.
3. Resource endowments are the means to achieve the given developmental goals. Resources can be classified broadly into two categories: natural resources and human beings. Developing countries have not yet fully explored or exploited their natural resources of water, energy, mineral products. Nor has the vast potential of human resources been effectively tapped through investment in skills or creation of opportunities for productive engagement.
4. The third set, the economic and social milieu, includes a number of factors some of which cannot be changed over the short period. These are climate, environment, social structure of the population, traditions and cultural background. Others, while they should be considered fixed at the time of determining a development strategy, could change in the course of its implementation. These factors are the size of domestic and foreign markets, balance of payments, and economic (transport systems, energy development) and social (educational status of the population, health conditions) infrastructures.

5. It is clear, therefore, that no technology in itself is either appropriate or inappropriate. It becomes appropriate through an exercise of choice based on defined strategies for development or informed judgements encompassing the above sets of ends, means and conditions.

Development strategies

6. Appropriate technology, or as mentioned above, the choice of technology appropriate to development goals, resource endowments and economic and social milieu, is only a sub-aspect of the overall development strategy. The first policy issue, therefore, is an appropriate development strategy for resolving the macro-economic and social problems of poverty and unemployment. If the development strategy is not right, appropriate technology by itself will not be able to resolve the macro-problems of poverty and unemployment.
7. Most developing countries have followed policies and programmes in a manner that industrial progress has been concentrated only in organized urban sectors, which have attained high levels of prosperity. The rest of their economies have simultaneously co-existed with poverty, unemployment and unfulfilled needs. Not only has industry kept away from the rural sector, but in most countries it has restricted itself to a few large urban or metropolitan centres and thus bypassed the smaller towns and market centres. Introducing considerations of appropriate technology by itself without changing this lop-sided pattern of industrial development will only be skirting the problem.
8. A basic development strategy oriented towards meeting the primary needs of the poor has to be an integral element of economic and social planning of the developing countries. Relying on market forces alone leaves the poor out of the system. The vicious circle of unemployment - poverty - unfulfilled needs can only be broken by a conscious and predetermined national policy (and a plan) for providing employment opportunities for the production of goods and services in the areas where the poor live and meeting their basic individual and communal needs. Once these areas start humming with activity market forces could take over. Initial industrial investment into producing basic necessities would create both incomes and demand and, through multiplier effects, create the necessary conditions for the mushrooming of service establishments which often account for a larger portion of productive

income and occupation outside of agriculture in developing countries. Most of these industries and service-establishments will have low capital-intensity and high employment-intensity.

9. The major solution to the problem of unemployment lies, therefore, in an appropriate choice of industries (including service establishments) within a development strategy that is intended to employ the poor in producing goods and services they need. And if this is done in the areas where they live without dislocating them, creation of shanty towns and urban slums would also be avoided. Such a policy of moving away from conglomeration and concentration has been described in a UNIDO paper^{1/} under the term "decentralization" or "dispersal" of industrial activity. It is something more than what is usually included under "rural development" or "rural industrialization".

10. The plea for "decentralization" or "dispersal" does not imply a negative policy towards the "organized" or "modern" sector. The modern sector must continue to receive maximum impetus where market or technological conditions require it. In the export sector, quality and cost considerations might also make it necessary to employ modern large-scale methods of production. But in such cases, it must be a high-productivity sector, creating the "surpluses" needed for investment in and outside of the sector. The early industrial progress of advanced countries was largely financed by surpluses from agriculture and trade. On the other hand, the agricultural or traditional sector in the developing countries, except in a few export-oriented countries, is not capable of providing surpluses to support the "dispersal" process. The traditional economy carries the burdens of large populations and low productivity and is in need of investment. Such investment has to come from the modern sector, be channelled from the economy as a whole, including high-profit industries.

11. Economic policies pursued by the developing countries, on the other hand, have been reversed. For reasons of price stability, agricultural prices have been kept at relatively low levels, whereas the modern sector which has benefited from low agricultural prices has been given protection and an absence of competition. This monopolistic situation of the modern sector has turned the terms of trade against the traditional economy.

^{1/} "Towards a Strategy for Industrial Growth and Appropriate Technology"
ID/WG.264/1

12. The second element of the development strategy is the creation of basic industries. For large countries, these basic industries have been identified as iron and steel, power, fertilizers, petrochemicals etc. These are heavy capital-intensive industries, but these secure large "external economies". They give rise to a host of subsidiary and auxiliary industries. While the concept of "basic industries" has been used to denote these capital-intensive, large-scale industries, it need not necessarily be so. The engineering industry is also a basic industry, although it can be developed in small-scale units and is labour-intensive. The development of a labour-intensive tourist industry could also be a basic industry in certain spots. The establishment of such basic industries could be governed by technology or market considerations such as the availability of necessary raw materials or power or port facilities, etc.

13. The third element of the development strategy is technology development and transfer. Significant gains in productivity can be attained by injecting science and technology into the economic system. This fact is coming to be increasingly recognized in economic studies explaining the post-war economic growth in Europe and the dynamic growth of the economy of the United States over a longer period. The great economic distance between the advanced and developing countries is paralleled by a similar gap in the employment of science and technology. The gap could be considerably narrowed by a massive application of adaptive research and already known knowledge to the practical tasks of production. The gain in productivity would release resources and create incomes which could then be utilized for creating additional employment, production and incomes. Even if the initial introduction of technology leads to the reduction of some direct employment in the affected economic sector, the gain in productivity should create conditions for increasing employment in the rest of the economy. Technological progress should not be held back just because it threatens unemployment in the affected sectors over the short run.

14. It is in this context of a highly productive modern sector, a revitalized "traditional" sector, and a technologically-oriented production system that the search for appropriate technologies should assist in achieving development goals.

Macro-economic policies

15. Most developing countries have economic plans which in their introductions stress the need for meeting the basic necessities of the poor, provision of employment and removal of poverty. Since poverty resides, among other places, in the rural agricultural areas of the countries, the development of agriculture and rural infra-structures is given the necessary priority and the rest of the development is supposed to take place in the "modern" sectors - industry, trade, transport, power, construction and government. It is assumed that aggregate economic growth resulting from agriculture and other sectoral developments will take care of the major problems of poverty through "trickle-down" effects. There will be a general "diffusion" of welfare even though cognizance is taken of the maldistribution of incomes. Experience, however, has shown that, despite the attempts of governments to take corrective measures through fiscal action, the poor are left out of the system altogether, primarily because they remain unemployed or only intermittently employed. Agricultural progress benefits those who own or have access to land, and other developmental sectors concentrate the gains only to those who have found employment in the organized urban areas. The rural economy pushes out those who are left out, the urban centres attract them, but when finding no employment they live in shanty towns and slums, side by side with those who have benefited from development.

16. Planning for the poor, therefore, cannot be done on the broad assumptions of aggregate economic growth and general diffusion of benefits through the market mechanism. A direct attack has to be made on poverty. The best manner of doing that is providing the poor with employment. Jobs could be created by investment into industries which produce goods and services to meet their basic personal and collective needs. These should be quantified and met in the same way as we plan for meeting educational and health needs. This cannot be left to market forces. A plan directly aimed at the poor has to be an integral part of the national plan.

17. These investments, moreover, should be made into the rural areas and small towns to prevent migration to metropolitan areas or even to attract back the slum dwellers. The policy of industrial location has simply been governed by technical considerations or, where these were unimportant, by personal living preferences of owners of enterprises. Even in those instances, where technical considerations have demanded the establishment of an industry in the rural areas, it has created an island of prosperity for a few and often put a burden on the others. For instance, the establishment of an oil refinery in the countryside in one developing country, provided high-wage employment to some one per cent of the labour force. The spending of the employed workers raised costs all around and put additional burdens on the vast majority of workers who did not find employment either in the refinery itself or in secondary occupations resulting from the establishment of the refinery. However, the inflation affected them all. By and large, industry has concentrated in a few organized urban centres which have also experienced an inordinate growth in the number of residents. The rapid growth in numbers has overtaken any possible improvement of the urban infrastructures. The urban facilities - sanitation, transportation systems, etc. - have been overstrained and threaten a breakdown in a number of large metropolitan centres in the developing countries. For the non-metropolitan areas, on the other hand, outside of agriculture and housing constructions, neither the public nor the private sector has paid much attention to establish industry or other sustaining elements of economic growth. A policy of providing employment to the poor must, therefore, seek a decentralization of industry from the metropolitan areas and a wide "dispersal" into small towns and the rural areas.

18. Thirdly, employment creation itself is not a goal; the goal is to create productive and efficient employment. It should be productive and this would add to national output and not merely redistribute it. And it should be efficient. In being efficient it would make an optimum contribution which, in any case, should be in excess of the wages paid. The wages paid can be reckoned in terms of private or project costs or social costs. Where the industries are to be organized in the private sector, wages will be determined by market forces. If these are above social costs

the burdens have to be shifted from the specific industry to the community as a whole through subsidies on employment or price adjustments on products. Only a few societies are in a position to make countervailing adjustments for the difference between private and social costs; for most other economies market wages will have to be taken into account for measuring efficiency.

19. For demand reasons, dispersed industries producing the basic necessities will be on a small scale. On the other hand, the established industries in the modern sector have been organized to provide for larger markets and to benefit from the economies of scale. Technology, mostly imported from advanced countries, has favoured the establishment of large-scale plants and economy in the use of labour by the substitution of machines. The resources endowments of the developing countries dictate otherwise, and this will be particularly so for the industries to be established in rural areas and small towns. However, scaling down of technology which favours large-scale production raises costs for small-scale production. The search for an appropriate technology becomes a cardinal element, therefore, within the context of industrial dispersal, although it is also important for the modern sector, not so much for scale reasons as for those of resource endowments.

20. A policy of industrial decentralization and dispersal should be accompanied by the establishment of "basic" industries. As mentioned before, basic industries need not necessarily be heavy or large-scale. But the establishment of those industries should rapidly provide a stimulus to the growth of a number of ancillary or subsidiary activities, or promote exports or meet some critical domestic needs. These industries would mostly be in the modern sector and many would require sophisticated technology, if they are to compete in foreign markets, or in domestic markets with imported goods. The concept of appropriate technology, here, would have to be "advanced" technology. But, by and large, the technology in the modern sector will also have to be selected in relation to the resource endowments of the country concerned. Various alternatives will have to be examined. And this has particular relevance to the objectives, resource endowments and conditions of application in the importing country. The question of "appropriateness" thus becomes all-pervasive.

Technology policies

21. Many developing countries present a dual character in the technology they employ in utilizing their resources to produce the goods and services they need. Their modern sectors rely upon imported technologies whereas, at the other end of the scale, the rural economy particularly the non-market sector, relies primarily on the age-old traditional technological solutions. Technology policies in the developing countries, therefore, have three tasks: evaluation and upgrading of traditional technologies; application of modern science and technology with the assistance of research and development, that is "technology transfer" in the broad sense; and absorption, with or without adaptation of foreign-owned technology, that is "international technology transfer" in the narrow sense.

22. The important task of evaluating and upgrading the traditional technologies so that the poorest sections of the community are able to improve their levels of living has hardly received the attention it merits. Only in a few countries have research institutions begun to give attention to the traditional technologies used in food processing, construction, energy production and craft industries such as textiles, smithing, pottery, woodworking, basket weaving, etc. But what is needed for the traditional sector is a complete inventory of the technological processes and equipment used in production in all its aspects and mounting of a concerted effort at a scientific examination of these processes and the equipment employed individually with a view to improving output and efficiency. India, for instance, has sought to improve the performance of the bullock cart by introducing ball bearings in the wooden wheels in the rural areas or adding pneumatic tyres for hand-down carts in the urban areas. Bicycle frames have been used to support heavy loads in the United Republic of Tanzania. There is, therefore, a tremendous scope for upgrading traditional technologies which would not only be appropriate to the requirements and situation in the dispersed sectors of the developing countries, but also increase efficiency.

23. There are two points in this respect. Firstly, the rural community is generally tradition-bound and sceptical of innovations, often justifiably so in the light of past experience. The best way of approaching technical improvement is to select an enterprising farmer or artisan, to get him or her to accept the innovations and produce the results. The demonstration effect of a concrete success provides a much stronger stimulus than exhortation at a gathering of rural workers, even if backed up by slides illustrating laboratory successes. Secondly, any innovations introduced should be such that the traditional economies can handle themselves, or at best those that can be handled at the national level. If improvements are largely contingent on imports of machinery or materials, under the critical foreign exchange situations which have chronically or intermittently afflicted the developing countries, the economy may be subject to serious dislocation. Subject to these provisions, a massive application of science and technology to the traditional sector would open up possibilities of growing new crops, reducing the need for imported items of food and raw materials, discovering suitable materials for housing, fuel and clothing and thus make the countries more self-reliant in meeting their basic needs.

24. Consideration of the traditional sector already leads into the question of the application of modern science and technology to production with the assistance of domestic research and development. Governments of several developing countries have been generous with the establishment of research facilities at universities and specialized institutions. The research work performed in these institutions has sought justification on the grounds of relevance to development objectives and some of it has been quite good. What is missing, however, in most developing countries is, firstly, an estimate of the total volume and distribution of the nation's research and development effort required to achieve the development objectives. Secondly, not enough attention has been given to the "development" side of R and D. Much more of national resources need to be devoted to this rather expensive aspect of technology development, if the research is to bear fruit. Thirdly, countries need to examine ways and means for making research less import-intensive. Not only are there direct costs of laboratory equipment, books, vehicles, etc. which have to be imported from abroad, but the patterns of living and working of the scientists also tend to be import-intensive.

25. Research, however, is only one end of the spectrum of science and technology policy and activities. A number of linkages have to be established if modern science and technology is to be applied to production. These are development, prototype testing, pilot plants, extension services, testing laboratories, standards institutions, information networks, technology examination and monitoring services, project planning and evaluation, equipment repair and servicing, management development and technical training and education. Technology development or determination of appropriate technology requires such a technological infrastructure of institutions and services if it is to be effective.

26. The other end of the spectrum is the apex structure for science and technology policy-making. Several countries have considered the alternative of establishing a technology ministry headed by a minister of the government. The ministry is in charge of identifying the technological needs and objectives of the nation; in several instances preparing and implementing integrated technology plans and monitoring technology acquisition. It need not necessarily administer the various scientific programmes, but has a voice and representation backed up by financial resources on all programmes which involve science and technology. The government consults the ministry on the technology aspects of the proposals - be they for the establishment of industries or for determination of import policy. The minister for technology, being a member of the government, participates in all these decisions. The process of consultation on technology matters thus becomes a matter of routine rather than remaining an ad hoc process.

27. For their industrial development, for the most part, the developing countries depend on foreign-owned technologies. In respect of these, the policy goal should be the attainment of technological independence, at the minimum, in two respects. Firstly, developing countries should be able clearly and precisely to enunciate what they want, and secondly, to evaluate the appropriateness of what is being offered. In these respects, they cannot rely on the suppliers of technology, very often the salesmen hired by equipment manufacturers. Building up a national capability and self-sufficiency in these two respects is a must. It would involve the building up of a cadre of industrial economists and technical personnel who are experts at project formulation, who can disaggregate or unpackage the technology

with a view to having some of it obtained from domestic resources, discarding what is inessential or unsuitable and buying only that part which is absolutely essential. The countries should, moreover, regularly monitor the inflow of foreign-owned technology as to its impact and incidence on domestic technological progress.

26. The establishment of an engineering industry constitutes an essential item in the technological infrastructure for developing countries. It establishes the very essential skill base for technical progress. It permits the indigenous development of appropriate technologies and their innovative developments. It helps to eliminate the critical shortages of spare parts experienced by many developing countries. Because of the "external economies" it provides to technology development in the rest of the economy, it could be included as a "basic industry" the establishment of which was recommended in the preceding section. It is labour-intensive, it can be diffused in location and it helps to create an industrially-oriented labour force. Learning to tinker with things is the first stage towards the discovery of appropriate technology, and there is nothing better than mechanical, electrical and electronic workshops to give this necessary on-the-job training.

29. As a concrete embodiment of the articulation of their technological policies and programmes for building up technological infrastructure, several countries have prepared or are in the process of preparing technology plans. A country wishing to prepare such a plan may take into consideration the following essential ingredients described in a UNIDO paper^{1/}:

- (a) The identification of technological needs in terms of processes and services in critical and priority sectors of growth in each country;
- (b) The establishment of a comprehensive information system which would assist national institutions and enterprises in providing information on alternative techniques and processes;

^{1/} "Reorientation of Industrial Strategy in Developing Countries and Selection and Application of Appropriate Industrial Technology" ID/WG.279/4, dated 20 June 1978, paragraph 13.

- (c) The growth of technological service capability at various levels of development, including capacity for engineering and design;
- (d) The creation of institutional mechanisms for screening the selection and acquisition of foreign technology considered more suitable or appropriate in a given set of circumstances;
- (e) The development of institutional facilities for monitoring the impact, absorption and innovations in respect of foreign and indigenous technology together with the growth of R and D activities in important sectors;
- (f) The defining of a suitable policy package for the rapid growth of indigenous technological development.

30. Where an economic plan exists, the technology plans should be closely integrated with it in its dual role: the development of the technology sector itself and the utilization of technology as an instrument in achieving the development objectives in other sectors.

Appropriate technology

31. To achieve the major objectives of development already outlined, a framework of appropriate economic and technology policies (and planning) has to be established. Within such a context the selection of appropriate technologies becomes an essential and all-embracing element of the development strategy.

32. In the dispersed sector, there are two distinct elements. The first is the very traditional rural agricultural population. Here the problem is one of disguised unemployment. The agricultural workers have full-time employment for only a few days in a year, generally at the harvest time, and partial or no employment in the rest of the year. Their incomes could be supplemented by industrial work, if it could be so organized that the families can work in their own cottages and in their spare time. There are several industries which promise a disaggregation of technology to enable such a recourse. For instance, in the field of textiles, technological requirements indicate modern production methods for producing yarn. But weaving could quite well be done in the cottages with the help of one or two handlooms or powerlooms, if power is available. The finishing of cloth and marketing again require the facilities of the organized sector. Provision of such industrial work without dislocating the rural agricultural economy would not only be feasible, but appropriate. The usual

migrations from rural to urban centres for industrial employment cause labour shortages in the rural areas during the periods of high agricultural activity at the same time as cities develop slums. By taking work to the people where they live, not only the labour of the migrant young persons is utilized, but that of the whole family; at the same time the young are available to perform agricultural tasks. Of course, there are organizational problems involved, but, by and large, it is easier and cheaper to move materials than people. And it is not new. Many developing countries have production systems organized on a cottage basis. The need is to look into technological possibilities of extending the scope of cottage production to non-speciality industrial products.

33. An additional aspect of assisting the traditional rural workers is upgrading of the traditional technologies and making them more appropriate by the injection of modern science and technology. This aspect has already been referred to in the preceding sections.

34. The second element is the large number of people residing in the market centres, smaller towns and those who have to be brought back from slums and shanty towns. The policies recommended here were investment into industries producing goods and services which the poor consume. The demand for these would obviously be created, if employment brings in incomes; the needs are already there. Investment should be possible through resources mobilized through the organized sector, including the banking system.

35. The question of appropriate technology here is one related to scale. Undoubtedly such dispersed units would be small-scale units. The search for appropriate technology here will have three aspects: product alternatives; process alternatives; and substitution of local materials. Firstly, many industrial commodities permit product variations which enable small-scale production without loss of efficiency. The making of Portland cement or refined crystal sugar might require large-scale units. And if the technologies used in these units are scaled down, costs per unit of product might rise. But one does not need Portland quality of cement or refined crystal sugar to meet the needs. Many structural requirements of the small towns and rural areas can be met by cements of a lower standard such as puzzolana cement, or refined crystal sugar can be replaced by brown sugar or

jaggery. The second aspect will be examining alternative technologies. Many of the modern technologies were developed through several stages; some of the now obsolete processes in the advanced countries might be more suitable to the resource endowments, particularly of labour, of the developing countries. The sectoral papers have outlined such alternative processes which are appropriate to small-scale production. Thirdly, the developing countries have hardly examined their own natural resources with a view to utilizing them or processing them so that they can replace imported raw materials. Local oils could replace imported oils for making soap; a pottery industry could be established on the basis of local earth and clay.

30. The modern sector faces a diversity of situations. Most of the technology is foreign, although not all of it is foreign-owned and, therefore, to be paid for. All of it, however, needs to be evaluated against the criteria of "appropriateness". Most of the technologies in the modern sector are embodied in processes and machines developed in advanced countries with the aim of saving on imported raw materials and labour. The processes could be disaggregated but not the machines. And the disentangling of processes without the possibility or capacity of adapting the machines might leave little choice in practical terms for the developing countries in the initial stages of development. It is only when the required technological infrastructure, including establishment of engineering industry is built up that the developing countries will be able to achieve their technological self-reliance. It is then that institutions and enterprises in developing countries will be able to ensure that foreign technology which is acquired is suitable and appropriate to local conditions and that such acquisition is consistent with domestic technological development. With progressive industrial development, paid-for imports of technology could be reduced. "Turnkey arrangements" can be reduced to "limited licence arrangements" for acquiring only the designs and know-how; foreign plant engineering and other services can be replaced by national enterprises. More locally produced components should reduce the need for imported parts. Thus "appropriate technology" and "technology development" move in parallel directions, replacing foreign elements by domestic ones.

37. On the other hand, as has been mentioned already, that while appropriate technology in general terms would refer to labour-intensive methods or be related to small-scale production, in several heavy or export-oriented industries, the most appropriate processes could well be capital-intensive, sophisticated and related to large-scale production. Even so, this may not be all that clear; there may be a built-in long-term dependence on imported components and spare parts with relatively high costs. Regulatory institutions which have been set up in a number of developing countries for screening proposals relating to foreign technology, in addition to looking at the conditions of technology contracts, need to develop greater experience and expertise in evaluating technological suitability and alternatives in the modern industrial sector.

38. Finally, it must be stressed that the technological dualism between the modern sector and the dispersed sector, although broadly real, is not sharp and clear-cut. It represents the two extremes: one where modern industrial technology has played a dynamic role as an engine of economic growth and the other which continues to remain tradition-bound and poor. In most countries, there should be a continuing effort towards narrowing the gap between the two.

Major policy issues

39. It is clear from the foregoing discussion that policy issues in the field of appropriate technology are closely interwoven with those of an appropriate development strategy and corresponding macro-economic and technology policies.

40. The first issue is the nature of the apex structure, mechanisms and procedures by which governments of developing countries can arrive at decisions concerning technology development, acquisition and transfer. There is a two-fold task: direct overview function of national technology policy-making, planning and budgeting; and harmonizing the programmes of other ministries in dealing with special aspects of science and technology in their respective areas. Several developing countries have appointed ministers responsible for science and technology, some of these have established ministries dealing specifically with technology. In other countries, the apex body is one step removed from the day-to-day operations of the government. Science and technology councils

or other similar bodies have been appointed primarily for research and in an advisory role at the policy level. Actual decision-making is undertaken by individual ministries or public corporations in their respective areas of competence. In all cases, the apex bodies are at or near the centre of the government and indicate the recognition of the clear need "for means whereby scientific and technological activity can be brought and kept into a more coherent and purposive relationship with the way national goals and objectives are selected and pursued."^{1/}

41. The second issue is planning. While economic plans have been prepared in most countries, technology plans are a relatively new development. More and more countries, however, are moving towards this direction. The technology plan should enumerate national development objectives and priorities, the policies to be pursued, the programmes to be implemented and budgeting not only in terms of domestic outlays, but also in terms of foreign exchange and skilled manpower requirements to conduct and manage the programmes and institutions covered by the plan. Skilled manpower, particularly at the management level in science and technology is indeed scarce and subject to "brain-drain". The plan should indicate long-term perspectives as well as a medium-term (five-year, seven-year) plan-period. Generally, the plan-period should be consistent with that of the economic development plan. The contents of the plan would include the requirements of the developmental needs of the technology sector itself, as well as technology inputs required for achieving the developmental objectives in the other sectors. The plan should clearly outline the parameters for assessing the technology needs for each of its major sectors and should make provision for continuous monitoring as needs will change with growth. The programmes should be broken down into instruments of action needed: research and development; design and engineering; extension services; institutional mechanisms; and education and training. The proposals as elaborated in the various sectoral reports could be developed by organizing sectoral panels for major industry groups. And since there is never enough money, foreign exchange or manpower to do all the things that need to be done the important question of priority allocation has to be tackled: where will the scarce resources give the most results? What can be quickly realized? What programmes are addressed to critical short-term problems? The preparation of a plan will thus be a balancing

^{1/} "Science, Technology and Governmental Policy", UNESCO/MINESPOL II/3 September 1978, page 7.

act and require trade-offs. But this is a necessary exercise. The alternative is ad hoc responses to a welter of unco-ordinated and unevaluated action proposals.

42. The third issue is one of resources to be devoted. A great deal of attention has been given in recent policy discussions on the resources to be allocated to research and development. For the developing countries, UNESCO regional conferences on Africa, Asia, and Latin America have recommended one per cent of gross national product. Current expenditures in most countries range around 0.25 to 0.50 per cent only. These, therefore, have to be expanded to take in the vast volume of research, development and design engineering required to upgrade traditional technologies, evaluate and adopt modern technologies, and analyse and discover new uses for local materials. The sectoral papers prepared for the Forum indicate clearly that a large volume of new and adaptive research is required to move appropriate technology from a subject of discussion to one of reality.

43. In addition to research and development, the developing countries need to build up a technological infrastructure of institutions and services with the requisite manpower for the massive application of already known knowledge to practical production of goods and services. No estimate of the resources required here can be given in definite terms. But perhaps an additional two per cent of GNP might be taken as a norm against which individual countries might wish to measure their needs and resource availability in the course of framing their technology policies or plans. If the dispersed sector is to be activated, linkage institutions with the modern sector will have to be developed. One of the background papers deals with the establishment of rural workshops to train the rural population in some of the essential engineering trades, to equip rural artisans with knowledge of repair and maintenance of simple farm machinery, to transfer modern skills in the manufacture of components or sub-contracts from organized sectors, and to eventually transform them into small rural industries producing equipment of simple designs. Many sectoral papers have also emphasized the very strong need for standards institutions and adoption of national standards.

44. Two additional and critical elements of technological infrastructures are information and training. Every country needs to build up an appropriate framework for the collection and processing of technological data from various sources and combining them to produce the desired technological input for national economic, technological or industrial decision-making. This is particularly important in acquiring foreign-owned technology. The other critical element is technical and management training and the relationship of such training to the general systems of education.

45. Should the countries set up a central institution for appropriate technology? Many countries have considered this question in the affirmative and made proposals for the establishment of such institutions. There is undoubtedly a need for: a central overview of the technological needs of the country in the different economic sectors or branches of production; an inventory of the technologies in use in the traditional and in the modern sectors; identification of the research and engineering effort required to upgrade and adapt these to make them "appropriate", and to review internal technological development and monitor the inflow and operation of foreign-owned technology. Where suitable regulatory bodies exist, they could take up such functions and a central institution can be assigned the functions of technology supervision and funding of research. As mentioned earlier, appropriate technology question is all pervasive; every industry, research institution and government department will have to examine the technologies in the areas of its concern and undertake the necessary evaluation, research, development and design work to make them appropriate to the country's development goals, resource endowments and conditions of their application.

46. The next issue is policy with regard to the acquisition of foreign-owned technology. Although technology agreements take place between private parties, government policies and regulations are required to secure an appropriate choice and application of technology in the different sectors. The government could announce in an industrial policy statement the fields in which the country would welcome foreign technology and the type which it would like to acquire. Regulatory institutions could add to their functions of reviewing terms and conditions of acquisition the requirements.

of technology suitability. What is needed is a more expanded and more active role on the part of the regulatory agencies in respect of technology decisions than has been the case so far. A critical need is the building up of a cadre of able negotiators backed up by an institutional network of pertinent information and consultancy services. Availability of negotiating assistance through private or governmental consultancy services can be a great help even if the technology negotiations remain the ultimate responsibility of user enterprises.

47. To what extent should regulatory fiscal and credit mechanisms be used to secure appropriate technology in the modern and dispersed sectors? In a sense, both sectors may stand in need of protection. The growing medium- and small-scale national enterprises might be threatened by the operations of transnational corporations and the economic pressures they could bring to bear upon the nascent or infant industries of the developing countries. And similarly, the infant industries of the dispersed sector might be threatened by the more sophisticated and powerful industries in the modern sector. All protective measures involve shifting of burdens irrespective of the method adopted. Undoubtedly, activity and employment in the protected segment will be stimulated. But the cost of such stimulation through protection is borne by other segments or the community at large. While employment and productivity gains in the protected segment are visible and yield political dividends, the off-setting losses of potential employment and productivity in the other sectors of the economy are invisible and likely to be overlooked. In general, protective measures through the fiscal and monetary system are justifiable only under certain conditions. Firstly, they could be effectively employed where the segment is sought to be protected against monopolistic pressures which is often the case with the operations of transnationals in the developing countries. Secondly, if the protection is for a short period required to build up the necessary experience and skills, then the cost to the community is considered as infra-structural investment.

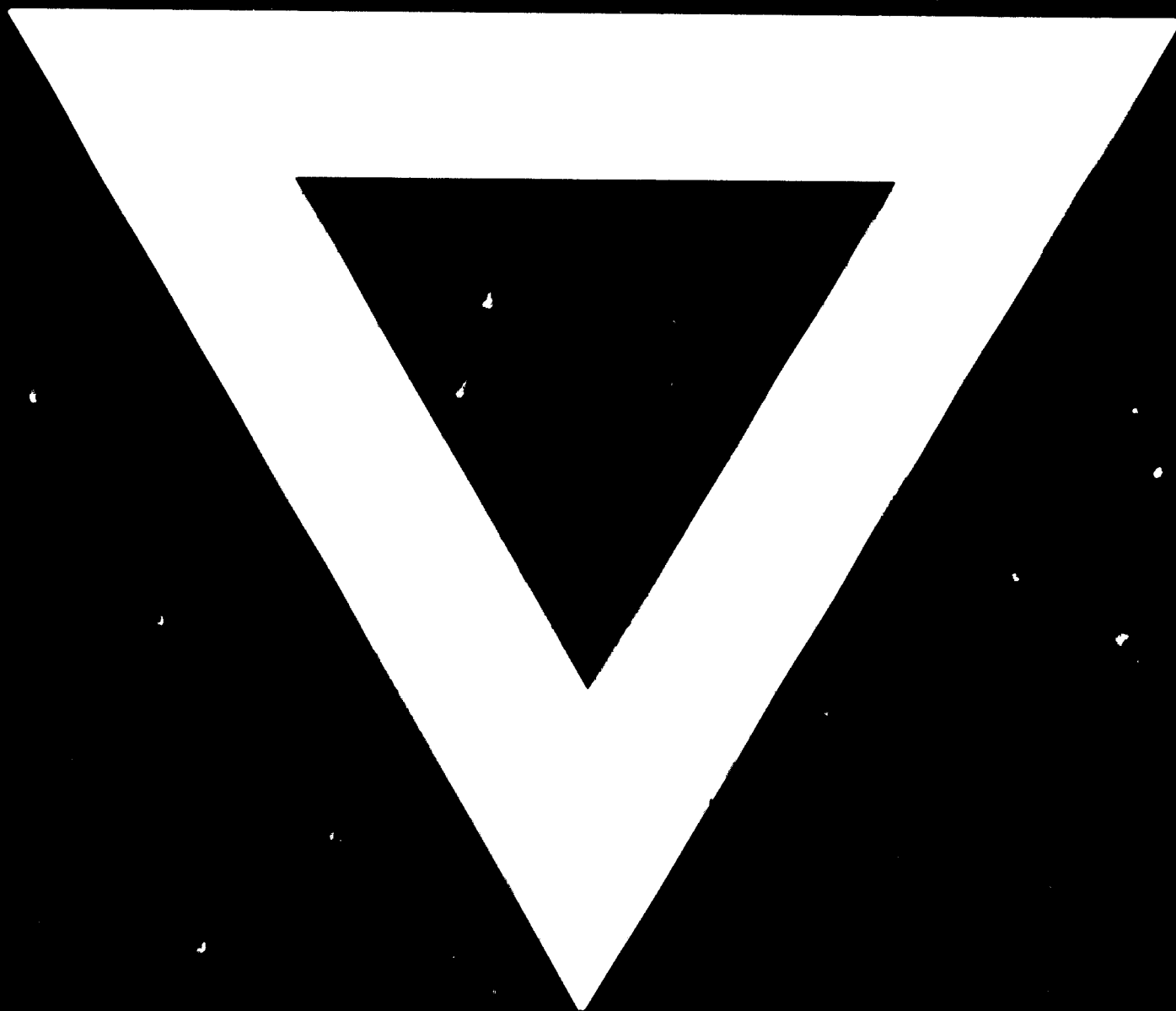
48. There are many instruments to implement such a policy of resource transfer: reservation of fields of production; physical allocation of scarce essential inputs; allocation of investment money; regulation of production capacities or output; discriminatory credit policies; tax concessions and disincentives; subsidized provision of infrastructural facilities; preferential purchase arrangements; import controls; and price controls. The governments of the developing countries have already used packages of such policy instruments and could continue to do so. Every sectoral paper also pleads for protective measures for the specific sector. However, these regulatory, fiscal and financial measures are delicate instruments and countries will have to develop a fine degree of administrative sensitivity and capability, if they are to be efficiently used.

The following background documents are being circulated:

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| 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 Approp-
riate 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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