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PREPARATIONS FOR THE UNITED NATIONS CONFERENCE ON SCIENCE AND TECHNOLOGY FOR DEVELOPMENT

Science and technology and the concept of development

Consolidated paper related to the discussion of items 4, 5 and 6 of the provisional agenda of the Conference, prepared by the Secretary-General of the Conference

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** Section V relates to item 6 of the provisional agenda for the Conference. It constitutes the first part of the relevant section of the discussion paper referred to in decision 16 (IV) of the Preparatory Committee (A/34/43, Vol. II). The consolidated views of the organizations of the United Nations system on the proposals contained in this section will be issued separately.

NOTE

1. At its second session the Preparatory Committee for the United Nations Conference on Science and Technology for Development decided 1/ that discussion papers should be prepared on agenda items 1 to 3 (now items 4 to 6 of the provisional agenda), "setting out synthetically the issues, conclusions and recommendations presented in the national papers and the reports of the regional meetings". At its third session the Preparatory Committee decided 2/ that these papers should be integrated into one consolidated discussion paper of approximately 50 pages in length.

2. As the substance of item 4 (d) of the provisional agenda (New science and technology for overcoming obstacles to development) deals with specific sectoral areas for possible action by the Conference, the Secretary-General of the Conference has thought it preferable to discuss it in a separate paper rather than in the present document, which covers the items and subitems dealing with more general and horizontal issues.

3. In preparing the present consolidated paper, the Secretary-General of the Conference has felt it desirable to preface it with a brief treatment of the concept of development that is progressively emerging in the international community since any decisions, if they are to be relevant to the objectives of the development strategy now being elaborated and to the New International Economic Order, must be made in this context. The paper should be read in the context of other documents of the Conference and especially of the analysis presented in the regional papers, 3/ the documents relating to agenda item 7 (Science and technology and the future), 4/ and also the background documents prepared for the Conference by organizations of the United Nations system.

1/ Official Records of the General Assembly, Thirty-third Session, Supplement No. 43 (A/33/43), annex II, decision 4 (II), sect. I.A.

2/ Ibid., Thirty-fourth Session, Supplement No. 43 (A/34/43), Vol. I., annex II, decision 10 (III).

3/ A/CONF.81/PC/14/Add.1, A/CONF.81/PC/15/Add.1, A/CONF.81/PC/16/Add.1, A/CONF.81/PC/17/Add.1, A/CONF.PC/18/Add.1.

4/ A/CONF.81/5.

I. CONCLUSIONS AND SUMMARY

4. Preparations for the Conference have revealed a widespread consensus that the concept of development, which focuses primarily on economic growth, needs to be reviewed in relation to the application of science and technology. In the view of the Secretary-General of the Conference, this broadened concept of development which emerged from the "national and regional analysis of relevant socio-economic problems which may be solved with the help of science and technology" (Economic and Social Council resolution 2028 (LXI)), can be characterized in the following 12 points:

(1) Development shall be comprehensive. That is to say, it must transcend exclusively economic dimensions in order to include such social considerations as adequate provision of food, health, suitable living conditions, and employment. It also should embrace the need for cultural and spiritual self-realization as well as promotion of creativity, improved quality of life, and safeguarding the rights of man.

(2) Development should have endogenous roots and not merely imitate models. Consequently, styles of development should not only be diverse and respond to country-specific economic and social structures as well as the natural and human environment and cultural identity, but should also be in accordance with national objectives and the way each country perceives its own future. Viewed in this light, the concept of "gap" between developed and developing countries now acquires a different significance. While the need to reduce sharp contrasts in standards of living remains, the heretofore limited concept of the "gap" defined somewhat negatively on the basis of external economic indicators must be redefined in order to allow for a more positive strategy of development.

(3) Development should be self-determined and self-generated. This applies not only to the capability for selecting a developmental style, but also to ensuring elimination, or at least reduction, of dependency and vulnerability, by such means as creating larger and stronger markets in the developing world and also by ensuring an autonomous base for production of food and other basic goods.

(4) Development should be approached co-operatively and collectively. Full self-reliance cannot necessarily be achieved by national effort alone. Often, and indeed in most instances, self-reliance is achieved in a broader context - either "horizontally" by co-operation among developing countries, or in a "triangular" pattern, that is to say, with the added participation of developed countries.

(5) Development should be integrated. "Truncated" growth in certain sectors - usually a consequence of redeployment policies of transnational corporations - is not concordant with real development but causes ever-growing dependency and vulnerability. Strong horizontal and vertical linkages must bind the various productive sectors together (in particular, agriculture and industry) and ensure their concerted and harmonized interdependence so as to meet national supply and demand.

(6) Development must respect the natural and cultural integrity of the environment - as well as the traditional social structures of a country which are necessary for the

preservation of its cohesion. This requires the safeguarding of the national heritage and its protection against imposed alien values.

(7) Development should be planned and requires constant attention from, and intervention by, national authorities without, necessarily, the exclusion of private interests and free-market mechanisms. It is now generally accepted that the free play of economic forces does not automatically lead to an equitable diffusion of scientific and technological potential but, rather, leads frequently to polarization and to concentration of capabilities and benefits in highly developed centres. The alignment of the interests of private enterprise with national objectives needs to be ensured by appropriate mechanisms.

(8) Development needs to be directed towards the establishing of a just and equitable social order. This requires, in general, structural transformations allowing for the participation by all sectors of the population in the benefits and not only the negative effects of science and technology. In developing countries, in particular, it is necessary to eliminate the dichotomy of demand that may exist where élites have consumption patterns similar to those in highly developed countries, in contrast to the mass of the population which does not participate in the market for lack of purchasing power.

(9) Development must be democratic in still another sense. It must respond to the choices made by the population as a whole. The idea that technological decisions are dictated by an inherent scientific-technological logic with an independent rationale of their own must be rejected. The goals of society are neither scientific nor technological, and science and technology must serve and not dictate to the people.

(10) Development must be competitive. It should not insulate less developed countries or regions to such a degree that they are, in fact, "enclaves", where they would barely survive and lead a marginal life far from the main flows of growth and dynamism. On the contrary, development should encourage active participation in a new optimal division of labour, which is at the heart of the objectives of the New International Economic Order. Such a new division of labour should lead to structural changes in developed countries which should promote expansion into new types of productive activities. This calls for the design of long-term measures as a part of the revision of the concept of development.

(11) Development should be innovative. It must neither depend on the import of outmoded technologies from developed countries, necessarily, nor upon advanced technology developed somewhere else. Only the mastery of world scientific knowledge - including the knowledge which for economic reasons has never been applied in developing countries - can ensure genuine, creative technological development.

(12) Development planning should be based on a realistic definition of national needs and on consumption models that are consistent with the national characteristics of a country including its resources, gross national product, capability for capital formation and effective interaction of science and technology with the productive sectors.

5. There are three observations which should be made with regard to the above concept of development:

(a) Three closely connected criteria govern the categorization of a country as developed in relation to science and technologyg: (i) the capacity to create and innovate; (ii) the elimination of economic and social dualism; (iii) the faculty for effective integration of its productive sectors;

(b) The broadened concept of development, within the framework of the New International Economic Order, implies not only modification of relations between States - particularly between developed and developing countries - but also social and economic adjustments within developed as well as developing countries themselves;

(c) Over the long term, there is a congruence of interests between developing and developed countries. In consequence, it is in the interest of developed countries to move to an effective promotion of development of the third world as a prerequisite of their own dynamic development over the long term, and away from the present short-sighted approach directed towards increasing benefits resulting from their monopoly of science and technology.

6. An important characteristic of this broadened concept of development, as mentioned above, is that science and technology should be integrated as a major contributing factor. It is now increasingly being realized that the problems of development, and particularly those of developing countries, do not lend themselves to mere sectoral solutions; they call for integrated approaches. It has also become apparent that economic growth does not automatically result in scientific and technological development. The existing science and technology framework is largely based on the structural concentration of science and technology generation in the "centre" of the present international system (the developed countries) and a process of selective, expensive and inadequate transfer of knowledge to the "periphery" (the developing countries), often on monopolistic and oligopolistic conditions. Science and technology need to be perceived as integral parts of a nation's socio-economic-political structure and their application oriented towards the elimination of obstacles which are a mix of historical, social, economic and political factors.

7. It is necessary to conceptualize science and technology more explicitly as a principal tool of development. The absence of this consciousness has been a major obstacle to the more effective application of science and technology for development and is a root cause of the gross imbalance in the development and distribution of global scientific and technological resources. It is now recognized that a more direct role should be assigned to science and technology in the formulation and implementation of international and national development programmes so as to ensure that their potential shall be fully utilized in the service of mankind in general and of developing countries in particular. To that end, the United Nations Conference on Science and Technology for Development should provide a comprehensive framework for such incorporation in national and international schemes in the light of the requirements of the New International Economic Order.

8. The need, it must be emphasized, is not merely to mobilize science and technology, but to reorient and redirect its potential to tackle development problems, especially on the developing world. In other words, what is needed is both quantitative and qualitative improvement of science and technology as instruments of development. The scientific and technological infrastructure of developing countries not only varies in quantity - whenever it exists at all - it is also often incompatible with over-all materail development objectives and priorities. The scientific and technological systesm of many developing countries have grown more as extensions or imitations of systems in the developed world, rather than as manifestations of national aspirations or as instruments of national self-reliance.

9. It is necessary for countries not only to formulate coherent science and technology policies but also to ensure that these shall be fully integrated into this over-all process of economic and social planning. In this context, countries must, as an integral part of the technology planning, acquire the capability for assessment of technological options.

10. The most fundamental aspect of an international strategy for the application of science and technology is its contribution towards redressing the global technological imbalance. It is evident that the technological dependence of developing countries cannot be remedied merely by greater technology transfer from developed to developing countries. What is needed is a fundamental shift in the "centre of gravity" of technological decision-making towards developing countries. The imperative is to enable developing countries to participate in the global scientific and technological system as full partners. Such a transformation cannot take place without basic structural alterations in the international scientific and technological institutions and systems, particularly in the developed world, where science and technology are at present concentrated. A fundamental change cannot in reality take place unless the whole perception of priorities and the scenario of self-interest in the developed world undergo a profound metamorphosis. It is also clear that the present political will and the public response in the developed countries are still inadequate for such a change. There is a need for a vigorous movement at the grass-roots level in the developed countries designed to promote a better appreciation of the dynamics of development and of the adjustments required in developed economies to establish the scientific and technological dimensions necessary for the implementation of the New International Economic Order which is not only beneficial but essential to both developed and developing countries.

11. Another essential element in any global strategy for the application of science and technology is greater emphasis on co-operation among developing countries. Indeed, the potential and the scope of this co-operation is such that it could greatly alleviate their technological dependence on the developed countries and dramatically alter the present global imbalance. Such co-operation, however, cannot be achieved by mere ad hoc arrangements, as the obstacles to such co-operation are partly political, partly historical and only partly economical. There are also powerful interests within developing countries as well as in developed countries which resist any attempt towards changing the present technological status quo in the developing countries with its dependence on developed countries. To bring about a significant measure of scientific

and technological co-operation among developing countries, the developing countries should institutionalize their scientific and technological co-operation through the establishment of appropriate bodies designed to serve as catalysts and stimulants. A built-in component of such institutionalized co-operation should be measures designed to overcome the special problems of the least developed and geographically handicapped developing countries which suffer from the almost total absence of scientific and technological infrastructures.

12. Notwithstanding the tremendous scope for greater scientific and technological co-operation among developing countries, a genuine commitment by developed countries is also essential to arrive at a reduction of the global scientific and technological imbalance. Indeed, co-operation among developing countries and co-operation between developed and developing countries are complementary and dependent on the sectoral needs and capacities of individual countries. The essential point, however, is that the current, largely bilateral, scientific and technological exchanges need to be supplemented with a greater measure of multilateral scientific and technological co-operation. While bilateral co-operation in science and technology will continue to play a role in the global scientific and technological system, it is only multilateralization that has the potential to make an impact on the technological dependence of developing countries. And that includes co-operation among developing countries, between developed countries and developing countries, between socialist developed countries and market-economy developed countries, and indeed even between developed countries of the same system. Multilateralization of scientific and technological co-operation constitutes a very important element in the new strategy for the application of science and technology.

13. An important prerequisite of real development is to increase substantially the science and technology expenditure of developing countries, bearing in mind in particular the Lima target set for achievement by the year 2000. 5/ Research and development constitute the centrepiece of science and technology, and it would be impossible to envisage any reduction of the global imbalance without a substantial increase in the endogenous R and D efforts of developing countries.

14. It is also essential to take specific measures to monitor the role of proprietary technologies. New avenues of technology transfer need to be explored. These include: greater de-commercialization of publicly funded technologies; more active participation by Governments of developing and developed countries in the diffusion of technologies where patents have expired; large roles for small and medium-sized enterprises of developed countries. At the same time, these activities should not obviate the important need to regulate the activities of private producers of technology and transnational corporations since these have a decisive effect on technological development, distribution and direction.

5/ See report of the meeting of the ad hoc working group on financing machinery for science and technology for development (A/CONF.81/PC/40).

15. What is especially needed is to transform transnational corporations into instruments of development of the host countries in accordance with their science and technology policies and research and development priorities. The Governments of developed as well as developing countries should co-operate with one another to effect such a transformation. The United Nations Conference on Science and Technology for Development should identify and elaborate the science and technology elements of the role of transnational corporations, which is currently under discussion elsewhere in the United Nations system. Without a comprehensive national and international framework for regulating the activities of transnationals, it would be unrealistic to attempt any kind of restructuring of the international science and technology system.

16. If knowledge is power, information is its instrument. The absence of an organized network of technology information is one of the major obstacles to the strengthening of the endogenous capacities of developing countries. It is necessary to establish a network of national, subregional, regional and international science and technology information systems which would enable developing countries to obtain full and free access to unpackaged technological information. The United Nations system should establish and monitor such a network.

17. In view of the critical role of technology in establishing and implementing the New International Economic Order and a new international development strategy for the 1980s, it is evident that technology cannot be left preponderantly to private initiative and profit-motivated corporations. The need for public intervention on a global scale to monitor and influence technological distribution and direction constitutes another important element of a new science and technology strategy.

18. Some of the problems of development are of such a character and nature that they transcend the narrow confines of States and require, as it were, a global approach. Such problems as mass poverty, malnutrition, energy and disarmament require a global mobilization of science and technology resources so that their solution will not depend exclusively on the action taken by individual countries. Any international science and technology strategy must therefore include as a specific component the identification and solution of global issues relating to pressing world problems, including those of development.

19. Any framework for the controlled application of science and technology for development is ineffective without the necessary financial means and resources for its implementation. While there is an undoubted need for resources for development in general, science and technology that address specific problems merit specific provisions. Without a distinct and identifiable source of funding for science and technology at the national, regional and international levels, it would be difficult, if not impossible, to realize their full potential as tools of development. The establishment of a mechanism with provision for science and technology financing at the international level, in particular, therefore appears to be a most important component of any strategy.

20. It is sometimes stated that the problems of development, or indeed of science and technology, are not exclusive to developing countries. The problems of developing countries are indeed not their problems alone; in a broader sense they belong to the

entire community of nations, and unless undiluted attention is devoted to their solution, the very fabric of mankind's future could be destroyed. Even in the short term, the accelerated development of developing countries should provide a vital stimulant to the economies of developed countries, socialist as well as market-economy. Such a proposition does not dilute the need for eliminating other obstacles or for ensuring a better and more even spread of science and technology, be it between North and South, East and West, or even within a given country.

21. To sum up, it is necessary for any new international science and technology strategy to comprise, inter alia, the following elements:

(1) Technology planning as an integral part of the over-all development planning;

(2) Allocation by developing countries of at least 1 per cent of their gross national product to science and technology;

(3) A contribution by the developed countries to such an endeavour within the framework of a consolidated target designed to bring about a substantial reinforcement of the capacity of developing countries;

(4) New avenues of technology transfer from developed to developing countries, including a greater role for the public sector and for small and medium-sized enterprises;

(5) Greater emphasis on de-commercialization of publicly funded technologies and more organized diffusion of non-patented and patent-expired technologies;

(6) Integration of the activities of transnationals into the science and technology policies of developing countries, including contributions to comprehensive national development, greater quantitative and qualitative research and development activities in their subsidiaries;

(7) A more direct role for the State, in developing as well as developed countries, in ensuring that technologies serve as instruments for the elimination of obstacles - internal as well as external - to an orderly, integrated and equitable development.

(8) The establishment and strengthening of science and technology information systems at the national, regional and international levels;

(9) Greater multilateralization of science and technology co-operation between countries, including in particular among developing countries and the institutionalization of such co-operation;

(10) The identification and solution of global issues, compatible with the priorities of developing countries, so as to mobilize and concentrate the spectrum of global science and technology resources to achieve concrete results within a specified time-frame;

technology are not exclusive to [illegible] they belong to the

(11) The reorganization and reorientation of the activities and programmes of the United Nations system to play a more direct role in strengthening the science and technology capacities of developing countries.

22. The very raison d'être of such a science and technology policy is to provide an essential component for the establishment and implementation of the New International Economic Order; its relevant elements should be integrated into the new international development strategy for the 1980s.

II. A CONCEPTUAL FRAMEWORK

A. Preliminary remarks

23. The potential contribution of science and technology to development objectives is widely recognized. Scientific and technological knowledge has contributed, perhaps more than any other factor, to the economic growth of developed countries - the conquest of disease, the improvement of productivity, the creation of new materials and, in general, the possibility of transcending the limitations of nature. At the same time, however, modern science and technology have been found to be at the root of the present inequitable division of labour that concentrates productive activities with high scientific and technological content in a few developed countries. Most developing countries still employ traditional productive methods and are passive recipients of innovations originating in the developed countries.

24. The reasons for the ambivalent impact of modern science and technology can be found in the historical processes that led, within the context of a world-wide expansion of trade, to the emergence of science-related technologies, the internationalization of production, and an international division of labour that accelerated in the nineteenth century and established the basis for the present inequitable world order. The New International Economic Order is directed towards the revision of this state of affairs and, since science and technology have been intimately involved in the emergence of the existing order, measures to alter the present structure of international science and technology relations are an integral and clearly identifiable part of the New International Economic Order. Indeed, it is impossible to conceive the New International Economic Order, let alone to move effectively towards it, unless the basic structure underlying technological dependence is radically altered.

B. A historical overview

25. From a general viewpoint, it may be said that for thousands of years before the industrial revolution each society "produced" the kind of knowledge now known as science and technology, which was thus automatically adjusted to its own requirements and structure. Change was slow, diffusion and transfer were balanced and reciprocal. The emergence of world political and economic integration, a consequence of colonialism and capitalism, resulted in a new pattern of domination from the centre of societies to the periphery. The production of science and technology was concentrated in a few countries, whether as a result of an internal cumulative process (Western Europe) or of a transplant which grew its own roots (United States, Japan). The knowledge thus generated had little relevance to the requirements or the structure of the dependent societies; transfer was one way and therefore created major problems.

26. Moreover, the systematic generation of knowledge at the centre, organically linked with the production of goods and services, took full advantage of the crafts practised by artisans, which were gradually transformed into manufacturing and industrial activities. The evolution of agriculture and that of industry supported each other and science and technology helped to build integrated economies and societies.

27. On the periphery, however, foreign knowledge, foreign trade and foreign domination provoked serious distortions and disruptions, such as foreign and non-integrated economies, elimination of traditional structures, marginalization of the artisans, socio-economic dualisms and imitation of models. As a result of centuries of colonial domination, the growth of scientific activities and speculative thinking, the import of technology for the expansion of modern productive activities, and the technologies associated with traditional production remained isolated from one another. The interaction processes that led in the developed countries to the creation of an endogenous scientific and technological base did not take place. In contrast, even in the case of developed countries that were "late-comers" in the process of industrialization, the transplant of European science and technology carried with it the essential interactions between the evolution of scientific thinking and the improvement of productive techniques, and these countries did not have to contend with the heavy burden of a colonial past that emphasized a differentiation between the realms of knowledge generation and production.

C. The need for endogenous scientific and technological capabilities

28. The growth of modern science and technology in the developed countries has been characterized by a process of concentration and control of resources for research and development, by a rapid increase in the introduction of innovations, and by the orientation of a substantial part of scientific and technological activities towards military or prestige purposes. A relatively small number of government agencies and private corporations tend to control an increasingly large share of resources allocated to scientific and technological research and development. This arises from a combination of factors, which include the increasing demands for resources on the part of modern research, and a socio-economic and institutional context that permits, and even encourages, the concentration of scientific and technological activities. There has also been a rapid increase in the introduction of innovations, particularly in the more dynamic and research-intensive branches of industry, in which the time between scientific discovery and commercial exploitation is considerably reduced.

29. Parallel with this process of concentration, with the increase in the rate of innovation, with the orientation of research towards military and prestige purposes and apparent wastage of resources in the developed countries, there has been a certain disenchantment with the fruits of technical progress, as environmental and social consideration have acquired greater prominence.

30. There has been a growing awareness in the developing countries that modern science and technology are indispensable factors for socio-economic development. As the understanding of the characteristics and interactions among science, technology and society has improved, there have been conscious policy efforts to counteract the negative trends that have accompanied the growth of modern science and technology, to minimize the undesirable effect of the existing patterns of international technology flows, and to develop endogenous scientific and technological capabilities.

The disadvantages associated with imitative patterns of development, and particularly with industrialization processes that unduly emphasize import substitution of previously imported goods or that focus heavily on exports for the markets of developed countries, have emphasized the fact that technological dependence is at the root of the existing patterns of inequitable international economic relations, and that the development of scientific and technological capabilities is a necessary - but not sufficient - condition for over-all socio-economic development.

31. The importance of building endogenous scientific and technological capabilities in the developing countries, even though it is a long-term task, is reinforced by the shortcomings of the technology transfer process and by the continuing need to import technology. The fact that by far the greater part of scientific and technological knowledge is concentrated in the developed countries makes it necessary to examine and screen carefully scientific findings, research methods and technologies from the developed countries, to choose those suitable for development objectives. However, in the process of obtaining access to the scientific and technological knowledge accumulated in the developed countries, there are several major difficulties that need to be taken into account.

32. First, there are a very large number of problem areas in the developing countries for which little or no scientific and technological knowledge has been generated in the developed countries (for example, management of tropical ecosystems, provision of energy to remote rural areas). Secondly, there are many technological responses available in the developed world that, although addressing a particular problem area, cause serious distortions in the social, ecological and economic fabric of the recipient country (e.g. capital-intensive and labour-saving manufacturing techniques). Thirdly, even when the adequate technological responses are available in the developed countries, there are often artificial restrictions imposed on their flow and they are frequently provided under unfavourable conditions that involve high costs for the recipient (e.g. high cost of licences, tying purchases of intermediate products). Finally, even when adequate techniques are provided under favourable conditions, developing countries often lack the capacity to use them effectively. These difficulties imply that developing countries cannot rely exclusively on technology transfers, and that they must develop their own capacity to evaluate, import, absorb and improve upon those aspects of the scientific and technological knowledge accumulated in the developed countries that would be suitable and would contribute to their autonomous development, even and mainly if, owing to the dynamics of innovation in the developed world, essentially based on profit or cost considerations, they have not been used in practice.

33. There is another issue that underscores the importance of building endogenous capabilities for science and technology and for changing the present structure and characteristics of international technology flows. Developing countries find it difficult to generate a sufficiently large economic surplus to attend simultaneously to the needs of the greater part of their populations and to accumulate capital for their economic expansion. They have had to rely, with some recent exceptions, on international resource transfers to provide the investment capital needed for economic growth. However, the traditional patterns of resource transfers that emphasize

direct foreign investment, Government-to-Government financial assistance and loans from multilateral agencies have not been conducive to the development of endogenous scientific and technological capabilities. These sources of capital have usually been tied to the use of particular technologies and to the purchase of goods and services in the countries providing the funds, and as a consequence, they have not generated a sustained demand for locally produced goods and local science and technology services that could have stimulated the development of endogenous scientific and technological capabilities. Even the practices of multilateral financial organizations, with their emphasis on immediate technical proficiency and performance, involve an inherent bias towards goods and services from developed countries with higher industrial and technological capabilities.

34. Considering the difficulties involved in the accumulation of capital in developing countries and also the fact that the present patterns of international resource flows are not likely to promote the development of endogenous science and technology capacity, it becomes necessary to alter in a major way the conditions of access to international capital sources. The expansion of commercial financing that became available to the developing countries during the early 1970s signalled a shift in this regard, even though most developing countries were not able to take advantage of the situation to expand the demand for local goods and science and technology services.

35. But, even if sufficient capital were available from the surplus generated by economic activities in the developing countries, the lack of an industrial capacity - particularly for capital goods - and the lack of a well developed infrastructure for science and technology would make it almost impossible for developing countries to transform this surplus into investment without resorting to the import of capital goods and technology. While it is clear that a policy of autarky is illusory and would be counter-productive, it is clear that no country can retain its sovereignty, independence and autonomy unless it acquires control over the main decisions that affect its future development. The possibility of transforming savings into investment without undue external influences is certainly one of these. For such reasons, the development of endogenous capabilities for science and technology is an essential condition for any country that seeks to escape from the condition of dependency and to design independently and follow its own path to development.

D. Some global characteristics of science and technology for development

36. The characterization of the relations between science, technology and development presented in the preceding sections gives a general picture of the diversity of scientific and technological conditions of both developed and developing countries. For example, there are small developed countries that have an extensive scientific and technological infrastructure and that rely to a considerable extent on technology imports, even if they invest a substantial proportion of their gross national product in research and development. There are also developing countries that have a relatively large scientific manpower base and have made significant contributions in some specific fields of science and technology; others that are beginning to develop their scientific and technological capabilities; and others where science and technology still do not play any significant social role. Nevertheless, in spite of these differences, a common link that binds together the developing countries is their need to develop endogenous scientific and technological

capabilities. Because few developing countries can do this on their own, it is necessary for them to collaborate with other developing countries in this task, and it should also be possible to find a commonality of interests with some developed countries in this regard.

37. The diversity of national and regional situations has been dealt with extensively in the national and regional papers for the United Nations Conference on Science and Technology for Development. In this paper a few characteristics of the interactions between science, technology and development at the world level are highlighted, focusing on those international aspects of the problematique that need to be modified through common action at the international level.

Distribution of the world scientific and technological effort

38. Tables 1 and 2 provide data on world expenditures on research and development and the distribution of world scientific manpower. It will be seen that developed countries account for approximately 97 per cent of world research and development expenditures. The figures on manpower indicate that about 80 per cent of the world's scientists and engineers are to be found in developed countries. Furthermore, the fact that developing countries account for about 12 per cent of the world scientific manpower and only 3 per cent of R and D expenditures, indicates that the expenditures per researcher are much lower in these countries. While these figures hide substantial differences within each group of countries, it is clear that such wide disparities in resources and manpower are not conducive to the effective world-wide use of science and technology for development objectives.

39. The figures give a static picture, showing the differences that existed around 1973, the latest year for which accurate data are available. However, there are indications that these differences are growing as the pace of investment in R and D in the developed countries continues to grow, and as short-term economic difficulties in many developing countries have pushed the relatively long-term task of developing endogenous scientific and technological capabilities into the background. But it is not only the relative distribution of world scientific resources that should command attention. In most fields, scientific research and development require a minimum critical mass of human and financial resources and build upon a long tradition of cumulative achievement. These conditions are absent in most developing countries: they lack the financial, human and physical resources to engage in research in many of the fields of science that are of critical importance to their development, and they have not been able to evolve, for the historical reasons mentioned earlier, a cumulative tradition of scientific and technological research that would provide the basis for putting science and technology at the service of development objectives.

Nature of international scientific and technological relations

40. The imbalances in the distribution of the world scientific and technological effort are also reflected in the international flows of technology. These imbalances are increased by the imperfect nature of the international markets of technology with a few sellers monopolizing the access to technological knowledge and a large number of buyers having little information and bargaining power. In addition, transnational corporations, whose profit-making objectives and means of achieving them transcend

Table 1. Distribution of world R and D expeditures among major regions and by average share of gross national product and per economic active person, 1973

	Millions of US dollars	Percentage of world total	Per economically active population (US dollars)	Percentage of GNP at market prices
WORLD, total	96418	100.0	66.4	1.97
DEVELOPING COUNTRIES	2770	2.9	3.0	0.35
Africa (excl. South Africa)	298	0.31	2.8	0.34
South and Central America	902	0.94	9.0	0.37
Asia (excl. Japan)	1571	1.63	2.1	0.34
DEVELOPED COUNTRIES	93648	97.1	182.1	2.29
Eastern Europe (incl. USSR)	29509	30.6	160.0	3.82
Western Europe (incl. Israel and Turkey)	21418	22.2	135.1	1.55
North America	33716	35.0	331.1	2.35
Other (incl. Japan, Australia)	9005	9.3	129.8	1.76

Source: Global Resources of Research and Experimental Development; Jan Annerstedt; Institute of Social Economics and Planning; Roskilde University Center, Denmark, 1978.

Table 2. Distribution of Researchers (R and D scientists and engineers) among major regions and per million economic active population, in 1973

	Total (Thousands)	Percentage of World total	Per million of economically active population
WORLD, total	2279	100.0	1570
DEVELOPING COUNTRIES	288	12.6	307
Africa (excl. South Africa)	28	1.2	271
South and Central America	46	2.0	461
Asia (excl. Japan)	214	9.4	292
DEVELOPED COUNTRIES	1990	87.4	3871
Eastern Europe (incl. USSR)	730	32.0	3958
Western Europe (incl. Israel and Turkey)	387	17.0	2441
North America	548	24.1	5386
Other (incl. Japan, Australia)	325	14.3	4687

Source: Global Resources of Research and Experimental Development; Jan Annerstedt; Institute of Social Economics and Planning; Roskilde University Center, Denmark, 1978.

national regulations and do not necessarily coincide with national developmental objectives, have emerged as one of the key agents in international knowledge flows.

41. A new pattern of international economic relations is becoming discernible. Developed countries, and the large private corporations based in them, are moving towards a greater use of modern science-related technology in its various forms (embodied in capital goods, contained in blue-prints and specifications etc.) as one of the key factors in their relations with developing countries. A pattern of exchange is arising in which developed countries offer their technology, and in some cases their food and capital, in exchange for the resources - including energy - and access to the markets of developing countries. In some exceptional situations developing countries may be capable of providing their own food and capital, but in all cases they require access to the technology they are not at present capable of producing. Therefore, the sharing of scientific and technological knowledge by all members of the international community, and the conditions of access to the technology required for development objectives, are becoming major issues in international relations.

42. In view of the historical process that has led to the present imbalances in scientific and technological capabilities and the disparities in the distribution of knowledge, the mobilization of science and technology for development requires guaranteed access by all developing countries to technologies which satisfy development requirements, understood in the widest possible sense. This can be readily assured for those scientific findings and technologies generated by, or under the control of, government agencies in the developed countries. However, ensuring access to technologies does not imply merely putting them at the disposal of developing countries and eliminating restrictions on their availability. Because of the wide disparities in scientific and technological capabilities between developed and developing countries, it is necessary to assist the latter more actively so that they may be able to benefit from the stock of scientific and technological knowledge. International action is required in order to ensure that the improved conditions of access shall benefit the majority of developing countries, including the least developed.

Control of scientific knowledge and technology

43. General characteristics of the way modern science and technology relate to contemporary society, in both developed and developing countries, are the ever-increasing demands for specialization and the complexities of scientific research. As science advances, it becomes more difficult for the layman to understand fully the concepts and the implications of new scientific and technological findings and for the non-scientist and the general public to participate fully in discussion about science and technology. The fact that the allocation of resources for science and technology is coming under the control of a relatively small number of corporations and agencies in the developed countries and that government sources account for most of the funding for science and technology in the developing countries also has the result that decisions affecting the future of most of the people in all countries will be made by a few specialists.

44. In the developing countries, given the relatively lower degree of development of their scientific and technological capabilities, the number of persons involved

in the scientific and technological community is quite small and is usually oriented towards the centres of scientific excellence in the developed countries. In consequence, even though modern science and technology do not play a major role in the development of these countries at present, the fact that the intellectual élite in them can be alienated from its own environment has profound implications for the possibility of harnessing science and technology for development objectives.

45. Determined efforts are therefore needed to put scientific and technological knowledge within the reach of most of the population, in both developed and developing countries, and to redirect its application towards problems of concern to the most vulnerable sections of their societies. Such a reorientation is essential for a more balanced application of global science and technology.

Global problems that require concerted international action

46. The increased social, economic and political interdependence of all countries and the improved means of communication and transportation have given rise to a new set of global problems, whose solution is no longer possible solely on the basis of the action of individual countries, regardless of their power or influence.

47. The list of global issues varies according to differing points of view, but it includes invariably: population, food, energy, natural resources, environment and health. 6/ A characteristic of these global problems - which are partly the product of socio-economic development and of the scientific and technological revolution - is that because of their complexity and interdependence, they cannot be solved by only one or a few countries. The scale of financial, human and material resources needed for a successful attack on them is so large that it requires a combined effort of all countries to marshall the latest advances in science and technology, through large-scale and long-term international co-operation.

48. Several classifications of global problems can be made. First, there are problems of a physical nature that transcend national boundaries and escape national control, such as the contamination of the biosphere and the geosphere, the prediction of atmospheric conditions, the prediction of earthquakes, the management of natural disasters, and so on, for which international co-operation is essential for their solution. Secondly, there are problems that can be identified and located in a specific region or country but whose nature is common to a variety of them, so that both developed and developing countries will benefit from increased co-operation through co-ordination of policies and exchange of experiences. Among these are such problems as those related to increased urbanization, industrial pollution, transportation needs, health services, education and, in general, those problems associated with the need for greater social control of technology. In this case, solutions attempted in one region of the world may, after analysis and reinterpretation in a different context, provide guidelines for action in another region.

6/ Many of the topics covered by previous world conferences organized by the United Nations system are now increasingly accepted as global issues: environment, population, water, food, health, desertification, human settlements, etc. (see A/CONF.81/PC/33).

Another criterion is the distinction between problems arising from a man-nature interaction and those resulting from the action of man alone (e.g. war, underdevelopment). Some problems are global because they transcend natural frontiers by their very nature (for example, oceans, outer space, meteorology). Some are created by lack of knowledge (for example, those resulting from global pressures on food, energy resources and raw materials) or from misuse of technology (for example, armaments).

Policies for science and technology

49. Concurrently with the realization that science and technology are important elements in socio-economic development, there have been attempts in the last 30 years, encouraged and supported by international and regional organizations, at devising government policies to orient science and technology towards development objectives. On the whole, however, the success of such attempts has been limited, except in some fields and in a few developing countries.

50. Reasons for the ineffectiveness of science and technology policies include lack of political will and the fact that short-term problems and crisis management often divert attention from the longer term task of building endogenous scientific and technological capabilities. Another reason has been the inadequacy of science and technology policies themselves because of the limited knowledge of the interaction between science and technology on the one hand and development on the other. As research on science and technology policy has intensified during the last ten years and the interactions between science and technology and development have begun to be better understood, it has been possible to adjust such policies. However, this requires a highly flexible and receptive over-all government policy and implementation structure that can maintain key elements of policies consistently for sufficient time to show results, conditions that are rarely found in most developing countries.

51. The initial approach, in vogue during most of the 1950s, emphasized the supply of scientific knowledge and concentrated on the creation and expansion of an infrastructure for research. The implicit idea was that once such institutions were in existence, research results would be automatically incorporated into the productive system and contribute to development. After more than a decade of institution building and efforts following this "supply" approach to science and technology policy, it became apparent that even though scientific and technological organizations had been created, the results of their activities were not always being used effectively for socio-economic development and that the institutions remained practically isolated from the mainstream of production.

52. As a reaction to the difficulties encountered with this initial approach and as a result of newly available studies on the problems associated with international technology flows, there emerged an approach the primary emphasis of which was on the control and regulation of technology imports into the developing countries, emphasizing that the lack of demand for the knowledge generated by the scientific and technological infrastructure of the developing countries arose from the overwhelming weight of technology imports and the restrictive conditions associated with commercial technology flows.

53. While the creation of an infrastructure for science and technology and the regulation of technology imports have now been recognized as essential components of a coherent science and technology policy for development, recent studies have also emphasized the importance of managing the demand for technology, intervening directly in the productive and service activities that could provide an increased demand for knowledge and technology

III. STRENGTHENING THE SCIENTIFIC AND TECHNOLOGICAL CAPACITIES OF DEVELOPING COUNTRIES

54. Action to correct the structural dichotomy between developed and developing countries from the point of view of science and technology requires a double approach: first, at the national level, the strengthening of the science and technology capacities of developing countries and secondly, at the international level, the creation of an environment conducive to the success of action at the national level. The first is dealt with in the present section (section III) and the second in section IV of this report. In both cases, full use needs to be made of the United Nations and other international organizations, which should be strengthened for the purpose (see section V).

A. Integration of science and technology into national planning

55. A prerequisite of the effective application of science and technology for development is the formulation of a comprehensive and coherent national science and technology policy, designed with national policy objectives in mind. The science and technology policy should create or reinforce in each country an autonomous decision-making capacity in scientific and technological matters in accordance with the requirements arising from the realities of its political and social situation and its aspirations for the future. The formulation of a science and technology policy should be a coherent process that involves carrying out certain essential responsibilities such as planning, budgeting, management, co-ordination, stimulation and execution of scientific and technological activities relevant to defined development objectives. Such a policy should embrace independent and yet interdependent short-term, medium-term and long-term strategies, including the determination of scientific and technological priorities, mobilization of natural resources, management of local demand, dissemination of the existing national stock of technology, identification of sectors or industries in which external technologies would be required and a determination of R and D priorities for the development of endogenous technologies.

56. One of the major weaknesses of the science and technology system in many developing countries is that it functions in a vacuum, devoid of any significant contact with the social fabric and the common man. As a result, it has often lacked the support of the people. It is therefore necessary that Governments of developing countries ensure that in the formulation of their science and technology policy, close consultations shall be held with different sectors of the community and that they should in particular stimulate a social debate and interaction between the Government, the producers of knowledge and its users. Such a debate should create the necessary climate and scientific temper and make the common man feel that he is a full partner in the national effort to modernize the economy and reduce technological dependence.

57. A prerequisite of the formulation, and more important, the implementation of a national science and technology policy is the creation of the necessary infrastructure. Such an infrastructure should include not only the creation of the necessary institutional framework but also have co-ordinated human resource development policies. Given the fact that science and technology are not sector-specific, one of the major deficiencies in the developing countries in the application of science and technology has been the relative absence of suitable cross-disciplinary and cross-sectoral institutions. This absence, coupled with the lack of political will and lack of awareness of the importance of science and technology, has resulted in the neglect of science and technology as a tool of development and the absence of specific policy measures to eliminate the obstacles to its application.

58. It is now increasingly apparent that a science and technology policy per se is indeed insufficient to serve as an adequate tool in achieving technological self-reliance and that it should be supplemented and translated into a technology plan as an integral component of national development planning, including in its spectrum manpower development planning, education planning, industrial planning, and so on. A most important ingredient of technology planning should be specific measures to stimulate a demand for domestic technologies. National technology plans should also identify priority technological sectors and harmonize the need for indogenous technological development with the imperative to import advanced technologies. Many developing countries, in the absence of technology planning, have adopted an imitative and intuitive approach towards this aspect with very unsatisfactory economic consequences. An integral component of technology planning should be the allocation of resources for science and technology particularly for R and D. A science and technology budget as part of the national budget should ensure identifiable autonomous resources.

59. Developing countries should also establish appropriate science and technology institutions such as a national authority for science and technology policy-making at the highest possible political level. Such an authority, armed with the necessary political support, could ensure that the interests of science and technology should not be sacrificed for short-term needs in other fields. The national authority for science and technology policy-making should be responsible for formulation of science and technology policies, determination of science and technology and R and D priorities, advocacy of science and technology in intergovernmental forums, allocation of resources, regulation and acquisition of foreign technologies, modernization and upgrading of traditional know-how and rural technologies, and the like.

60. In addition to such an authority, it is also desirable for developing countries to establish a broad-based national council for science and technology, which might include directors of research and development institutes, representatives of universities, professional associations, trade unions and consumers. It should be the function of such a council to serve as an advisory body to the Government on such questions as co-ordination of science and technology institutions and to ensure close linkage of science and technology and R and D with the productive sector, universities, industry, rural needs and so on. It should also be responsible for advising on the measures necessary for full integration of science and technology policies and plans with the over-all process of national development planning, and also with the national fiscal, manpower, investment, taxation and distribution of income policies, and in particular ensure that science and technology should be mobilized and directed towards the areas and sectors of societies where it was needed most.

61. A major weakness of developing countries is to be found in the field of consultancy, design and engineering. Many developing countries do not have the capability of preparing feasibility studies for the setting up of even less sophisticated industries. They are dependent on external know-how and personnel to prepare feasibility reports, detailed project reports and the like. These external agencies, which are usually from developed countries, often formulate their reports on the basis of knowledge circumscribed by the environment in which they are developed. As a result, these reports are in many instances unsuitable to developing countries and, since the projects are designed and installed on the basis of them, they may result in undesirable distortions of the productive sector in developing countries.

62. It is necessary therefore that developing countries take steps to acquire the minimum capabilities required to set up consultancy, design and engineering organizations which could undertake these tasks locally. It might even be useful for developing countries to encourage, at least in selected sectors of technology, imports using the advice of local consultancy organizations in specific segments rather than permit manufacturing enterprises to import directly. Channelling the technology imports through consultancy and design organizations would permit these organizations to absorb the know-how and adapt them to national requirements before they were utilized by the industrial enterprises. These organizations could also provide a linkage between the domestic R and D institutions and the user, and ensure that technologies developed in the R and D institutions should be commercially applicable. Endogenous technological development depends largely on the strengthening of such organizations in developing countries.

63. Developing countries could also significantly reduce their dependence on consultancy, design and engineering organizations of developed countries through greater co-operation among themselves, particularly by establishing twinning arrangements between their specialized institutions or by seeking help from more advanced developing countries to set up such organizations. This is a most suitable and vital area for strengthening the TCDC concept.

64. Very often technologies developed in developing countries have remained secluded within the confines of a laboratory or within a particular industrial undertaking. There is a need for the adoption of specific policy measures which will stimulate vertical as well as horizontal diffusion of technologies within each developing country. In this context, developing countries should consider the establishment of appropriate mechanisms such as industrial extension services which will bridge the gap between laboratory R and D and the industrial user.

B. Choice and assessment of technology

65. It is necessary to recognize that technological capacity is not necessarily the same as research capability. The heart of technological capacity is the identification of national, sectoral and subsectoral goals, the choice of technology and the ability to undertake economic, sectoral and project planning and analysis; these are often embraced in the term "technology assessment".

66. The choice of technology is one of the most difficult choices that developing countries are required to make in their efforts to accelerate their development and yet retain their cultural values and their economic and political identity. Ensuring the suitability of technologies that are either imported or developed domestically constitutes one of the most important elements of national technology planning.

67. Modern technologies are needed to meet the fundamental requirements of the people of developing countries, and to overcome some of their chronic problems such as poverty and malnutrition. There is no contradiction between the use of modern and advanced science-based technologies and the use of modernized and upgraded traditional technologies. Indeed, modern technologies and traditional technologies complement each other and are needed in an appropriate mix. It is not a paradox for developing countries to have nuclear power-plants as well as bio-gas plants and large modern textile mills as well as traditional looms. Similarly, while agriculture continues to be the mainstay of most developing countries, these countries require greater application of technological knowledge to raise their agricultural productivity. Developing countries want to transform their traditional communities into modern societies without sacrificing their rich cultural and social heritage. They also want to acquire sophisticated technologies, which are necessary to sustain and preserve their political independence and acquire national self-reliance. "They want to assimilate technologies and not be assimilated." In this context, any controversy regarding advanced technology versus satisfaction of basic human needs, 7/ oversimplifies the position. The precise mix between the range of technologies is entirely a national decision, depending on needs, resources and absorptive capabilities. At the same time, the concept of appropriate technology should not be permitted to be used politically to influence the pattern of development of developing countries or deny them advanced technologies.

68. The concept of the choice of technology - and indeed of products - covers the whole spectrum of technologies, from the most labour intensive to the most capital intensive. It is the task of national planners and policy-makers to manage such a technological pluralism and ensure that the most suitable technology shall be identified and applied towards a specific need or the manufacture of a particular product.

69. It is obvious that there are no easy or ready-made answers and that each nation should make its own choices having regard to the imperatives and needs of its own economy and its socio-economic and political contexts. It is also clear that what the developing countries - and even developed countries - need is not a solitary technological path, nor even "dual technologies", but multiple technological paths. The latter concept has particular significance for developing

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7/ The non-aligned foreign ministers at their meeting in Belgrade in July 1978 declared that the basic needs approach to development at the international level "would inevitably imply the imposition of global priorities on developing countries, thereby not only distoring the allocation of domestic resources of the latter, but also perpetuating their technological dependence on the developed countries".

countries, since they are anxious at once to modernize their economies and to retain their traditional cultural values and the basic structures of their societies. There is a need, in this spectrum, for the most advanced technologies, which may indeed be capital-intensive, to enable developing countries to manufacture basic and intermediate goods and provide essential services needed for a modern economy. Most of these technologies would have to be imported and if necessary modified so as to suit local conditions while maintaining their basic features. In the short term, developing countries will continue to depend on imports of such technologies since to generate and develop them requires resources and skills that these countries cannot at present mobilize or divert from other priority needs.

70. The second category of technologies could be those which are imported from advanced countries but subjected to significant and substantial changes and modifications through the national R and D institutions so that the final technological product is in fact substantially different from the imported technology. In such cases, the basic character of the technology undergoes fundamental alterations, resulting in a virtually new technology. This requires considerable adaptive capacity on the part of the developing country which, in turn, requires a strong scientific and technological infrastructure.

71. The third category of technologies could be those based essentially on the traditional techniques of production which have proved their effectiveness over long periods in many developing countries and can in many cases be made more productive. Such technologies are mostly labour-intensive and simple in their processes. They are not only rural-oriented, and are often capable of wider application.

72. It is a task of the developing countries, and particularly of their scientific and technological communities, to improve and adapt traditional technologies, particularly those in the rural areas. What is required is to retain the basic structure of the traditional appliance or practice, and improve upon it by bringing in modern science and technology so that the process achieves a greater degree of productivity on the one hand and, equally important, reduces the burden and drudgery of the worker and user. Such an adaptation would produce what could be called "bottom-up" technologies as distinct from "top-down" technologies. And it is bottom-up technologies that will have to provide answers to many of the problems of developing countries. One of the true tests of developing countries' innovative capabilities is their ability to improvise and generate "mixed technologies". Developing countries should devote particular attention to the creation and strengthening of such innovative capabilities.

73. Developing countries need to acquire the capability for undertaking assessment of technologies. Such a capability is an essential ingredient in the formulation of technology policies and in achieving autonomous technological capability. It calls for a comprehensive framework and is linked with the broad participatory process which structural transformations should bring about. For example,

nuclear energy cannot be discussed outside the context of energy policies and options and these in turn cannot be dissociated from an over-all national development strategy.

74. One of the prerequisites for the choice and assessment of technologies is access to a comprehensive information system. Such a system should integrate national networks and be linked to international mechanisms. It should make possible the flow of information necessary for national decision-making, including the various sources, terms and conditions of supply and the cost of technological alternatives. It should also provide the necessary data bases for technological forecasting. Developing countries need to establish national science and technology information systems as an integral part of their over-all national development activities and link them with corresponding institutions at the sub-regional, regional and interregional levels.

75. Developing countries, in their efforts to strike a balance between technological imports and the generation of technology, need to establish appropriate mechanisms for screening and scrutinizing imported technologies so as to ensure that they shall be in conformity with their science and technology policies and amenable to the necessary adaptation and absorption. Centres for technological development and transfer are needed for this purpose, either on a sectoral basis or on a national basis. It is also necessary to formulate a policy on the requisition of technology which is closely tied to the policy on scientific and technological development. The following considerations could serve as a basis for such a policy:

(a) Every transaction should be determined by the national priorities corresponding to the over-all development plans of the country;

(b) The desire to make the production system more independent and to reduce dependence on foreign technology should not make the economy less dynamic. To that end, every selective policy on importing technology should be accompanied by measures aimed at strengthening the corresponding domestic sectors;

(c) The incorporation of domestic technology in the production system does not exclude the importation of technology but rather complements it. It is merely one of the phases of the process of technology transfer;

(d) The decision-making centres dealing with the transfer of technology must be kept at a national level and under the national control;

(e) Over-all uniform treatment is inadvisable when dealing with the process of transfer. Machinery should be flexible, so that each case can be evaluated in terms of the needs of each sector of the production system and the corresponding potential of the domestic scientific and technological system. Furthermore, imported technology should not impair the capacity for local innovation, should not be too costly in visible or hidden terms, and should not be accompanied by restrictive practices.

76. An essential element of technology assessment is the capability of "unpackaging" technologies, which permits the identification of composite elements of technology and know-how. Unpackaging should help to replace one or more ingredients with indigenous components and to absorb know-how and this contributes to the attainment of technological self-reliance. Technology suppliers and transnational corporations should be encouraged to facilitate the acquisition by developing countries of this unpackaging capability, even though this may appear contrary to their short term interest.

77. While a coherent science and technology policy and its implementation could help speed up the over-all development process, it is necessary to be aware of its limitations on the one hand and the possible undesirable consequences on the other. It is now widely recognized that the application of science and technology should be coupled with the introduction of socio-economic reforms. These often constitute the centre-piece of the development process. Structural reforms such as agrarian reform and redistribution of income policies should be undertaken parallel with the increased mobilization of science and technology for attacking development problems. However, structural reforms alone may be insufficient to raise the living standards of the people of developing countries, and mobilization of science and technology is a necessary complementary condition of the development process. It should supplement and serve the structural reforms and provide the tools necessary to make them productive.

C. Science and technology and integrated rural development

78. One of the major consequences of the style of technological development followed so far by most developing countries has been the increasing gap between rural and urban areas and the absence of technological progress in rural areas. Technologies imported by and adapted in most developing countries have been used mostly in urban areas and are also largely intended for the production of goods for consumption by the urban élite. As a consequence, the productivity of the rural industries and crafts has not increased, resulting in lower competitiveness. The rural artisan and the village entrepreneur have been dispossessed from their traditional occupational patterns, which has not only stimulated their migration to urban areas but also impoverished the rural community. The rural areas have been starved of technological inputs and have been overtly placed outside the main stream of technological development in most developing countries. The rural poor, namely the artisan, the small landholder, the landless poor, the seasonal labourer, have remained largely untouched by the positive aspects of modern technologies, resulting in a hiatus between the cities and villages and aggravated social tensions. One of the principal aims of the application of science and technology in developing countries should be to bridge such a gap and to inject and infuse modern technologies into rural areas so as to reduce the drudgery of the artisan and worker and enable him to increase his income and produce products of a quality and price comparable with those of urban industries.

79. Technological input in rural areas should at the same time aim to ensure that in the process of modernizing agriculture and village industries, the useful and productive elements of human skills and traditional heritage should not be destroyed. Technological endeavour in the rural areas should also seek to provide gainful employment to the large rural work force, which is often handicapped

because of the seasonal or marginal nature of its work. More direct application of technology as a tool for the integrated rural development of developing countries constitutes one of the major components of the application of science and technology for development. And it is necessary to recognize that rural technologies often have their own raison d'être and a specific role in relation to agriculture.

D. Human resource development

80. Fiscal, monetary and development policies of developing countries have often had the effect of restraining the use of manpower and providing incentives for increased use of scarce resources such as capital and equipment. The origins of this anomaly can be traced back to the colonial past of many developing countries at a time when colonial powers had structured the production, education and training systems of developing countries in a manner suitable for the situation in their home countries. By and large, the education and training systems evolved during their colonial past have survived in many developing countries and have proved inconsistent with the needs of their economic development. Developing countries need to restructure and reorient their entire education and training systems to serve their development needs and induce and stimulate an orientation towards science and technology at the primary, secondary and tertiary levels. Science and technology should be built into the very fabric of national consciousness and constitute an integral part of human resource development. The human resource policies of developing countries should, inter alia, be directed towards the attainment of a "critical mass" in terms of qualified science and technology personnel and link universities and other training institutions more closely with the problems of society and in particular with the productive system. They should involve training programmes which will produce qualified science and technology personnel capable of using their knowledge of social problems in a practical manner and stimulate indigenous innovation.

81. A major problem closely involved in formulating a coherent human resource development policy is the important question of migration of skilled manpower from developing countries to developed countries. 8/

82. In its broadest sense, the problem of brain drain symbolizes the dilemma of many developing countries; it is at once a source of concern and a sign of helplessness; they can neither afford to stop it completely nor permit it to continue unhindered. Whatever the dialectics of the debate, it is obvious that it is hazardous to generalize about the problem of brain drain. The nature of the problem as well as the solutions to it must necessarily be country-specific and indeed even time-specific. It must be borne in mind that it is neither possible nor even desirable to "insulate" scientists and technologists of developing countries from outside contact or exposure. Indeed, the question arises: is the science and technology capacity of developing countries strengthened by allowing unhindered migration or completely stopping such exposure through regulatory and other mechanisms.

83. It is for each country to decide where its balance of national interest lies and to adopt appropriate short-term measures as well as long-term policy measures. As a general proposition, however, it might be stated that what is required is,

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8/ See resolution..... on "Development aspects of the reverse transfer of technology" (adopted by UNCTAD at its fifth Session).

E. Resources for research and development

87. One of the major weaknesses in the development of many developing countries has been the inadequate allocation of resources for science and technology in general and research and development in particular. In 1973, developing countries, on the average, were spending less than 0.3 per cent of their GNP on research and development, as against an average of 2.3 per cent in developed countries. In comparison, the developing countries spend ten to twenty times more on the import of technologies. Developing countries need to adopt a strategy to divert a portion of the resources currently spent on importing technologies to measures designed to stimulate endogenous R and D.

88. In any event, the expenditure of developing countries on R and D and scientific and technical services should be increased, and a target of 1 per cent of their GNP has already been recommended in connexion with the second development decade by the Advisory Committee on the Application of Science and Technology to Development.

89. The developed countries should play a major role in supporting the national efforts of developing countries through international co-operation. (See paras. 99-104).

IV. RESTRUCTURING THE EXISTING PATTERN OF INTERNATIONAL SCIENTIFIC AND TECHNOLOGICAL RELATIONS

A. Technology transfer

90. International transfer of technology has a specific role to play in the restructuring of the international economic system. Technology transfer does not take place in a vacuum but is linked to over-all systems of production and the specific capabilities involved. The success of technology transfer likewise depends on the extent to which it is assimilated by and adapted to local socio-economic conditions, and on whether such technology transfer complements or displaces indigenous technological capabilities. The impact of technology transfer depends on the existence of an appropriate mix of other production inputs, including managerial and marketing capabilities, skilled labour, capital resources and the like.

91. Transfer of technology can be considered under four headings, namely, technology transfer from developed to developed countries, technology transfer from developed to developing countries, technology transfer between the developing countries and lastly, technology transfer within a country. Technology transfer involves the transfer of a skill embodied in products, processes and persons. It often also involves patents, designs, trade-marks and other technical data. Technology is transferred in different forms from country to country or from one enterprise to another. Technology is bought and sold internationally as well as nationally but the North-South flow of trade in technology is almost wholly uni-directional, namely, from developed to developing countries.

92. An adequate understanding of the impact of international technology flows and of the process of their commercialization depends on the types and modes of technology transactions involved, the types of usages to which they are put, and the specific recipient countries and enterprises concerned. The more technology-capable a purchaser is, the greater his ability to negotiate with technology suppliers. Two main factors contribute to the lack of capability on the purchaser's side: information gaps (potential sources of technology supply, technological characteristics etc.) and technological weakness (lack of expertise, skills, experience, R and D capabilities etc.). Information gaps and local technological weakness usually go together and seriously affect the terms under which technology is acquired.

93. International action required to redress the present situation must be taken in a co-ordinated manner in conformity with the principles and objectives of the New International Economic Order. In this connexion, it is important to emphasize that international scientific and technological co-operation must be conducive to the strengthening of the whole process and take account of the capacity for innovation in developing countries. International scientific and technological co-operation should not only impede undue introduction of an alien technological culture, but bring about a process of technology transfer beneficial to developing countries.

B. Science and technology information for development

94. Willingness and preparedness to share the knowledge and experience gained by each country through its own efforts to achieve political, economic and social self-reliance are inherent to subscribing to the concept of global interdependence and real co-operation among all countries.

95. A consequence of this is that scientific and technological information must be shared among all countries and that an increased flow of such information from developed to developing countries is necessary. It is equally important for developing countries to take advantage of the knowledge and experience of other developing countries; these can also be of use to developed countries. For all partners to make effective use of this flow of knowledge they must be equipped to receive and apply it in a manner consistent with their own development priorities.

96. International efforts for an increased and freer flow of information and knowledge involve three major elements. First and most important, the developing countries have to acquire the capability to assimilate and disseminate information received from abroad or available internally. Secondly, the developed countries should, as a demonstration of their commitment to the concept of global inter-dependence, provide liberal access to their technological information and know-how. Thirdly, the United Nations system and other international organizations should support developing countries in this process and stimulate and promote regional and international co-operative activities for the exchange of information. 9/

9/ See recommendations 1, 2 and 3 of the Intergovernmental Conference on Science and Technology Information for Development (UNISIST II), adopted in Paris on 2 June 1979.

97. A freer flow of information, knowledge and experience is essential for development. The obstacles to this freer flow are many, ranging from political to purely technical. The most important among those which will have to be overcome is that science and technology for development is often planned and implemented in the absence of an assessment of the needs of users, thus often resulting in irrelevant information. Moreover, much scientific and technical information remains concentrated in the developed countries, and channels or linkages do not exist to transmit it to those who need it most.

98. Other obstacles are that many developing countries have adopted communication technologies, media formats and methods successful in developed countries but not necessarily suited to their own needs. Related to these conditions is the fact that mechanisms or linkages are ineffective for the channelling of technical and scientific knowledge from developing countries into present international information systems, or into existing data banks, from which it could be redistributed to other developing countries in need of it. As the systems are predominantly serving the needs of developed countries, there is also little or no incentive to include this type of information in the systems.

C. Resources for science and technology

99. Developed countries can participate in strengthening the efforts of developing countries in the field of science and technology through three different types of action: (a) direct support of science and technology in developing countries, in relation to R and D and to scientific and technological infrastructure; (b) assistance in finding solutions to the specific problems of developing countries through the utilization of their R and D potential, by means of action in their own territory and in developing countries; (c) provision of educational facilities at home and abroad in the field of science and technology.

100. Action under (a) above would be directed mainly towards supplementing the resources devoted by developing countries to science and technology - overcoming their budgetary difficulties, furnishing foreign exchange, scientific and technological equipment and expertise - and may take the form of a transfer of resources, financial, material and human, which would be great enough to produce tangible results. Pursuant to paragraph 63 of the International Development Strategy for the Second Development Decade, efforts were made to quantify the participation of developed countries. The amount of 0.05 per cent of the GNP of developed countries was recommended by various bodies; at the time it represented roughly one fourth of the efforts of the developing countries themselves. The commitments under the International Development Strategy were renewed at the seventh special session of the General Assembly (resolution 3362 (S-VII) section III, paragraphs 1 and 2).

101. According to the Strategy, the developed countries would also assist (see (b) above) in seeking solutions to the specific problems of developing countries and for this purpose would endeavour to provide adequate resources within the framework of a target to be specified. A target of 5 to 10 per cent of the expenditure of developed countries has been advocated, but no figure has ever been agreed upon.

102. Lack of reliable and comprehensive information makes it impossible to determine the institutions in developed countries which are actively performing research on problems of developing countries, and therefore to evaluate such research activities. Despite the fact that it is difficult to make a distinction between those problems which are more or less specific to developing countries, enquiries relating to R and D for developing countries

have been initiated by a small number of countries and by UNESCO and other international organizations. In 1972 OECD launched an international inventory of projects and resources devoted to R and D for the benefit of developing countries and EEC has introduced a separate item on developing countries in its analyses by objectives of public financing of R and D. It is thus estimated that the current expenditure of developed countries on R and D for the benefit of developing countries ranges from 0.3 per cent to 2.7 per cent of their total expenditure on R and D.

103. It is obvious that any R and D activity carried out in industrialized countries on specific problems of developing countries would not be mutually beneficial without the active participation of developing countries themselves. The aim of co-operation in the field of science and technology between developed and developing countries should be to strengthen the R and D capabilities of developing countries through this form of co-operation, and to make the R and D of developed countries more responsive to developing countries' needs and problems by involving it in the solution of these problems.

104. As the emphasis is now on reinforcement of the endogenous capacities of developing countries, the concept of the target should if possible be reconsidered in such a way that the two targets for developed countries would be merged for the sake of comprehensiveness and simplification, and would also include expenses under science and technology education in the form of fellowships in developed countries as well as contributions to the infrastructure for science and technology education of developing countries. The relationship between this single aggregate target for developed countries and the target for developing countries should be studied and negotiated.

105. Most of the bilateral or multilateral co-operation in science and technology in the past has been unco-ordinated and not always adjusted to the science and technology priorities of the developing countries. In the belief that the scientific development models in current practices in the advanced countries are of universal validity, they have often been transplanted to the developing countries, regardless of variations in the cultural, traditional or structural needs and resources. On the other hand, results of research carried out in the developed countries on problems relevant to the developing countries have often not been adequately shared or transferred.

106. Such a situation has (a) increased the dependence of the scientists and scientific institutions in the developing countries on those of the developed ones; (b) contributed to the non-assimilation of the scientists of the developing countries and their alienation from the fundamental problems in their own societies; and (c) limited the potential for building up local innovative capability.

107. To alleviate this situation, there is a need for co-operation programmes in R and D designed to strengthen or build R and D capabilities in the developing countries. Among the proposals made to reach this goal are:

(a) Establishment of twinning arrangements between institutions of developed and developing countries : this will facilitate the flow of science and technology information as well as access to and sharing of the results of R and D efforts;

(b) The mounting of joint R and D programmes oriented to the needs of developing countries, where parts of the research activities could be done in the developing countries and part in the developed ones: this will help to make better use of the R and D potential of developed countries for the benefit of developing ones and in the orientation of the joint research efforts, and also take into account useful traditional knowledge of developing countries;

(c) The setting up of a co-operation mechanism between the innovation system in developed countries and the productive system of developing countries;

(d) The establishment of regional and international networks of R and D institutions with a view to developing joint research programmes, promoting exchanges of science and technology information and disseminating the results of R and D.

108. The application of science and technology for development requires, besides the existence of a suitable science and technology infrastructure, the participation of a "critical mass" of qualified and experienced scientists, engineers and technicians. Although the developing countries have achieved significant results in building up a limited science and technology infrastructure, they still lack adequate manpower and funds to solve their acute problems. They continue to depend on the knowledge and technical know-how produced in the advanced countries. This is inherent in the following :

(a) Inadequacy of the higher education system, which does not link science and technology training to the local productive system and therefore contributes very little to the development of an endogenous science and technology;

(b) The fact that scientists and engineers who were trained abroad usually continue to consider the scientific discipline of their training as their main activity and continue to work on problems that are less linked to their local conditions;

(c) The shortages of middle-level human resources, which are necessary for the maintenance of science and technology equipment and industrial plants etc.

109. To overcome these difficulties it is essential:

(a) To improve the training capability of developing countries;

(b) To associate scientists from developing countries in R and D activities relevant to them which are carried out in the developed ones with a view to ensuring their passage from a discipline-oriented training to a problem-oriented training directly related to the needs of their countries;

(c) To give incentives to foreign firms to provide in-service training facilities.

110. In this context, it is necessary to draw attention to an important element of global R and D, namely research and development in developed countries for military purposes. It has been estimated that of the total cumulative R and D expenditure since the second World War, about 40 per cent has been directed towards achieving military ends. And about 25 per cent of the world's scientific manpower is estimated to be engaged currently in military-related pursuits. Another dimension is that six developed countries are estimated to account for as much 96 per cent to 97 per cent of the world military R and D. The total expenditure on military R and D is currently estimated to be of the order of about 25 to 30 billion dollars. In addition military R and D is moving further and further away from any conceivable civilian use and itself constitutes a major influence on the arms race. It is necessary therefore that a specific framework for redeployment of S and T resources from military to civilian purposes should constitute an important part of any global R and D strategy.

D. International co-operation with developed countries

111. It is obvious that in any process of restructuring international scientific and technological relations, the role of developed countries assumes critical importance. About 90 per cent of the global technology trade takes place within the industrial world and, of this, more than half is within transnational corporations which are based in these countries. Parent companies invent or design new processes and then sell these to their foreign affiliates or subsidiaries, either for a lump sum payment or on a royalty basis.

112. Any strategy for redistributing S and T resources and rectifying the global S and T imbalance must take into account the transnational corporations and their network of global affiliates. While transnational corporations and the measures to be taken to regulate their activities are under consideration in other forums of the United Nations it is necessary to discuss their role in relation to S and T and to formulate proposals.

113. Major transnational corporations have at least one third of their assets abroad and market at least one third of their output in other countries or directly through a network of foreign affiliates. Activities of transnational corporations are entirely conditioned by their corporate interests and are often at variance with the policies and priorities of the host countries, mainly as the result of the contradiction between integrated development (the aim of the host country) and the over-all profit orientation brought in by policies of world redeployment of the industrial activities of transnational corporations, which normally result in truncated growth. Thus transnational corporations may indulge in activities that are inconsistent with or even prejudicial to the economic objectives of developing countries. Many of these corporations concentrate their R and D activities in their home countries and use their international network to transfer the resultant technologies to their affiliates, which are often "enclaves of irrelevance" to developing countries. In the rare cases where R and D activities are undertaken by their subsidiaries, these programmes are seldom in accordance with the host country's development priorities and R and D policies.

114. Developing countries are usually in a weak bargaining position vis-à-vis the transnational corporations, whose resources are often larger than those of many developing countries individually. Very often, the importer of technology in a developing country is an enterprise of modest size with high marginal costs for technology as compared with transnational corporations having low incremental technology costs.

115. One of the important means of strengthening the science and technology capacities of the developing countries is to require transnational corporations to undertake substantial local R and D activities and also to ensure that any such programmes shall be compatible with the host country's science and technology policies and R and D priorities. In other words, there should be significant quantitative as well as qualitative improvement in the R and D activities of the subsidiaries and affiliates of transnational corporations in developing countries. Thus, advantage could be taken of the structure of transnational corporations, which has been attacked as an impediment to the endogenous technological growth of developing countries, as an instrument contributing to the autonomous technological growth of these countries.

116. It is at once a challenge and an opportunity; such a transformation, if it is achieved, has the potential to reverse the present trend towards aggravation of global imbalances. Given the structure of the societies of developed countries, the Governments of these countries claim that, vis-à-vis transnational corporations, their role in the transfer of technology is small, if not minimal. While this claim has some validity, the power of Governments in influencing and conditioning economic and technological decision-making in such countries should not be underestimated. Governments of technologically advanced countries, including "market economies", can, when they choose, decisively influence corporate decisions through a variety of fiscal, monetary, taxation and regulatory measures. Given the necessary political will, it should be possible to adopt appropriate incentives and disincentives that result in a shift of R and D activities of transnational corporations from their home countries to their affiliates and networks.

117. Another major science and technology area in which the Governments of developed countries can play a significant role in helping developing countries is in relation to technology generated or developed with government funding. In many developed countries nearly 50 to 60 per cent of total R and D expenditure is from public funds, and even assuming that a large part of this is on military research, there still remains a substantial proportion of research results which could be useful to developing countries. It should be possible to devise appropriate mechanisms through which technologies resulting from this research can be made available to developing countries on acceptable terms. Most of such transferts have so far been bilateral. While such transferts have played a significant role on a bilateral basis, transfers on a multilateral scale should spread the advantages to all developing countries. The transfer of technologies resulting from government-funded research from developed to developing countries has so far received little attention, and it would be desirable to arrange for an international mechanism to undertake the promotion of such transfers.

118. There are also many technologies in developed countries which are either non-patented or for which the patents have expired, and are thus freely available to any potential users. These technologies are often considered as obsolete or uneconomical for use in developed countries. Some

of these technologies could be useful to some developing countries - if not for direct use at least for adaptation - and a prerequisite of this is the provision of full information on them on a continuous basis so as to make available a range of choices to developing countries. A suitable institution or institutions should arrange for this to be undertaken and linked with international information networks.

119. Other relatively unused sources of technology and know-how are small- and medium-sized enterprises in developed countries that should be encouraged to participate in the transfer of technology to enterprises in developing countries. Because of their size and style of operation, such enterprises are more likely to pursue policies that are in conformity with developing countries' interests than are transnationals. Here again, the most important element is information about their existence and activities; any global science and technology information system that may be established should provide access to such data.

E. Co-operation among developing countries in science and technology

120. Developing countries should, parallel with their efforts to achieve national technological autonomy, strive towards greater collective self-reliance in science and technology; among themselves they possess a relevant range of the resources and skills required. This does not mean that there is no role for developed countries in supplementing the efforts of developing countries, but that the potential for collective technological self-reliance is considerable. The obstacles to greater co-operation among developing countries in science and technology, as in other fields, are partly political, partly economic and partly attitudinal. It would seem that greater political will by developing countries for such co-operation is required for them to achieve independence from their historical links with the North. A step by developing countries in the direction of greater awareness and commitment towards technological co-operation among themselves has been the recent United Nations Conference on Technical Co-operation among Developing Countries held in Buenos Aires. It is now necessary to consolidate such co-operation by harmonizing science and technology policies, resource development and industrial strategies and by establishing appropriate multilateral institutions. Such co-operation might include the sharing of skilled manpower as well as educational and training systems; in particular, developing countries could undertake joint initiatives in the exploitation of their mineral and energy resources and in the establishment of "multinational" industrial projects based on the principle of optimizing common resources and sharing market potential.

121. In discussing horizontal co-operation in science and technology for development, ideas for action and specific proposals take two forms: types of projects that countries could co-operate in implementing and institutional mechanisms that specifically facilitate such projects and promote co-operation in general.

122. Instances in which co-operation among developing countries in specific projects might be facilitated include :

(a) Activities requiring a minimum critical mass : these include research and development programmes for which a minimal level of staffing, equipment, and financing is required for viability;

(b) Large undertakings in science and technology in which economies of scale are desirable because of the magnitude of resources required (information systems, training programmes, computers, satellite telecommunications, etc.);

(c) Activities that involve an international dimension and include the exchange of data and experience as a prerequisite for taking common positions or joint action. (An example would be the establishment of comparative information systems on terms and conditions for technology transfer, so as to increase the bargaining power of the countries buying technology. This could embrace agreement on common strategies for negotiations with technology suppliers and the adoption of common positions vis-à-vis transnational corporations, multilateral financial institutions, etc.);

(d) Problems common to a geographical zone embracing more than one country (relating, for example, to research into ecological conditions, the exploitation of natural resources and use of water systems);

123. Means of enhancing collective self-reliance of developing countries in science and technology might include:

(a) Harmonization of developing countries' interests in order to select or develop technologies critical for their development;

(b) Maximum utilization of the scientific and technological resources available;

(c) Strengthening the individual and collective negotiating capacity of developing countries vis-à-vis the industrialized countries;

(d) Establishment and operation of North-South networks for the exchange of information on all matters pertaining to the creation, acquisition and utilization of technology.

124. Developing countries should, in striving towards collective self-reliance in science and technology, pay particular attention to the problems of the least developed, land-locked and island developing countries arising from the virtual absence of science and technology infrastructure, lack of skilled manpower, geographical location, lack of access to the sea, small markets and limited economies of scale. More advanced developing countries should share technologies under their control with them on preferential terms and mobilize their science and technology skills to tackle the special problems of these countries. They should also place greater emphasis on the generation and development of technologies for solving the special geographical and transportation problems of some of these countries and provide preferential facilities for training. The more advanced developing countries should also consider the establishment of subregional or regional centres for the development and transfer of technologies specifically designed to solve development problems of particular significance to the least developed countries such as drought, desertification, health, and food production. Regional centres for technology transfer should also assign priority to the solution of the problems of these countries. Any strategy for fostering greater science and technology co-operation among developing countries should place special emphasis on the problems of the least developed countries, embracing in particular provisions for facilitating access to know-how already available in other developing countries, and for pooling science and technology resources of all developing countries to meet the special needs of the least developed.

V. STRENGTHENING THE ROLE OF THE UNITED NATIONS IN THE FIELD OF SCIENCE AND TECHNOLOGY AND THE PROVISION OF INCREASED FINANCIAL RESOURCES

A. Objectives

125. A review of the national and regional papers prepared for the Conference and other pertinent documentation reveals a certain concentration on the following issues:

(a) The need for a harmonized and gradually integrated science and technology policy and, if possible, joint planning within the United Nations system;

(b) The need for greater co-ordination between the organizations of the United Nations system, but in more than a purely institutional sense and without necessarily implying the creation of new institutions;

(c) The corresponding mechanisms for policy-making, planning and co-ordination;

(d) The role of the United Nations system in promoting action on global issues where action by one country alone is not sufficient;

(e) Other questions, in particular:

(i) The role of the United Nations system in strengthening the technological capacity of developing countries;

(ii) The problem of greater resources for science and technology activities in the United Nations system;

(iii) The need for decentralization of the activities of the United Nations system to bodies at the national and regional levels;

126. Until now, the response within the United Nations system to certain criticisms of inadequacies has been largely an institutional one, that is, institutional reforms involving review of the mandates of the various organizations in the system so as to reduce duplication, wastage and the like. When it comes to science and technology, it has become apparent that such institutional approaches are not the answer, but at the same time further work has been thwarted by the absence of an over-all, unified and internally coherent United Nations approach to the questions relating to the application of science and technology to development.

127. In this connexion, the first requirement is to secure from all Member States, developing as well as developed, a commitment to apply science and technology to development, and this is not fundamentally an institutional question. Similarly, institutional preoccupations should emphasize co-ordination mechanism between existing components rather than repeatedly redefining mutual areas of competence. Such co-ordination can be implemented only within the framework of an over-all science and technology policy for the United Nations system. At the same time, the formulation of specific objectives, the establishment of broad long-term, over-all planning and particularly the vertical and horizontal harmonization of the medium-term plans of the different agencies are required.

128. It should be recognized that the historical growth of the United Nations system has necessarily resulted in a number of separate entities and distinct modes of operation, born of different circumstances, for its several components. This diversity should be regarded as strength rather than weakness. In any discussion of the existing United Nations system, it is therefore fundamental that the mandate and competence of existing organizations be respected. It should also be recognized that these organizations are responsible to their own separate intergovernmental legislative organs, which approve their work programmes and authorize the necessary expenditure of resources for their implementation.

B. Over-all co-ordination, harmonized policy and joint planning in the United Nations system in the field of science and technology

129. There is general agreement on the need for greater cohesiveness and co-ordination among the organizations of the United Nations system, particularly in the light of the objectives of the New International Economic Order, not only to avoid duplication and wastage but, in a positive sense, to promote harmonization of the objectives and policies of the various organizations.

130. Since 1973, there has been wide discussion about the need to develop "a harmonized and gradually integrated" United Nations science and technology policy. At the same time, preparations undertaken for the United Nations Conference on Science and Technology for Development have stressed again the importance of an over-all United Nations policy for science and technology in the context of a commonly accepted international development strategy such as that now being prepared by the United Nations General Assembly for the third development decade. The United Nations Conference on Science and Technology for Development is expected to provide policy guidelines to be developed and translated by the United Nations system into an integrated strategy. One of the main tasks of the Conference and its follow-up will be to translate into specifically science and technology objectives the general goals of the New International Economic Order as they emerged from the basic resolutions of the General Assembly at its sixth and seventh special sessions and from later decisions.

131. While general policies for science and technology can be considered across the board, in practice science and technology are integral components of ongoing economic and social programmes from which they cannot be separated in the United Nations system. Steps going beyond general policy guidelines

would presuppose considerable progress in the development of appropriate methodologies and procedures, for example at the interface with socio-economic changes, of identification of scientific and technological components of over-all activities, and of reforms in functional budget classification and statistics so as to permit functional budgeting for science and technology.

132. The formulation of an over-all harmonized science and technology policy consistent with the development strategies required by the establishment of the New International Economic Order necessitates, as a prerequisite, a clear identification of the objectives and priorities of the United Nations system. Once current work on uniform technologies and budgeting procedures is sufficiently advanced for the United Nations system as a whole, the formulation of a comprehensive long-term science and technology plan for the whole system will become feasible. Such a plan, at least at the outset, should not specify the executing agencies for the implementation of its component parts and should make it possible for periodic adjustments to be made at the execution stage through the existing co-ordination machinery and through other measures. At the same time, concerned organizations of the United Nations system should examine the feasibility of evolving a medium-term plan vertically compatible with the over-all science and technology plan of the system as a whole. As for horizontal compatibility between the medium-term plans of the organizations of the United Nations system, this could be ensured through mechanisms of inter-agency consultation.

C. Programme co-ordination

133. The United Nations system should envolve specific policies and measures to ensure intersectoral programming and co-ordination of the scientific and technological activities of the various United Nations bodies having due regard to the different models and priorities of each Member State, with its own needs, as well as to the need to integrate United Nations programmes with national, bilateral and other efforts.

134. In other words, the question of programme co-ordination - of "who should do what" in specific programmes - among the United Nations organizations in the area of science and technology for development cannot be decided in any general way and for all cases by any central machinery. This must be tacked on a continuing basis, using appropriate ad hoc and sometimes informal techniques, including the establishment of interagency task forces, agreements and consultation procedures for co-operation and co-ordination in specific fields.

135. One concrete suggestion that has been put forward to develop co-ordination in the United Nations system is the selection of a certain number of action-oriented international research pilot projects of an interdisciplinary and interagency nature so as to illustrate the advantages of combining knowledge, resources and the political will of the Member States consistent with the social and economic preoccupations of developing countries and chosen within the subject areas identified by the Preparatory Committee of the United Nations Conference on Science and Technology for Development at its second session. 11/ To be fully effective, such projects should have independent financing, must attain a certain critical mass and should take advantage of ongoing activities in the United Nations system. It should also be realized that immediate results from such a venture cannot be expected as the gestation period for such projects is usually three to five years at a minimum.

136. Global and regional activities will of necessity continue to account for a large part of the system's programmes, and at these levels, interorganizational joint planning of programme activities in specific areas is already being actively pursued. It is, however, at the national level that organizations should make their most important contribution to science and technology for development. Joint programming of the activities of the system at the country level involves different kinds of decision-making processes since such activities are invariably undertaken on the basis of specific requests from the Governments concerned and are linked to specific and concrete projects. Action should lead to a strengthening of the capacity of individual Governments to select and co-ordinate external inputs, including those from the United Nations system. International machinery for co-ordination of activities directed towards national needs already exists. This machinery should be put to the best possible use with full respect for national sovereignty and nationally established priorities. At the regional level, again, the machinery already exists. The question is how this machinery

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11/ See Official Records of the General Assembly, Thirty-third Session, Supplement No. 43 (A/33/43), vol.I, annex I, resolution 3 (II).

could be put to better use or strengthened as necessary with due regard, in particular, for subregional co-operation.

D. Central mechanisms for policy-making and co-ordination

137. The machinery for co-ordination and over-all policy-making for science and technology in the United Nations has had in the past, and seems to require in the future, four principal elements, comprising an intergovernmental organ or organs, an interagency co-ordinating mechanism, machinery for the provision of expert advice, and secretariat services. In considering this structure, however, it is well to recall that such machinery is a means and not an end in itself. Its purpose is to improve the effectiveness of the system so as to produce greater cohesiveness and coherence. It is natural, of course, that the structure will depend upon the volume and nature of the science and technology activities for development undertaken in the United Nations system.

138. It is obvious that the four elements must be viewed as a part of the single dynamically interacting mechanism. Thus the organizations of the United Nations system must be involved in the discussions of the intergovernmental organ and the advisory body for the optimum functional efficiency of the mechanism.

139. Four such elements, representing respectively, the Member States, the agencies and organizations of the United Nations system, independent scientific and technological expertise and a substantive secretariat, are already part of the existing system. The main question at present is how to strengthen, upgrade or modify these components in the light of past experiences and of the expected future requirements of the system.

Intergovernmental organ

140. As far as the intergovernmental organ is concerned, this will naturally be the apex of the machinery for co-ordination and over-all policy-making for science and technology in the United Nations system. Among the possibilities envisaged, the most effective might be to entrust these functions to the highest organ, the General Assembly itself. The General Assembly is the supreme forum of the United Nations system for over-all policy-making, for establishing priorities for the system as a whole and for formulating guidelines and directives which command the universal respect of the system. Moreover, the General Assembly is responsible for those important scientific and technological activities of the United Nations system in which the Economic and Social Council is not actively involved (for example, outer space, oceans, disarmament). Science and technology are now increasingly looked upon as a system transcending the economic and social sphere and interacting with political, cultural, information and other systems.

141. The Economic and Social Council has so far been the focus for science and technology for development in the United Nations, working through its Committee on Science and Technology for Development. Over-all policy guidance for activities of the United Nations system in the field of science and

technology for development has been provided by this Committee, which was established by the Council in 1973. From its inception, the Committee has been trying to develop a harmonized United Nations science and technology policy. In connexion with the rationalization of the procedures envisaged for the Economic and Social Council, it has been proposed that the Council itself could play the role of the Committee by meeting periodically in subject-oriented sessions devoted to science and technology for development. These meetings should be at the ministerial or equivalent level.

142. Another existing organ which could continue to play a valuable role at the intergovernmental level to ensure horizontal and vertical compatibility of the medium-term plans for the United Nations system with an over-all science and technology plan would be the Committee for Programme and Co-ordination, which is subordinate to both the General Assembly and the Economic and Social Council for planning, programming and co-ordination, particularly in inter-disciplinary fields.

143. In the light of specific requirements, one can envisage the use of these three bodies, the General Assembly, the Economic and Social Council and the Committee for Programme and Co-ordination, in accordance with their respective mandates.

144. In any case, States may wish to consider whether the intergovernmental organ should not be open to all countries and be able to attract the participation in its sessions of high-level decision-makers in science and technology in the States Members of the United Nations. This would endow it at once with high political status and specialized competence and thereby facilitate its work in giving the necessary guidance to the United Nations system in science and technology.

Consultative arrangements for interagency co-ordination

145. Under the general direction of the intergovernmental organ or organs, the problems of programme co-ordination between the various organs of the United Nations system will need to be tackled on a continuing basis, using appropriate machinery within the framework of the Administrative Committee on Co-ordination.

146. Consultative arrangements for co-ordination under the Administrative Committee on Co-ordination should involve officials of the organizations concerned at a sufficient level of seniority and experience to enable them to contribute to the formulation of policy issues relating to the application of science and technology to development. They would also review the execution of decisions arising from the Conference.

Machinery for the provision of expert advice

147. For the United Nations system as a whole, there is a continuing need to harness the available independent, scientific and technological expertise in the

cause of promoting the application of science and technology to development. Up till now, a major role has been played in the United Nations system in this respect by the Advisory Committee on the Application of Science and Technology to Development. Future arrangements for the provision of expert advice should build on the extensive experience of the Advisory Committee on the Application of Science and Technology to Development. They should be as flexible as possible and capable of responding to changing needs and should make possible consultation with the widest spectrum of scientists and technologists in the natural and social sciences as well as those concerned with managerial and operational questions, including decision-makers, and policy-makers from the public and private sectors. It is essential that the best available independent expertise for dealing with any particular problem should be available on an ad hoc basis when required. In selecting experts and appointing members to any advisory group, the Secretary-General should consult with the executive heads of the organizations concerned. Any standing scientific advisory body should refrain from becoming involved in sectoral problems or in problems of co-ordination, which are best dealt with by the interagency co-ordinating mechanism. One of the main roles of experts should be to provide a bridge between the United Nations system and the non-governmental, scientific and technological community.

Secretariat services

148. The secretariat services should make full use of the experience and competence available in the organizations of the United Nations system. To this effect, the secretariat services could take advantage of the increased inter-changeability of personnel between the organizations of the system. Decisions on its organizational location and level should take account of the rapidly increasing importance of science and technology in relation to development.

149. There can be no doubt that the Conference and its preparation have contributed to the recognition at the national as well as at the international level of:

(a) The specificity of science and technology, which is not to be considered simply as an element of the productive process but as a supporting system that underlies all economic, social, political and cultural activities;

(b) The importance of science and technology in national and international activities and the consequent need to place them at the highest level. These considerations should have a direct bearing on the location of the secretariat services in the United Nations system.

150. With this in mind, the secretariat services should be subject to the overall guidance of the Director-General for International Economic Co-operation and Development, so as to enable it to play an effective role in co-ordinating activities related to the application of science and technology to development in the United Nations system as a whole.

151. Provision should be made for reciprocal interchange of personnel between the organizations of the system according to the tasks to be performed. The secretariat should not perform any sectoral, vertical or operational functions since this would prevent it from discharging its responsibilities effectively.

152. The secretariat services would service the intergovernmental organ and assist in developing and implementing the over-all science and technology policy of the United Nations system in close co-operation with the relevant organizations. It would follow up the implementation of the recommendations of the Conference and the intergovernmental organ. It would likewise service the interagency co-ordinating mechanism, and assist the ACC as necessary in its consideration of co-ordination problems related to the application of science and technology to development. It could also be responsible for arrangements concerned with obtaining expert advice. Its competence would cover "horizontal" fields of activity and it should have the capacity to undertake wide-ranging policy studies and system-wide analysis in co-operation with the organizations of the system. The secretariat services would also have a function of promoting the integration of scientific and technological inputs from the system with development programmes. The secretariat services would also perform a referral function in regard to science and technology activities performed by the system.

E. Global issues

153. The United Nations family of organizations, as the only intergovernmental system of general scope, should par excellence be involved with the solution of global issues.12/ However, one should recognize that the current methods of work in the United Nations system are not entirely appropriate to such a task. Allocation of competence in the United Nations system, as well as in Member States, tends to be sectoral, or vertical, with little provision for the inter-disciplinary and horizontal treatment necessary for the study and management of global issues. Global problems, by their very nature, require an interactive and systemic treatment, taking always into account all the problems as well as societal, economic, cultural, and political dimensions. That is why it is imperative to ensure horizontal linkages, interdisciplinary and interagency treatment, better co-ordination between the several elements of the United Nations system, and a procedure, still badly missing, for setting precise objectives and priorities for the whole system with a corresponding over-all plan in science and technology. The United Nations, being charged at the global level with the problems of peace and development, should be able to help Member States considerably in the identification, study and solution of global issues.

12/ For a definition of global issues, see chapter II, D.

154. The solution of global issues does not necessarily presuppose the creation of new international bodies or agencies. The major effort for global issues should be national activities co-ordinated by a common understanding and a common effort at the international level. The complexity of global problems and their dependence on diverse economic, social, political, cultural, natural, scientific and technological factors imply interdisciplinary approaches to research, decision-making and implementation. It is essential that the elaboration of new approaches to international co-operation in science and technology, as they apply to global problems, should try to make optimum use of institutions and resources, both national and international, already in existence. A new concept of co-operation and interaction between national institutes, international agencies and programmes and non-governmental organizations, representing the world scientific community, should be worked out. This could take the form of creating a network of contacts, information exchanges, co-ordination of research, planning and implementation, funding institutions and the like.

155. The areas for collaboration need to be clarified. In the first place, there is a need to keep global problems under close observation in order to trace the emergence of new problems or of unknown aspects of the old ones and to determine their urgency and dynamics. Particular attention should be given to the interaction of various global problems and to the harmonization of steps towards their solution. For it is quite probable that measures intended to solve one global problem will aggravate or complicate others. Another important area of international co-operation is the entire spectrum of methodological problems related to the analysis and the elaboration of possible solutions to global problems. Their novelty calls for the working out of a new and adequate methodology for the analysis of the available options and for subsequent decision-making.

156. There is an urgent need for elaborating new analytical tools and approaches, such as unified, co-ordinated methods of collecting and storing data as well as for the adoption of standard terminology for the major fields of basic and especially applied research. If this is not done soon, international co-operation for the solution of global problems may suffer as a consequence.

157. Many developing countries, because of vulnerability, lack of diversification, and other well known characteristics, would be the first victims of global problems that are not solved, and yet developing countries have shown certain reservations as regards any priority consideration of global problems for a number of reasons: they feel that if priority were given to global issues, it could serve to divert the attention and resources of the international community away from their specific problems of development; they consider that the gobal objectives should be adapted in order to give special attention to their development goals and strategies. Moreover, the developing countries feel that the traditional approach to global problems was designed with the help of a sophisticated science and technology capacity and a highly capital-intensive establishment that are available only to the few most advanced countries; as a result only the most developed countries have so far been able to monitor and attack the global problems according to their own intersts. Any endorsement

of this state of affairs by the international community would inevitably lead to the acceptance of new forms of monopoly and consequently continuing external dependence.

158. These concerns of developing countries must be taken into account in tackling global problems by ensuring that they become full partners in such activities, and at the same time by demonstrating that emphasis on global issues is complementary and not alternative to the concerted attack on the specific problems of developing countries. Indeed, under-development is in itself a global problem and should be taken into account in any global systemic approach.

F. Strengthening the scientific and technological capacity of developing countries

159. A major substantive role for the United Nations system must be a part of any international framework for strengthening the scientific and technological capabilities of developing countries. It must stimulate and catalyse in developing countries the strengthening of their endogenous capabilities. It must co-ordinate its efforts with those of developed countries and orient its projects and programmes in developing countries in such a way as to strengthen more directly their scientific and technological capabilities in accordance with their national policies and priorities. In the formulation, identification, appraising and implementation of United Nations projects in developing countries, specific attention must be paid to science and technology.

160. Science and technology information is a common asset of mankind and its unhindered availability constitutes a vital element in strengthening the science and technology capacities of developing countries. The United Nations system should play a major role in establishing or strengthening a network of science and technology information systems, including technology banks.

161. The United Nations should also provide leadership in strengthening the manpower capabilities of developing countries, particularly in the skills required for assessment, selection, unpackaging and absorption of technologies. Manpower constitutes the most valuable resource of developing countries and broad-based coherent and comprehensive programmes for the human resource development of developing countries must therefore continue to be of primary concern to organizations of the United Nations system.

162. The United Nations system can also help developing countries in elaborating technology policies and in ensuring their integration into national planning. It should also play a more active role in relation to the redeployment of industries from developed to developing countries. It is well placed to develop specific programmes aimed at strengthening the capabilities of developing countries in design, consultancy and engineering as these constitute a fundamental component of strengthening the endogeous capabilities of developing countries.

163. The United Nations system should also undertake specific projects to tackle the infrastructural and accessibility problems of the least developed, land-locked and island developing countries; in this context, it could institute detailed studies to examine whether the problems of the least developed countries require any different approach from that of other developing countries in striving for technological autonomy. To this end, it could attempt to clarify whether structural changes required in such countries are conceptually different from those needed in other developing countries.

164. As a general principle, the best way to ensure the full identification of the working of the United Nations machinery with the goals of development is for developing countries to be in a position to exercise their rightful decision-making power in all legislative bodies and assume a proper authority in the administrative and technical structure of the Organization.

G. The provision of resources

165. The fundamental constraint on a stronger role for the United Nations system in science and technology for development is lack of financial resources. An increased level of activity is directly dependent on their greater availability on a predictable, continuous and assured basis. While better co-ordination must of course continuously be sought, it cannot by itself bring about significant improvement unless substantially greater resources become available.

166. In national papers for the Conference, recommendations have been made for the provision of greater funds in the United Nations system for the application of science and technology to development. A group of developing countries has recommended a fund for financing science and technology projects which should be able to attract resources from interested Governments. Another possibility that has been raised in this connexion would be to redeploy some of the savings accruing as a result of any tangible progress in disarmament.

H. Decentralization

167. There is a wide measure of agreement that the activities of the United Nations system in the application of science and technology to development could be made more effective by increased decentralization to the regional, sub-regional and national levels. Indeed, such activities could increasingly be delegated to the regional and sub-regional levels if the regional commissions of the United Nations were strengthened so as to enable their better interaction and contacts with national activities in developing countries. In addition, co-ordination with the activities of regional and sub-regional organizations outside the United Nations system should be strengthened. Activities at the national, sub-regional and regional level in connexion with the preparations for the Conference have demonstrated the value and feasibility of such decentralization and provided a basis for its continuation and extension.

A Review of Some of the Important Science and Technology Policy Issues

It would be difficult, and not very useful, to give a precise definition of what is included within the scope of science and technology policy research. It will suffice to give a very general definition and follow this with examples of important policy issues which have been the topics of research projects in recent years. This will also serve to identify some of those issues which require further study and research.

Science and technology policy research for development can be defined as any research which contributes to the body of knowledge on how science and technology contributes to development. Ultimately, this knowledge should lead to better decisions and policies. It is not only government policy makers who can benefit from this knowledge, but anyone who makes decisions about how to use technology in their work, and indeed, in everyday life. These could include factory managers, farmers and members of the general public.

This general definition has little operational value, but it serves to demonstrate the very wide range of issues and approaches which must be considered. A better idea of the scope of science policy research can be gained by a consideration of some of the policy issues which have been studied in recent years.

At the national level one of the most fundamental technology policy issues is the choice of whether to import technology or to try to develop it locally. This decision will vary according to the level of development of the country and its existing scientific and technical resources, its development objectives, its attitude to foreign investment, the suitability of existing foreign technology, its ability to pay for that technology, its ability to find out what technology exists abroad, and a host of other factors. It will be a decision which varies from sector to sector in the economy, and will also depend on whether a short-term or a long-term perspective is taken. The 'make or buy' decision is, in fact, a central policy issue for all countries, industrialised or developing.

For many developing countries, in most sectors of the economy there is little real choice. They must depend heavily on foreign technology. The challenge to the policy makers is how to improve their bargaining strength so that the technologies which are imported are most suited to the country's needs and are acquired on the most favourable terms. It was this latter issue which dominated the research agenda of most developing country research groups working on science and technology policy problems in the 1960's and early 1970's. The principal objective of the early work was to identify the costs of importing technology, especially from multinational enterprises.

Several instances of excessive financial costs were discovered, especially in the pharmaceutical industry, but equally important for the developing countries was the revelation of the extent to which the acquisition of foreign technology was accompanied by restrictive business practices on the part of the suppliers. This research led directly to a number of policy measures whereby governments sought to monitor and control the flows of foreign technology. There are some doubts about how effective these measures have been in achieving their avowed objectives, but the link between policy research and policy formulation was extremely close.. In many instances in Latin America, the researchers themselves assisted in policy formulation.

At the international level, the developing country concern about technology transfer has been reflected in the efforts to negotiate, within UNCTAD, a code of conduct on technology transfer. This has led to a good deal of debate and the code is still a long way from being finally negotiated. Many of the more controversial issues would benefit from more research. The claims and counter claims are often based on too little information, but surprisingly, the amount of empirical research on technology transfer has decreased substantially in the developing countries in recent years. Those studies which have been carried out have demonstrated the complexity of the issues, and have shown that the market for technology has many imperfections. These need to be examined on an industry-by-industry basis, in order for appropriate policy measures to be designed.

Other research has started from the proposition that technology will have to be imported, but has tried to identify ways in which the previous turn-key package approach can be altered. It is argued that if the developing country can learn how to put together the package of technology from its component elements, not only might it be possible to bargain more effectively for those elements purchased from abroad, but the learning effect will be considerable, and there will be more opportunity to substitute local technologies for some of the elements. Research on unpackaging technology was carried out very successfully in the Andean Pact countries, and the detailed studies in several industries had a major impact on the investment decisions in those industries.

But while recognising the need to import foreign technology, most developing countries are committed to a policy of building up their own problem-solving capabilities so that more techniques can be developed locally. But, as those countries which have tried to build local scientific and technological capabilities have discovered, it is one thing to invest in scientific and technological institutions and manpower, and quite another to ensure that the fruits of this investment are used in production. In part, the problem lies in knowing what policies will encourage local entrepreneurs to make greater use of the emergent national science and technology system.

There is little information to guide policy makers responsible for building up a local science and technology system. In the past, most have modelled their institutions on those existing in the industrialised world. Science councils, universities, industrial research institutes, Academies of Science, scientific and technological information systems, have all been copied and transplanted often without modification, in the developing world. Are they the most appropriate models? Have they performed their tasks well? What lessons can be drawn from the experience of those countries which have set up such institutions? Most observers would agree that the results have been disappointing, but very little policy research has been carried out to pin down the causes of the disappointment. The result is a good deal of conventional wisdom based on partial evidence. Some people argue

that it is the fault of the scientists who use their newly established Councils to act as pressure groups so that they can continue their own basic research, regardless of development priorities. Others point to the fact that the productive sectors of the economy exercise no demand on the science system, and hence the latter operates in isolation.

It was to examine the ways and means open to government policy makers for encouraging closer links between supply and demand of technical knowledge that the Science and Technology Policy Instruments Project (STPI) was designed. This project has now shown how difficult it is to design a package of policy measures which will encourage entrepreneurs to make greater use of the local science and technology institutions and capabilities. This is a topic which will be explored in greater depth in subsequent papers and discussions at the workshop.

The rather simplistic picture of supply and demand of technical knowledge, so far portrayed in this note, needs to be modified by a better understanding of how technical change actually takes place in firms. Excellent empirical research on this topic has already taken place in Latin America, Korea, India and Thailand, and the importance of minor adaptive research, the role of the engineering profession and the extent of the similarities and differences between different industries is now well documented.

Much of the science and technology policy research carried out in developing countries has focused on the science and technology decisions related to modern industry. There has also been research on the diffusion of agricultural innovations, and some studies on the effectiveness of agricultural research. But many countries are embarking on a policy which puts much greater emphasis on rural development and the satisfaction of basic needs of the whole population. What are the implications of these policies for science and technology? How can local traditional technologies be upgraded and improved and new tech-

nologies designed? Can new ways be found to link the scientific and technological community with the problems of the rural and urban poor? These are questions for which there are no easy answers. Policy research is required.

Countries do not exist in a vacuum. They are connected to other countries through flows of capital, people, and trade in commodities, manufactured goods, technology and knowledge. The nature of the flows is governed by many factors which collectively contribute to the constraints which national policy makers face in devising their own science and technology policies.

Some of the international relationships can act to release constraints, as happens when regional groupings of countries agree to share their scientific and technical resources. This occurred very effectively for a while with the Andean Pact. Here there was a political commitment to rationalise industrial investment in the region, and this provided the opportunity for effective collaboration in a variety of scientific and technological activities.

The links between the developing and industrialised countries are the ones which have given rise to greatest discussion. The rules which govern the economic relationships between States were, for the most part, set by the industrialised countries. They have resulted in what all developing countries would call an 'unfair' distribution of the world's income in favour of those countries who made the rules. The efforts to change these relationships and hence gain a 'New International Economic Order' (NIEO) have not, as yet, met with much success. But the relationships have considerable impact on science and technology policy issues.

The most obvious one is the trade in technology. This has already been mentioned, and the efforts to obtain improved access to world technology are a major issue for the negotiators at NIEO debates. The attitude of several of the developed countries to this issue appears to be hardening, due to the perceived threat to their own economies'

well-being, following increased competition from developing country manufactured goods produced with the technology originating in the industrialised countries. Both developed and developing countries have come to recognise that technologies provide the ultimate source of economic power. If the concern leads to policies which limit the export of new technologies, then the policy of technological self reliance in the Third World will take on even more urgency than at present.

Another way in which technological developments in the North may affect the international economic relationships with the South is through the development of new technologies for substitutes and synthetics, which affect the demand for the primary commodities of the South. The development of high-fructose corn sweeteners already provides a threat to the cane sugar producers, and further research and development, which make it economic to open up low grade mineral resources, weaken the position of many Third World countries.

The brain drain, international scientific collaboration and aid are all issues which have a direct bearing on the science and technology policies of countries in the Third World. Appropriate policies to exploit the opportunities afforded by international collaboration, and to minimise the disadvantages, all require analysis and research of the issues before policy measures are devised and implemented. These studies all fall within the rubric of science and technology policy studies.

So far, only those lines of research which affect the major policy decisions have been discussed. There are other more micro-level decisions about technology which have been the topics of many research projects. Some are related to policy alternatives in specific sectors or industries, studies which seek to identify the full range of economic and social consequences of using one technology rather than another. Many of the studies on appropriate technologies fall into this category, as do recent studies on rural energy, and those studies which

assess environmental impact. The methodologies for making these 'technology assessments' are still rudimentary, but the process of evaluation is a necessary one in order to make the most appropriate choice of technique.

This brief survey has identified some of the policy issues which have been studied during the past few years. The body of knowledge which has accrued is still partial and incomplete in most areas of policy making. But the survey does reveal the wide range of issues which have been researched. It will be for the workshop to identify other issues and problems and to suggest priorities for future research.

c) Some Characteristics of Science and Technology Policy Research*

The previous section has summarised some of the policy issues which have been studied in the past few years. From this research experience, it is possible to make the following observations about science and technology policy research:

1. The clients for most of the science and technology policy research carried out in developing countries have been government policy makers. Some University researchers have seen their academic peers as the target audience for their work, but most have been willing to work closely with policy makers. This has meant that science and technology policy research, like most other policy research, has been 'action-oriented'. It has required interaction between policy makers and researchers. There are implications for the time span of the research from this approach. There is usually a conflict between the immediate need for results on

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* This section is based on discussions at a meeting convened by IDRC in September 1977 to discuss the future directions of science and technology policy research.

the part of policy makers and the time required for a more rigorous and scholarly work. Furthermore, a balance has to be found between research to meet the immediate needs of policy makers today, and research which anticipates the needs of policy makers tomorrow. If exclusive attention is given to the former it may mean that many important policy decisions have to be taken before the relevant research is completed.

2. Much of the research has tended to be diagnostic. It has sought to understand the way in which science and technology are related to the process of development, but only on relatively few occasions has it gone beyond diagnosis to devise solutions and outline policy options. The work on international technology transfer is a notable exception.

3. The more recent science and technology policy studies have demonstrated that:

   a) investments in the non R and D scientific and technological activities can be expected to yield quicker returns to production than investment in R and D. Hence science and technology policy making must give attention to the full range of scientific and technological activities.

   b) Policies originally devised for other economic and social objectives frequently have a greater impact in determining technological outcome than policies specifically formulated for this purpose.

4. There has been an emphasis on industrial technology policy research, and a relative neglect of agriculture and social services (health, education, transport). Although agricultural economists have covered the field of agricultural innovation and extension, little work has been done from the perspective of science and technology policy, and even less on the ways of relating science and technology policies in the agricultural, industrial and social services fields among themselves.

5. There has been an emphasis on economics and engineering as the main disciplines involved in science and technology policy research, and many of the initial researchers in the field came from the physical sciences. There is a need to incorporate other disciplines such as law, administration, social psychology, anthropology, history and so on, particularly because science and technology policy is not a 'field' in the traditional disciplinary sense of the word, but more an 'area of concern' on which many disciplines should converge and be brought to bear.

6. Science and technology policy research in the developing world has not paid sufficient attention to the differences among the various less developed countries, and there has been an implicit tendency to treat them as if they were a homogeneous group. The knowledge accumulated during the mid 1970's shows that this approach is highly inadequate for science and technology policy research, and that the heterogeneity of the developing world must be acknowledged and taken into account in the conduct of research.

7. In many instances, the statements and opinions of 'wise old men' (particularly from the industrialised world)

have been used as a surrogate for science and technology policy research.

8. Although these notes are concerned with science and technology policy research in the less developed world, there is a large body of knowledge developed in the industrialised nations, which may be tapped to provide ideas and suggestions for science and technology policy research in developing countries. Great care must be exercised to avoid extrapolations of findings into different contexts, but there is no point in ignoring the contributions to knowledge, particularly those of individual disciplines, that may assist researchers in science and technology policy in the less developed countries in the generation of policy-relevant knowledge suited to their own countries.

9. There are some topics on which a good deal of research has been carried out. However, science and technology change rapidly, and it is almost impossible to consider any particular problem area as 'closed' for research purposes. For example, even though much work has been done in the field of technology transfer, the changing situation and the modification in the behaviour of the suppliers of technology, make it necessary to study their reactions to policy measures and their new forms of behaviour, both of which are rapidly transforming the existing knowledge of the situation into obsolete conventional wisdom. Furthermore, there is justification for replicating some types of studies in different regions and countries in order to take into account their specific contexts, and to ensure that a learning process emerges through involvement in research.

10. One of the features of science and technology policy research carried out in the developing world has been that a large part of it was performed through research networks involved in comparative exercises. This allowed a mutual learning process to take place, which has led to some generalisations and to the identification of 'transmittable' science and technology policy research findings. This is one characteristic that should be preserved whenever appropriate, but without neglecting completely individual studies that would shed light on the heterogeneity and uniqueness of some situations.