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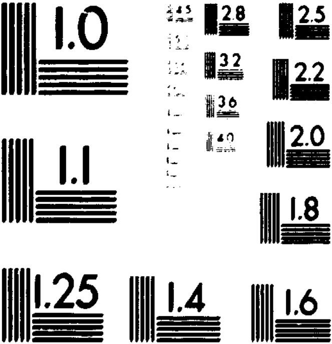


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NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No. 2)

14530

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Distr.
LIMITED

UNIDO/IS.522
18 March 1985

ENGLISH

# MID-DECADE REVIEW OF THE IMPLEMENTATION OF THE VIENNA PROGRAMME OF ACTION *

(Science and technology for development).

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V.85-24007

## Abbreviations

| | |
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| BIOREDs | Biological Resources Development Teams |
| ECDC | Economic Co-operation among Developing Countries |
| ESCAP | Economic and Social Commission for Asia and the Pacific |
| ICDC | Industrial Co-operation among Developing Countries |
| INTIB | Industrial and Technological Information Bank |
| IRSI | Industrial Research and Service Institutes |
| NTICs | National Technical Information Centres |
| ODA | Official Development Assistance |
| R and D | Research and Development |
| SBIR | Small Business Innovation Research |
| TCDC | Technical Co-operation among Developing Countries |
| TH | Technologies for Humanity |
| TIES | Technological Information Exchange System |
| UNCTAD | United Nations Conference on Trade and Development |

## Contents

Introduction

1. This paper attempts to present an overview of the progress, problems and prospects for the implementation of the Vienna Programme of Action, and more particularly from the UNIDO point of view, relating to science and technology for industrialization.

2. Since the United Nations Conference on the Application of Science and Technology for the Benefit of Less Developing Areas in 1963 a conviction has grown that science and technology are catalysts for development and propellants for progress, reducing the widening gap between the advanced and developing countries.

3. The World Plan of Action for the Application of Science and Technology to Development 1971 called for the building up of indigenous science and technological capacity in developing countries and for mounting an attack through United Nations agencies on a number of specific problems of high priority for research and application of existing science and technological knowledge for development. It was further suggested that the judicious introduction of 'new' technologies, like space, computers etc. might accelerate the progress of developing countries. The apparent emphasis, however, was on appropriate technology and technology transfer, on the premise, that enough knowledge was already available to be transfered. The limitations of such an approach are now well recognized. Further the hope that industrialized countries would increase their financial aid (0.05 per cent of their GNP) to develop science and technology in developing countries; that industrialized countries would devote 5 per cent of their non-military development outlays to science and technological needs of developing countries as well as developing countries achieving a target of 1 per cent of their GNP devoted to R+D in the decade of 1980 have not been realized. However, it must be stated that since then, there has been a visible progress in the indigenous science and technology infrastructure in several developing countries and the World Plan of Action is still valid.

4. The United Nations Conference on Science and Technology for Development in 1979 lead to the Vienna Programme of Action on Science and Technology for Development. The Vienna Programme seeks to build indigenous science and technological competence and self-reliance in developing countries. Its major programme areas are (a) science and technology policies and plans for development; (b) the creation and strengthening of science and technology infrastructure; (c) the choice, acquisition and transfer of technology; (d) the development of human resources for science and technology; (e) the financing of science and technology for development; (f) science and technology information; (g) the strengthening of R+D in and for developing countries and their linkages to productive system and (h) the strengthening of co-operation in the field of science and technology among developing countries and between developing countries and industrialized countries. These really constitute the elements of technological self-reliance.

5. UNIDO's role is to promote, encourage and assist in development, selection, adaptation, transfer and use of industrial technology and to serve as a clearing house for industrial information as an integral part of industrial development and to meet the target set in the Lima Declaration and Plan of Action.

6. UNIDO's work in the area of development and transfer of industrial technology has been substantial. More than three quarters of UNIDO's work is directly related to technology. All the operational, technical assistance and promotional activities and consultation meetings of UNIDO have had, as an integral component, the transfer of development technology and cover total self-reliance in the spectrum of technology. Many of the activities of UNIDO including the programme on technological advances span all of the programme areas under the Vienna Programme of Action. The past experience has shown that the technology policy has to be integrated in the industrial policy, which, in turn, has to be integrated with other national policies and development goals. Local science and technological competence is needed even to import technology, lest the inappropriate choice will be not only expensive but also distort the pattern of consumption, production, distribution and development and creating social and economic inequities and could be destructive to the environment. The ability to discern and choose technology is an essential ingredient of self-reliance. This ability to 'discern' can

only come from the ability to collect, analyse, assess information and arrive at alternative choices and from awakening and awareness intelligence about the technology impact on social, economic and industrial development. This calls for easy access to industrial technological information, trained personnel to analyse it and build up the necessary structures and organizations. That indigenous science and technological competence and industrialization have a cause and effect relationship, and that it is the essence of the strategy for industrialization is well recognized by and reflected in UNIDO's activities. UNIDO further recognizes that in a world of imposed North/South asymmetry, nowhere are the disparities between industrialized countries and developing countries more marked than in this crucially important field of science and technology and indigenous science and technological competence building, therefore, becomes imperative. Lack of indigenous technology leads to imports of technology and foreign investments, loss of control, enclave economy leading to further imports perpetuating technology dependence. Attempts are now made to bring about industrial transformation through technology transformation which in turn brings about a reduction of technology dependence on transnational companies and industrialized countries; through development of technology and strengthening the technological capabilities of developing countries; improving access to technology under fair and reasonable terms and improving the bargaining position of developing countries in international technology markets.

## The Present State and Current Constraints in Developing Countries

7. Due to the national and international actions, there is a growing awareness in developing countries for the cause and use of science and technology for development and for building local science and technological competence. Developing countries are also unanimous about the need for explicit governmental action in regard to technology, though the level of technological awareness in different developing countries is not the same. Even today, there is a persistent reliance on imported technology in some countries. Some of the least developed countries are more reliant on international assistance for both technology and financial investments. Some

face financial, managerial and market constraints; some others feel that the climate may be upset for foreign investment by regulating technology and that setting up industries is more important than building up technological competence at this time. But in this process they may run the risk of charting a wrong course of development.

8. The need for technology policies and planning is well recognized in developing countries. Several developing countries have now science and technology plans (Brazil, Guatemala, Guyana, Mexico, India etc.) and some have special chapters on science and technology in their national plans (Iraq, Nigeria, Romania, Thailand etc.). Several others are preparing science and technology plans and strategies for the future. India and Mexico have technological policy as separate from science policy. UNIDO has been assisting several countries to build their competence in science and technology policy and planning. Only a few countries have explicit science and technology policies. Fewer still are those that have integrated science and technology policies with other policies to make science and technology as deliberate instruments for development. An integrated system approach is not visible. The efforts in general have been ad hoc and fragmentary than within a total framework of development policy. Sufficient interaction of science and technology with productive sectors has not taken place to create a self generating dynamism in industrial structure.

9. Several countries have set up national science and technology boards or councils for policy-making, promotion, co-ordination, etc. Some have ministries or special departments for science and technology and several others are planning to set up such science and technology councils or departments. However, there is no systematic evaluation of the existing science and technology structures and science and technology policies and programmes. Evaluation, monitoring and co-ordination are the weakest links. Some countries have wise policies but there are not enough policy instruments and where they exist implementation is weak because of both internal and external influences and vested interest. The important elements of consistency, co-ordination and monitoring are the weakest links.

10. A number of mono- and multi-purpose research, service, management, educational and training institutes have been set up in developing countries. In most cases, they are government funded and only in a few countries and even

there only a few industrial manufacturing companies have their own R+D establishments. The expenditure on R+D as a percentage of GNP is yet to reach 1 per cent in most developing countries. Several countries have taken advantage of UNIDO's assistance in infrastructure building. A survey of IRSIs (Industrial Research and Service Institutes) and their constraints in functioning in developing countries have also been well documented.

11. Developing countries are characterized by shortage and low utilization of scientists and engineers with attendant brain drain problems. The qualified technologists and engineers engaged by the industry are very few. There is a mismatch between the felt needs of the user industry and the indigenous research results and trained manpower. These institutions still work on traditional lines or copying colonial patterns or international fashions and find themselves unequal to meet the development needs of developing countries. The much needed linkage and free mobility between research, industry and education are mostly missing. There is still a big gap in technological service capabilities like project preparation, feasibility studies, design and engineering consultancy etc. Expenditure on R+D has not yet reached even 1 per cent of GNP. The private sector plays little role in technical training except in a few countries like Brazil, Singapore, the Republic of Korea etc. The need is strongly felt for a coordinated, intensified manpower programme and for both formal, informal, on-the-job training and special training programmes for technical, managerial and financial skills and for women. Some countries have given several incentives for in-house R+D in industry and some important changes have also been made in patent laws.

12. Only a few developing countries export technology to a limited extent. There is room for expanding this activity as the technologies adaptated to one developing country may better suit another. Most countries are still primarily dependent on imported technology leading to an enclave economy with the small urban elite controlling money and power and a large section of the people not reaping the benefits of industrialization. Some developing countries have introduced measures to regulate technology transfer through laws, guidelines, regulations or administrative controls. However, several developing countries have decided not to regulate as at the present stage the regulations are not convenient or are no longer necessary. UNIDO's guidelines

for project evaluation, evaluation of technology transfer, for setting up technology registry, technology regulatory agencies, system of consultations and checklists for negotiations etc. and the United Nations Conference on Trade and Development's (UNCTAD) code of conduct for technology transfer have been valuable inputs for developing countries. Much is talked about international code of conduct for technology transfer and changes in patent systems but little is done. The capacity to assess, select, negotiate, unpackage a package, and bargain is still very weak in many developing countries.

13. Several countries have set up national scientific and documentation centres, technology information centres, technology transfer centres etc. as well as regional technology information networks. But yet the appropriate linkages between technology generators and users are still missing. Some countries do not possess technology information and some even do not know where to obtain information. Some have information on the progress of science, but not on technology alternatives and related investment packages to help the industry and investors to decide. Industrial technology information is also not so easy to obtain. UNIDO's INTIB and TIES have proved to be very helpful in this regard.

14. There are several technology cooperative programmes to supplement and complement the local competence of a developing country. There are several governmental bilateral, regional and multilateral programmes and also non-governmental assistance programmes. Training and experts advice are important components in such programmes in addition to financing. Other types of assistance are in the area of setting up information, documentation and patent centres. Latterly this developmental assistance from industrialized countries particularly for multilateral funding has slowed down.

## Missing Elements

15. No doubt much progress has been made in developing countries in building local science and technological competence. Many countries are still short of the requisite infrastructure, trained technical manpower and the critical mass in order to be effective.

16. Technology and its effective use are influenced by the degree of industrialization: Without an indigenous technology base, industrialization could take a wrong path and without industrialization the demand for technology would be less. The cause and effect relationship of industrialization and indigenous technology base was mentioned earlier.

17. Technology transformation also needs a social political transformation. A society's capacity for technology innovation is the result of complex relationships with available capital, skills, information, infrastructure, co-operation between government and industry, existence of 'social carriers', tracing of hidden technologies and implied national confidence. Creative, inventive, innovative environment is conducive to technology generation and use. A small increase in problem solving capability and productivity of a large number of people is more effective than a large increase in productivity of a small number of people. The general level of technological awareness and capability of the population as a whole as distinct from scientists and engineers is much to be improved in developing countries. Such a social political transformation is essential for technology changes. On the other hand, technology change brings about social change. This interaction and cause and effect relationship between technological change and social change has to be recognized. Scientific temper, as a way of life of the people, their thirst for science and technology and participation in the total technology spectrum will have to be improved to ensure effective use of technology.

18. It is realized that since developing countries are at different levels of development, each country has to decide for itself the level of science and technological competence it wishes to achieve. A single pattern for science and technological development and a cure for all the deficiencies cannot be prescribed. But attempts should be made to build minimum level of local competence for autonomous decision-making.

19. The development of indigenous science and technological capabilities is not necessarily to be a slow evolutionary process. Certain minimum capabilities for self-reliant autonomous decision-making could be developed in the short run. A co-ordinated policy action can secure the optimal use of available resources and capabilities.

20. It is also time to learn from the lessons of both developing and industrialized countries in regard to the different models and strategies followed by different countries. The United Kingdom was the first to have an industrial revolution. At present the United Kingdom has a strong base in basic science but not in technology. The United States of America at first devoted all its efforts to applied research and innovative technology and later built up a strong basic research group. Japan showed wisdom in assimilation and synthesis of imported technology, and in building its own comprehensive technological capabilities. Among the developing countries the Republic of Korea put the emphasis on export promotion, foreign technology, investment and management know-how and later internalization and selective delivery of imports on the basis of the expertize gained. India, on the other hand, blocked rather than promoted foreign ownership and control with emphasis on internalization of skills, structures, acquisition of self confidence and then entry into world markets. A systematic study of other models of Brazil, Mexico and other developing countries will greatly help to decide future directives for science and technological development.

21. The hope has not materialized that when appropriate structures were built, science and technology would automatically interact with society and improve the standards of living of people, increase their incomes, employment potential and improve the lot of the poorer sections, particularly in rural communities. It is recognized that technology has to be used as a deliberate tool for development and the incentives and the policy frame should be loaded in favour of it.

22. The extent of technology payments by developing countries as a whole in the form of royalties and fees increased from US$ 1.4 billion in 1978 to US$ 2 billions in 1980. The technology supplied has been limited in scope and generally followed the tail end of technology innovations in industrialized countries. Indigenous technologies have little opportunity or incentives to develop. This position has to be improved.

23. In spite of several progressive steps taken by the developing countries, the age old constraints still continue regarding the widening technology gap between industrialized countries and developing countries; technology transfer costs, relevance, the international industrial property

system and the control of transnational corporations. No doubt there is an awakening and consciousness in developing countries for the cause and use of technology for development but the efforts are not commensurate with the needs and conditions.

## Changed Conditions

24. The current constraints are further aggravated by the changed conditions in the world economy in the recent years. The world is going through an unprecedented economic crisis (with some promise of recovery) with a monetary and financial disarray, high inflation and unemployment even in industrialized countries; developing countries faced with impossible international debts and debt service burdens, sharp deteriorating terms and volume of trade, growing protectionism and low levels of Official Development Assistance (ODA). Added to this are the problems of growing population, inequity and unemployment.

25. The world economy system is interdependent through trade, finance and communication. But this interdependence is asymmetrical in character as the South depends for more on the North for flow of information, technology, trade and finance. Any change in the policy in the North affects the South. The South is thus highly vulnerable. The need is to reduce or remove both asymmetry and vulnerability.

26. Nowhere is this asymmetry greater than in science and technological development between the North and South. Industrialized countries not only possess technology and technologists; the advantage is sustained by increasing R+D and by undefined rules of technology transfer and the working of the international patent system thus leaving developing countries inherently in a weak bargaining position. The impact of emerging technologies has added a new dimension.

27. The close and dynamic interrelationship between industry and technology and the immense influence they exert on economic activity is well recognized. A dynamic exploitation of this interrelationship provides the key to both

industrial and technological development. The developing countries are faced with the dual tasks of rectifying the deficiences in their past efforts and improving upon the present position and concurrently responding quickly to the impact of emerging technologies. To come to grips with this situation with tasks unfinished and the new ones emerging is the challenge to developing countries in the 1980s.

28. The UNIDO International Forum on Technological Advances and Development* concluded that technological advances have a great potential and relevance to developing countries; would be feasible of application and the opportunity costs of overlooking technological advances by developing countries is very high. The Forum recommended inter alia that developing countries individually and collectively examine their existing levels of competence and ke steps to reorient their technological institutions and structures to respond readily to the technological change.

29. It is important at this time to understand the character and impact of technological advances. They are increasingly basic research based; transdisciplinary in character and appear to converge with a synergetic effect, e.g. biotechnology and microelectronics combine to bring about a new stream of production equipment, materials of construction, services and information systems. Further the total innovation chain from basic research to production and commercialisation has become considerably short and the economies of scale tend to be changed. The scientific research and technology development may be sophisticated but the applications in several cases are relatively simple. Fortunately, technological advances do not conflict with existing and traditional technologies but help to upgrade them. Technologies like biotechnology appear to be particularly designed and tailored to suit the local sunbelt resource; its generation and utilization; for decentralized production and providing alternate pathways for industrialization.

30. The convergence of technological advances has contributed to a significant measure to technical change. Their continued impact is bringing about a radical change in the very structure of industrial, economic,

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* International Forum on Technological Advances and Development, Tbilisi, USSR, 12-16 April 1983 (ID/WG.389/6).

educational and cultural systems. Already 65 per cent of the existing industry is affected by it with a likely uprooting of some industries and the changes in international technology markets and technology transfer process. This technology change is altering the rate and pattern of growth; of industrialization; of the development and society as a whole encompassing skills, attitudes, employment, work environment, leisure, family and social life. We now talk of the post industrial society, bio-information society, space colonization, laws of space, sea and seed, knowledge industry, high technology and sunrise industries, education technologies and an explosion of the service sector. The very concept and contents of science and technology capabilities are also undergoing changes and the new types needed may provide the key to productivity and international competitiveness in future. These technological advances offer great promise for developing countries for leap-frogging, e.g. biotechnology and genetic engineering providing new solutions to the old and basic problems of food, fodder, fuel, fertilizer, pharmaceuticals, mining of minerals etc. with low energy, low capital intensity etc.; similarly microelectronics have far reaching effects on the productivity, quality, cost effectiveness, competitiveness, flexibility to manufacturing of industrial operations and above all they have a direct impact on quality of life of people, improving public health, education and communication levels of a community.

31. In an interdependent world economy and technology dependent developing countries, the inevitability of the diffusion of technological advances is recognized. Some technologies required by developing countries and alternate pathways for industrialists may not be of interest to industrialized countries as they are already saddled with heavy investments in the existing patterns of industry. Then what are the options open for developing countries? The current concerns on the rate and pattern of development make it all the more necessary to apply technological advances to accelerate development processes in developing countries. Each country has to decide for itself the point of entry, the degree of penetration, sources of inputs, linkages, vehicles of implementation etc. but the minimum level is a must for any country. The entry points for minimum, medium and high levels were suggested by the Tbilisi Forum.

32. A timely and quick response is of paramount importance. Such a policy response may include awareness campaign, concentrated programmes for transdisciplinary research, education and training; and changing and strengthening the institutes, structures and approaches in the total technology system.

33. The economic asymmetry and vulnerability and the total science and technological dependence of developing countries and the present crisis, hardening the arteries of the North resulting in a reduction of development assistance, require serious attention. Every crisis poses a challenge and every challenge an opportunity. It is time for developing countries to look inwards rather than outwards: find alternate pathways for industrialization and technological self-reliance; upgrading existing and traditional technologies; generating, mobilizing and optimally utilizing local natural resources and human skills; appreciate technological advances as new opportunities for revitalizing and accelerating the development process and seeking collective self-reliance through more and more South-South co-operation in the fields of economy, trade, industry, finance and technology, in addition to the North-South co-operation. Given the political will and commitment, this can be done.

## Possible Elements for Future Framework of Action

34. The above account gives an insight in the present status of science and technological self-reliance in developing countries, the continued constraints, the missing elements and the changed conditions that have to be taken into consideration for implementing the Vienna Programme of Action in future. The real challenge for developing countries for the remaining half of the decade is to come to grips with the situation of unfinished tasks, improve upon the past performance and concurrently offer a quick response to the impact of new and emerging technologies. UNIDO thus finds itself undertaking a dual task of trying to correct the existing imbalances and looking into the future in the dynamic character and context of the technological advances to assist developing countries in establishing a policy framework for national action for the 1980s and in building up local science and technological competence and self-reliance.

35. What then are the future perspectives and framework to implement the Vienna Programme of Action? Each Programme area may be considered in this regard.

## I. Science and Technology Policies and Plans

36. It is recognized that it is not enough to have technology policies and plans. There should be a minimum "tool box" of policy instruments and the political will to implement them. The tool box should, among others contain a system for monitoring technology change at global level and its implications for the country in question to be able to respond quickly; to review and reorient the existing institutions, groups and structures, or to create new ones. Technology information awakening and awareness intelligence is a must for every country. UNIDO has been advocating assisting developing countries to set up such technology assessment and monitoring systems. A special independent, small group containing the representatives of the industry, government, labour, public interests, science and technology, bankers, planners and administrators may help to monitor technology trends and suggest industrial technology promotion policies and policy responses and methods of implementation. In a recent UNIDO project preliminary steps were taken for setting up a national system for industrial technology perspectives.

### Methods of implementation

37. Technology policy should be integrated with other national policies like industrial, education, economics, trade policies etc. UNIDO further suggests drawing up a Complementary Technology Programme that is complementary to industry development programme and priorities, identifying and defining clearly the technology tasks to be undertaken within the country and the technologies to be imported etc. in the identified priority areas. The national priorities in developing countries in general are economics, employment, equity, energy, efficiency and environment.

38. The technology is yet to be used as a deliberate instrument for development and yet to be integrated in every walk of life and every department and activity of the government. Technology policies and plans in developing countries appear to have given more emphasis on infrastructure development and that too in a few segments of the total technological spectrum and very little in regard to using technology as an instrument for development. Integration, monitoring and review of technology, consistency and co-ordination appear to be the missing elements or weakest links in the development process. This position has to be corrected soon and UNIDO has a critical role to play in this regard.

39. UNIDO's programme on technological advances proved to be timely and valuable to developing countries in being alerted to the policy implications, the potentials and limitation of technological advances. Studies, meetings and other promotional programmes were organized at the national, regional and international levels. The overall policy issues, the implication and potential of six selected technological advances in the fields of genetic engineering and biotechnology; microelectronics, materials and related technologies, petrochemicals, energy from biomass and solar photovoltaic cells, were critically examined. An expert group meeting held at Moscow,* and an International Forum held at Tbilisi** took a transsectoral view of the potential of technological advances, possible policy responses and a possible framework for national action. A follow-up of this activity was the Dubrovnik Meeting*** to examine the institutional and structural responses to technological advances of the developing countries.

40. Technological advances are not to be seen as an escape route from the problems of development but as options to be placed within the range of available technology options, ranging from the traditional to advanced and

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* Expert Meeting Preparatory to International Forum on Technological Advances, Moscow, USSR, 29 November - 3 December 1982 (ID/WG.384/14).

** International Forum on Technological Advances and Development, Tbilisi, USSR, 12-16 April 1983 (ID/WG.389/6).

*** Workshop on Institutional and Structural Responses of Developing Countries to Technical Advances, Dubrovnik, Yugoslavia, 31 May - 4 June 1983 (ID/WG.401/7).

opting for "technology pluration". UNIDO studies also indicate that a framework for national action for the 1980s should be (a) based on both technical and socio-economic assessment of technologies; (b) be integrative in many respects - integrating modern and traditional technology systems with industrial and other systems, transdisciplinary research and education; integrating various persons in the development process etc.; (c) be innovative and reformatory, leading to a new pattern of skill profiles; discarding obsolete systems and ideas; and (d) be dynamic, forward-looking and flexible to take note of and adjust to rapid technology change.

41. The technological advances are bringing about a quiet second industrial revolution. The economies of scale, economies of scope, flexible manufacturing systems, the decentralization of industry; the information explosion in science sector, the changed telecommunication systems etc. have significant meaning for developing countries to improve education, health, nutrition and quality of life of people. Thus the changed conditions for industrialization can be used for rapid social and economic development with technological advances throwing up newer opportunities and possibilities. The policies and programmes must reflect these changed conditions.

42. The economic vulnerability of developing countries should induce them to devise policies and programmes for a two pronged attack:

(a) Emphasis on local resources and skills:

Generate, mobilize and utilize the local rich renewable resource like biomass and biomass-based industrialization strategy as an alternative pathway for industrialization, utilizing every part of the plant from "Leaf to root" as an industrial raw material. This may lead to decentralized rural industrialization and rural development leading to a rural urban continuum rather than rural-urban conflict. This may also reinforce the nexus between Agriculture, Food, Energy and Industry/Development.

(b) Emphasis on exports and competitive aspect:

This leads to upgrading existing technologies, to improve productivity, quality and international competitive strength with a dynamic and aggressive technology policy keeping a keen eye on technological advances and their introduction.

43. The policy issues that have a bearing on technology should relate to certain key result areas, identifying specific growth poles in terms of specific clusters and activate the dynamic interlinkages within and among these clusters. Technology thrust areas have to be identified and defined. Some of these ideas will be discussed later.

44. Other policy instruments would include differential and direct taxation, credits, regulation of foreign investment and import of technological capital goods, raw materials etc. and promoting local R+D and industrialization.

## II. Creation and Strengthening of Science and Technology Infrastructure

45. The technological status of individual industrial sectors in a country must be assessed first as well as the technological service capabilities. Possible impact of technological advances on these sectors should be evaluated and certain lead sectors and niches for competition in external markets identified and then integrate industry technology policies, plans, programmes and priorities.

46. The science and technology infrastructure should cover the total spectrum. Though much progress is seen in developing countries, there are still several gaps that need to be bridged. There is considerable need for creation or strengthening of local capability for specialized technology services like design and consultancy engineering; access to and ability to analyse information to arrive at alternatives and choices and awareness intelligence. Market intelligence, financial management, techno-economic

feasibility studies, project preparation and implementation, standards and quality control are few other areas where local competence is yet to to be built in several countries.

47. New institutions may be built only after (a) translating existing national programmes into concrete technology tasks, assigning these tasks to existing centres; identifying the gaps and only then create new core groups or institutions to close these gaps. The weaknesses of existing IRSIs have been well documented by UNIDO. The mere presence of IRSIs is shown to be no guarantee for technology self-reliance. Their rational management, making their researches relevant to meet the needs of the nation, an inward looking research programme utilizing indigenous resources for import substitution and export promotion, translating the results of research into usable production technologies, and transmitting the technology impulses to rural areas and productive sectors are some critical areas that need careful attention. Pilot plants, proving plants, design engineering, equipment manufacture and venture-oriented capital that are so necessary for translating the results of research need strengthening.

48. The whole range of technological institutes, their relevance, effectiveness and interaction have to be reassessed. Among existing institutions, interlinkages and transdisciplinary, transsectoral, transorganizational links have to be established and/or strengthened. Where small or less developed countries find it difficult to establish a wide range of institutions, the concept of a "core group" of 10 to 15 people could be explored for each priority area, providing the group with common facilities and allowing them to grow into centres of excellence or advanced institutes.

49. Up till now the emphasis has been wrongly or rightly placed on applied research and monodisciplinary research. But more and more technology is science based. Technological advances are basic research based and transdisciplinary in character. In basic research "excellence" is the motto. Research institutes should have a portion of their time and funds allotted to basic research in relevant areas where technologies will help produce high value-added items. There should be a reconciliation between the liberty of choice for a researcher and relevance to national needs and priorities.

50. Whether it is technological advances or a product development, the concept of integration is the key, demanding transdisciplinary team work approach. This calls for a change in attitudes of researchers, engineers and managers, and the very structures of science and technology institutions, their policies, plans, programmes and projects have to be changed.

51. Science and technology institutions have tended to copy the international fashions without a look inward for local resources, age-long experience and skills on the finger tips of the people and the traditional technologies. There is much science behind the traditional technology. This has to be discovered first and then upgrade them with modern science and technological knowledge: There is a great need for science and technology institutes to take up this activity. The exogenous character of these institutes in developing countries should become more and more endogenous and relevant.

52. Many countries do not have national scientific academies and professional associations. In some countries, there is no critical mass yet. But the promotion of such institutions is an important activity for the future to bring about intellectual independent stimulative thinking.

53. UNIDO implemented over 165 projects of technical co-operation, and expenditure under institutional infrastructure amounted to US$ 12.7 million in 1981. Assistance was provided to national Councils for SIT, IRSIs, industrial information sources, appropriate technology institutes, technological innovation centres, technology transfer centres, technology services and industrial consultancy companies in a number of countries. In addition, several promotional meetings for small industries development, technology fairs, technology delivery, technology services etc.

## III. The Choice, Acquisition and Transfer of Technology

54. The technological alternatives were examined in some detail in the 1975 UNIDO International Forum on Appropriate Technology at Delhi. The "Co-operative Programme of Action on Appropriate Industrial Technology"

(ID/B/186) of UNIDO introduced the concept that different technologies could be appropriate to developing countries depending on the development objectives, resource endowments and conditions of application of each country. Thus a wide range of technologies from traditional to modern to emerging technologies could be appropriate. Alternative technologies could be identified even in some ostensibly capital-intensive sectors like mini-steel, fertilizer, paper, cement plants etc. The need is to upgrade traditional and exisiting technologies and find alternate pathways to industrialization.

55. The choices can only come from alternatives and alternatives from a systematic evaluation of information against set objectives and priorities and impact statements on costs, benefits, employment, environment etc. This applies to both indigenous and imported technology. There is not much evidence to show that decision-makers are being provided with such technology alternatives. No doubt, many countries have a review of technology imports in developing countries. But even here the screening and evaluation of technology are focused only on the terms and conditions of technology acquisition, rather than the impact of technology itself. The technology regulations are largely confined to foreign payments, investments, restrictive clauses etc.

56. Only a few countries have mechanisms to effectively co-ordinate and mesh the imported technology with domestic competence with a view to adapt, absorb and even improve upon imported technology. Japan, known for its ability to adapt, absorb, synthesize and improve upon imported technology, spends US$ 7.00 to 14.00 on every dollar paid for its import. Such a system is not visible in most developing countries. This aspect, adaptation and absorption, does not become a part of the screening and evaluation process of technology choice.

57. In several developing countries, repetitive imports of the same technology still continue, though turnkey projects are being discouraged. But technology is also embodied in equipment imported. Horizontal transfer of imported technology is also not taking place to the extent desirable, due to lack of trust among the industrialists themselves of the same country or because there is no monitoring and feed-back system, identifying areas where no further imports are needed.

58. Indigenous science and technological competence building could be accelerated using the technology import regulatory mechanism - for coupling indigenous R+D and consultancy engineering institutions with acquisition, adaptation, absorption etc., making training of personnel at different levels compulsory as a part of project costs, insisting on using local resources and skills etc.

59. UNIDO continues to be involved in the promotion and dissemination of technologies like mini-hydro power, energy conservation in selected sectors etc. Profiles of solar equipment manufacture, plans for metal production development, disaggregation of technology in petrochemical industry, low-cost vehicles in rural communities, tanning of hides and skins and small-scale footwear manufacturing and other publications of UNIDO are to help developing countries in the selection of technology. Advisory missions were fielded to strengthen the negotiating capacity of developing countries for technology acquisition. Training workshops, study tours, manuals for negotiation of joint ventures, training in acquisition of technology and reviews on the experience of developing countries in technology regulation are other activities.

60. UNIDO's TIES and INTIB systems continue to serve developing countries in the area of information exchange, trends in technology flows, technology acquisition etc. responding to requests for detailed information on contracts for specific technologies, providing manuals and guidelines on an approach to software licensing agreements, providing a regular information exchange with a coding manual, through technology services and delivery systems etc.

## IV. Human Resource Development for Science and Technology

61. It is now recognized that a greater emphasis should have been laid earlier on human resource development as it is the key and centre for all development. Though there has been considerable progress made in this area, several constraints still continue. There is a mismatch between the products of education/training system and the industrial and other needs of the

nation. Educated unemployed on one side and the lack of qualified personnel for the vacant posts on the other; the problem of brain drain, lack of skilled workers and top managers bring into clear focus the imbalances to be corrected. "Development education" is the recognized need. A greater and cohesive effort may be needed to convert "brain drain" into "brain bank" to take full advantage of qualified nationals resident abroad.

62. In several developing countries, the desire for a degree and white collar job is great and the skilled worker/technician is not given the social status. This has to be changed. Delinking of degrees with the jobs; providing facilities for technicians to go up the ladder of education as well as salaries and social status as separated from formal university education will greatly help.

63. Further the new "education technologies" - computer-based education are altering the very nature of the learning process - leading to "learning to learn" - a more "anticipatory learning" and not "maintenance learning" as at present - preparing the child or adult to adapt and modify their knowledge as circumstances require. Particularly at adult level, there is a major shift from instructor-taught seminars towards individualistic computer-based self-study, operating at a level and pace suited to individual needs. The question is not "do we use computers" but "how do we best use them?" What this all means to developing countries is yet to be studied in depth.

64. Technological advances are also affecting the skill and employment patters requiring training and retraining for changing jobs at least three times in a person's life time. Retraining of people at all levels with employees' contributions or by a tax on wages has to be given due consideration.

65. Technological advances are basic research based, transdisciplinary and converge with a synergetic effect. This demands change in the attitudes and structures of educational and training institutions. The newer courses like Life Sciences, Earth Sciences, Material Sciences etc. are interdisciplinary and the syllabi and curricula of the courses thus require change. The trainer-teachers have to be retrained.

66. Basic to all innovation and creativity is a strong foundation in mathematics and science. All over the world, the growing importance of rebuilding mathematics and science education is recognized even at pre-college level.

67. Education satellites, extensive TV networks, video, radio etc. are other tools available for education and training of people, particularly in the hinterland. Developing countries will be ill advised not to take advantage of these several educational technologies.

68. In all the UNIDO programmes, human resources and training become an integral part. The training also covers the total technology spectrum from policy formulation, generation, selection, acquisition, adaptation, absorption, transfer and utilization of technologies and implant on-the-job training. Training in industrial manpower; including training component in all capital goods projects, upgrading of technological capabilities and retraining form part of UNIDO activities. The integration of women in the industrial development process continues to receive priority by UNIDO. Expenditure for fellowships and training components in technical operation projects implemented by UNIDO amounted to US$ 11.4 million. The demand is for 20 times more than the available fellowships etc. This area needs greater strengthening, and training of personnel in developing countries where such facilities exist should be encouraged.

## V. The Financing of Science and Technology

69. In spite of several economic pressures, the expenditure on R+D has increased in a number of developing countries, more particularly in the ESCAP region, yet it is still below the accepted level of 1.0 per cent of GNP. UNIDO proposed that developing countries should aim at 1.5 per cent of their GNP for R+D by 1990 and to reach a minimum level of 2.0 per cent by 2000.

70. R+D expenditure is mostly funded by the governments, so also the educational and training institutions. There is the relative if not total lack of R+D at enterprise level. Some countries are providing special

incentives like tax exemptions, long-term low-interest loans to induce industry to set up captive R+D establishments. Foreign joint venture companies are persuaded or make it incumbent on them to set up R+D centres in developing countries. The Republic of Korea tried a financial reserve system for technology development by business but it did not work well. Instead, a new Technical Development Corporation was set up to provide funds to industry to do research by themselves or through public institutions, to develop and exploit technology; to import, adapt and absorb advanced technologies. The Small Business Innovation Research (SBIR) Act, 1982, USA, is designed to increase the flow of federal R+D money into companies with fewer than 500 employees, recognizing technical innovations are greater, faster, cheaper to come by in small business than in large business.

71. No increase, on the contrary, a likely decrease in the amount of international funding to finance science and technology in developing countries is anticipated. In view of this, co-operative endeavours in science and technology among developing countries become imperative and urgent.

72. Additionality for funding for R+D etc. can only come by (a) Governments' own phased increase in priority funding in specified areas; (b) taxing the industry and the user; and (c) as an inbuilt component in foreign investment, foreign joint ventures and bilateral and international aid or co-operative programmes.

73. Whether the government should limit itself to creating a climate conducive to R+D by removing legal and regulatory hurdles or even provide subsidies, tax incentives, risk capital etc. to private and public enterprises is a policy question. But until science and technology becomes a way of life, the developing countries would have to look for every avenue to promote science and technology development.

## VI. Science and Technology Information

74. Information intelligence and awareness intelligence are still weak in developing countries. Global technological trends and their impact on social economic and industrial development have to be studied: Information required

by the researchers, industrialists, bankers, the public and the policy-makers will vary both in content and presentation. Communication, delivery and dissemination of science and technology information is yet another weak link in the system at present in developing countries. The local capability in these areas has to be strengthened.

75. Information on patents; on technologies in the public domain; on technology regulations; on technology transfers etc. is another area that requires greater attention.

76. UNIDO's Industrial and Technological Information Bank (INTIB) is now well established and is becoming increasingly important in the general information exchange system for industrial development. It is also building close links with National Technical Information Centres (NTICs).

77. UNIDO's Directories on Industrial Information Sources and Systems; on IRSIs; on IRSIs in Africa; IRSIs in metallurgical sector, on Solar Equipment Manufacturers, on Solar Energy Applications, Solar Research Institutes in Developing Countries and on Institutes for Industrial Conversion of Biomass, Monographs and other publications like Guide to Information Sources, Development and Transfer of Technology Series, Industrial Development Abstracts, UNIDO Newsletter, Monitors on different technological advances have proved to be of assistance to developing countries.

78. Presently the information given is more bibliographic. The need is for industrial technology information for dissemination and extension into the industry and for the decision-maker to decide. This requires a different approach. Also there is an information explosion. The need is for both selectivity and proper methods of handling and communication. Modern methods of communication have to be introduced.

79. UNIDO has also several promotion missions to set up or assist industrial information networks in different regions.

## VII. Strengthening of R+D and Linkages

80. A number of mono and multidisciplinary R+D laboratories as well as science departments of higher educational institutions that conduct research do exist in developing countries. UNIDO's Directory lists 250 Industrial and Technological Research Institutes. Several constraints these institutes face have also been well documented. The question is how to make them more effective. The need is for a change in the approaches, strategies and linkages of these institutions.

81. As stated elsewhere, a complementary Technology Programme has to be drawn that complements the industrial priority programme. Such an exercise will help identify technology gaps to be bridged by indigenous or imported technology. The technology tasks may then be clearly defined and assigned to a competent group - a transdisciplinary task force with a team work approach. It has been proved time and again that when a goal is set, a task is clearly defined, a task force formed and given the authority, responsibility to the leader, successful results have been delivered on time if not ahead of time.

82. Such a Technology Programme's preparation should not be left to the technologists alone. All persons concerned should be involved: the researchers in the laboratory, pilot plant, design engineers, economists and marketing experts, bankers, industrialists and members of governments. In the project formulation itself, the linkages are seen, the concerned involved from the inception and monitoring and evaluation inbuilt into the project. Success is assured thereby as the researchers are made relevant to the needs.

83. Similarly, the industry-related research institute should be involved in the service related to technology information, assessment, awareness, alternatives, choices, import, adaptation, absorption and improvement of technologies and technology policies.

84. A R+D institute should have strong forward and backward linkages both for inputs and outputs. Such an institute must have linkages (a) internal to it, namely monodiscipline specialists interacting on a common project as development is a transdisciplinary process; (b) linkages with universities,

academies and others to pick the best man for the job in forming a task force; to have joint research projects, to make better use of library, equipment and laboratory facilities and to have intellectual stimulation; (c) linkages with design and consultancy engineering forms for scaling-up laboratory results, preparation of feasibility reports, bankable projects, to provide guarantees, economic and marketing studies and to act as a technology broker; (d) linkages with industry, the ultimate user of the results; (e) linkage with technology delivery system - extension service workers, industry centres, technology transfer centres, technology brokers etc.; (f) linkages with government departments and policy-makers; and (g) with the public to make them aware that science and technology is for their development. The major lacuna at present in several developing countries is the lack of such well thought out firm linkages with all those concerned.

85. The academic community should also get away from their ambivalent attitudes and accept "public service" as a third dimension in addition to education and research: Extension services must be given the due emphasis.

86. On the other hand, it is time the industry in developing countries recognizes its role in the promotion of R+D and its utilization. Research captive to the industry is quickly utilized. So several incentives have been provided by several countries for industry to conduct its own research and or sponsor research in national laboratories and the universities as discussed earlier. Part of space and other government-funded research can be off-loaded in favour of industry.

87. Risk capital, venture oriented capital, seed capital, and capital for adaptation and improvement of imported technology is lacking in developing countries. This should be remedied.

88. Governmental policies and policy instruments could help in building stronger linkages between research, industry and education. For example, the public purchases, fiscal incentives, subcontracting, incentives for use of indigenous industrial technology, setting up co-operative research centres funded equally between government and industry, easing antitrust rules; patent law reforms to reward contractors for innovations developed with public funds; tax write-offs to encourage limited partnership between federal, university

and industry laboratories, setting-up government advanced centres; generous write-offs that equipment manufacturers and vendors may take for donating equipment to schools, research laboratories, tax credits for incremental R+D expenditure; providing venture-oriented capital and soft loans by the development bank, setting-up awards for invention and innovation and allocating special products, funds and institutions to upgrade traditional technologies and to assist rural, cottage, small and medium-scale industries. Similar incentives and policy instruments could be used effectively for education and training as well.

89. In the field of technological advances, because of the scarcity of highly trained and talented scientists and engineers; because of escalating costs of manpower and equipment, it has proved to be highly expensive for generic technology development single-handedly. So several interested firms join together to form R+D consortia. This recent trend is clearly visible in USA. For example, Research Triangle Park together with Semiconductor Industry Associated together with a number of universities on microelectronics; Council of Chemical Research (43 major chemical companies and 142 universities); MIT Advanced Technology Centre for Television Studies and several others. This principle may equally apply to developing countries - more particularly to set up joint R+D consortia among a number of developing countries.

90. Science and technology parks set up in the vicinity of universities; research centres captive to industry located in the university campus, an industrial research laboratory running educational and training courses for the university and industry (an unique example: Central Leather Research Institute, Madras, India); polytechnology clinics, regional extension centres etc. are several other examples of bringing research, education and industry together.

91. A national mechanism for a free mobility of scientists, technologists and engineers between industry, research and education is needed, overcoming the bureaucratic hurdles and departmental diseases.

92. Adoption of schools, districts or blocks of villages by industry and research establishments to bring technology to the doors of the people who need it; to make researchers aware of the local needs and existing technologies and to make people aware of science and its use for their own benefit.

93. Selectivity is a cardinal principle for developing countries for setting up national centres of excellence with an open international window. Research is risky, costly and requires long lead time. The yardstick for basic research is its excellence and technology for its applicability. It may not be possible to achieve these ends in all fields so selectivity and priority becomes imperative. Foster sister relationships could be thought of with its counterparts in both developing and industrialized countries.

94. UNIDO has a critical role to play in strengthening the existing R+D institutions and more so in strengthening their linkages to productive sectors. UNIDO has recently made a significant contribution to help developing countries in setting up an International Centre for Genetic Engineering and Biotechnology (ICGEB). It continues to assist in setting up several pilot plants and networks of IRSIs and consultancy engineering firms etc.

## VIII. International Co-operation in Science and Technology

95. The economic asymmetry and vulnerability and total science and technological dependence of developing countries make it imperative for a stronger co-operation among developing countries themselves. Much has been said and several steps have been taken for Economic (ECDC), Industrial (ICDC) and Technical (TCDC) Co-operation among Developing Countries. While there are several successful examples of such co-operation there is still much to be done.

96. Subregional, regional and international networking is another concept that has gained ground in the areas of science and technology information, research institutes, technology registries, consultancy engineering firms etc. A critical review of these networks and their efficiency may reveal the need for more effective operational use of such networks.

97. Setting up international centres has its own limitations: International funding is becoming harder to get. In spite of that UNIDO has been successful in setting up an International Centre for Genetic Engineering and Biotechnology (ICGEB).

98. In all these co-operative endeavours, it is increasingly realized that co-operation is best between equals especially if it is for mutual benefit. Co-operation should be distinguished from assistance and aid. Co-operation on the basic research side is easy among academicians. But in the case of industry technology where monetary benefits are involved, at the outset a clear understanding of sharing the benefits is essential.

99. As mentioned earlier there is great scope and advantage for regional co-operation in the areas of technology awareness services, technology transfer and acquisition, joint R+D consortia, particularly in emerging technologies and in design and consultancy engineering services.

100. It is to be clearly understood that South-South co-operation is not at the expense of but in addition to North-South co-operation. The North has most of the scientific and technology talents and money. A serious attempt has to be made by developing countries to take advantage of their nationals resident abroad, e.g. TROTKEN and similar programmes.

101. UNIDO has been active in the promotion of co-operation in the areas of Technology Registries, solidarity meetings to mobilize developing country support and co-operation; at the specific industrial sectoral level between two countries; promotional activities for transferring technologies between developing countries and industrialized countries. The System of Consultations also includes science and technology issues apart from industrial financing and training of industrial manpower.

102. The beneficial application of science and technological advances for rapid development should be declared as a major goal for international co-operation in the 1980s. UNIDO has taken initiatives in this regard. UNIDO is preparing an International Roster of Outstanding Scientists and Technologists at the cutting edge of science and technological advances who are willing to assist developing countries. Such a roster could be used by developing countries requiring specific expertise. Technologies for Humanity is another concept promoted by UNIDO that is worth pursuing to help alleviate human suffering and improve the quality of life of people in developing countries. UNIDO has also been actively assisting developing countries in setting up national centres of excellence; subregional and regional centres in

microelectronics etc. and regional and international networks. UNIDO's innovative approaches in international co-operation are the programme on technologies for humanity as an international movement and the possible additionality in science and technology financing of an inbuilt component in international aid and other programmes.

## Alternative Conceptual, Methodological and Policy Approaches

103. Having reviewed the existing situation in local science and technology competence building in developing countries and some of the elements for future action it may be useful to summarize here a few specific concepts and approaches for effective implementation of the Vienna Programme of Action for the remainder of the decade.

### Gearing for Change

104. In the earlier days much emphasis had been placed on rapid industrialization and production of goods and services. Later the relative emphasis switched to the tool for industrialization namely technology. The concepts kept swinging like a pendulum between industry on the one end and technology on the other. The changing concept now is the technology links with the productive sector. That is not enough. Both technology and industry must be geared for rapid change; be flexible and dynamic.

105. Much emphasis has been placed before on infrastructure and institution building. While this activity may continue, the emphasis may now be turned to alternative concept building.

### Integration: Transdisciplinary Task Force

106. The need for an integrated systems approach, an transdisciplinary task force/team work approach comes out clearly in the review. The dire need is for integrating technology policy with industrial, economic, educational and

other national policies, the need for complementary technology programmes, clearly defining and delineating technology tasks, technology missions and assigning them to competent transdisciplinary task forces, cutting across scientific disciplines and institutions to get the job done early at lower costs.

107. Similarly, the need is for a transdisciplinary group of economists, scientists, social scientists, systems analysts, bankers, industrialists, management experts etc. to collect, analyse, assess information, offer alternatives; for technology assessment, forecasting, technology awareness, technology choices and for negotiations.

108. Similar is the need to set up core groups - small but interdisciplinary for emerging technologies like biotechnology/genetic engineering, microelectronics, informatics etc.

## Levels of Entry

109. Recognizing the differences in the size, resources, needs, priorities, levels of competence and rate of development, each country would have to decide for itself a pattern of science and technological competence. There are also special constraints for small, economically, politically vulnerable countries. 50 countries have less than one million people. The constraints of critical mass, dualism of traditional and modern; the small elite controlling power and money; the exogenous and not endogenous science and technological base which is not organically linked to local development problems etc. have to be kept in mind.

110. The Tbilisi Forum suggested that each country may decide for itself the point of entry, the degree of penetration, sources of inputs, linkages, vehicles of implementation etc. The Forum identified three broad levels. Entry point for each level was suggested as follows:

> Minimum level: Awareness, continuous monitoring, critical and relevant technological intelligence; identification and relevance, ability to assess, select, negotiate and utilize technology; autonomous decision-making;

Medium level: The above and in addition, ability to adapt and generate technology;

High level: The above as well as the capacity for commercialization, design, manufacture of equipment and participation in international markets. These levels and elements were to be viewed in a dynamic framework with each country selecting its entry point and advancing its level.

## Key result areas

A few examples are given here that indicate a different concept and approach.

## An Alternate Pathway for Industrialization - a Biomass Based Strategy

111. Recognizing the factors of economic vulnerability and total science and technological dependence, developing countries may do well to look inward, generating, mobilizing, utilizing and maximizing the returns for their local resources and skills. Biomass is a local, renewable, rural rich, sunbelt resource. Technological advances like biotechnology/genetic engineering, cell fusion, cloning, tissue culture techniques help not only to improve food crops but also increase biomass yields even with problem soils and fragile environment. Coupling biomass with technological advances would not only ensure food security but convert the excess biomass: every part of the plant from 'leaf to root' into food, fodder, fertilizer, fuel, pharmaceuticals, pesticides, insecticides, industrial chemicals and construction materials. This is an alternate pathway for industrialization - that too, a decentralized rural industrialization as the bulk biomass is in rural areas and with a strong nexus between agriculture, forestry, food, energy and industry.

112. For this purpose the need is for Biomass Resource Survey, a National Biomass Resource Policy and responsible use of biomass and for taking advantage of tropical economic speciality plants like aromatic, medicinal, ornamental plants and a treasure chest of microorganisms.

113. The techniques related to conversion of biomass are separating cellulose, hemicellulose and lignin in lignocellulosic materials; utilizing lignin as a chemical feed stock and cellulose for enzymatic conversion into sugars, alcohols, chemicals and microbial proteins etc. The technology spectrum varies from simple mechanical processing to combustion, hydrolysis, gasification, pyrolysis, fusion apart from chemical and enzymatic processes. Biological Resources Development Teams (BIOREDs) with mobile pilot plants for bioconversion have been suggested to train rural people.

Leaf to Root Concept - Cluster of Industries

114. The complete utilization of every plant, from leaf to the root will permit a cluster of industries to be set up around each crop. Each component of a plant can be used to manufacture one or more industrial products consistent with demand and techno-economic feasibility. The product spectrum varies from large demand, high volume, low-cost consumables such as food and processed foods, paper and packaging materials to fine chemicals to low-volume high-cost items. For example, centred around the paddy plant 54 products and an average two or three alternative technological routes for each product have been identified. Similarly, a cluster of industries could be produced from cane sugar base. Similarly, integrated processing plants or cluster of industries could be set around cassava, coconut, banana etc. UNIDO documented some 170 coconut processing technologies covering different scales of production.

115. The full utilization of medicinal and aromatic plants is another possibility fetching higher returns for its products like essential oils, pharmaceuticals etc. and giving added employment in the rural areas.

Construction, building materials and capital goods

116. Construction, building materials and capital goods provide yet another cluster in a strategy for revitalization of industrial and technological development in developing countries. Construction and capital goods constitute practically the entirety of capital formation in an economy.

Competence building in this area would mean reduction of imports, satisfying basic needs and generating employment. Building materials from local natural resources lend themselves for production in developing countries.

Upgrading of Traditional Technologies

117. Technology preceded science and in many countries there is valuable store of traditional knowledge and skills based on age long experience . But the small elite that control power in developing countries, more attuned to the industrialized countries, neglected the study of science behind traditional technologies. The Indonesian traditional fermented food tempeh based on rice or cassava contains as much or more protein than meat though vegetarian, adds desired texture to Indonesian diet, introduces vitamin B-12 instead of milk or meat, is cheap and is one of the world's first quick cooking foods. We have investigated only the surface of a gold mine of such traditional knowledge. This position has to be remedied.

118. Invention and innovation are not the prerogatives of scientists in the laboratories only. A number of creative innovative ideas come from the grassroots level. An environment has to be created for the creativity to flourish in the unorganized sector also.

119. Fortunately technological advances are not in conflict with traditional and existing technologies and could easily be woven into the traditional technology tapestry. For example, genetic engineering/biotechnology can help to upgrade the traditional fermented foods. This aspect of upgrading traditional technologies deserves greater emphasis and attention.

An Approach to Changes in Institutions and Structures

120. The general character of technological advances and the challenges posed by them calling for changes in existing structures and institutions and a reorientation towards interdisciplinary approaches and integrated systems have been discussed earlier. The UNIDO Workshop on Institutional and Structural Responses of Developing Countries to Technological Advances, held

at Dubrovnik, 1983, had dealt with this issue at length about the changes needed in Technology and Human Resources Development, Industrial Production, Structuring Demand Patterns, Finance, Labour and Role of the Government.

## Science and Technology Financing

121. The traditional forms of funding resources are getting saturated and some even drying up. There is a limit for government funded science and technology, or taxing the nascent industry in developing countries. Other means have to be found. UNIDO has been suggesting that in all bilateral and multilateral aid programmes, international co-operation programmes and in case of foreign investments, joint ventures etc. there could be an inbuilt component for funding indigenous science and technological competence building, e.g. R+D, training, infrastructure building programmes. This concept needs considered thought in terms of science and technology financing.

## International Co-operation

122. The true test of international co-operation lies in its ability to harness modern and emerging technologies to unique developing countries' applications that would enhance productivity and improve the quality of life of their people. Developing countries are at different levels to take advantage of the technological advances. This makes it all the more essential to devise new mechanisms of international co-operation, particularly to help the weaker countries.

123. Technologies for Humanity: UNIDO took an initiative to suggest that the beneficial application of technological advances for rapid development of developing countries should be declared as a major goal of international co-operation in the 1980s. UNIDO also floated the concept of Technologies for Humanity (TH): they are those modern technologies including technological advances that in their application would bring benefit to the largest number of people in greatest need. Technologies for Humanity will help alleviate human suffering and improve the quality of life and meet the basic processing

and urgent needs of the largely resourceless people in developing countries. Such technologies should be both accessible and acceptable to people and appropriate to their social, cultural and environmental conditions.

124. Extreme poverty is a violation of human rights. The central concern of Technologies for Humanity is to improve the welfare of the human being especially addressed to the poorest of the poor.

125. An ideal candidate for Technologies for Humanity is gari food. It is a poor man's traditional fermented food in Africa, based on cheap cassava, a rain fed crop grown easily in arid and semi-arid soils. But the nutritional value of gari food needs much improvement. Genetic engineering/biotechnology offers promise to improve the efficiency of the traditional fermentation process, increase nutritional value, producing needed vitamins and amino acids. Technologies for Humanity upgrade traditional technology and come to the rescue of the majority of the poor in producing easily grown local resource material, offering an already acceptable food with added nutritional improvement, making the countries self-sufficient in food and reducing an external vulnerability and dependence and also reducing imports.

126. These are Technologies for Humanity that should attract the attention of the international scientific community and international funding agencies to accept them as a priority project.

127. Technologies for Humanity thus should become an international movement like the Pugwash movement. Even where policies divide, Technologies for Humanity unite all nations in the cause and use of technology for the food of the people.

## Conclusions

128. This review gives an insight into the present status of science and technological self-reliance in developing countries, the continued constraints, the missing elements, the changed conditions and the possible elements for a future framework of action.

129. This exercise has also led to the thinking that for effective implementation of the Vienna Programme of Action in the coming years alternative concept-building is essential, apart from the past emphasis on infrastructure and institution building.

130. Some alternatives, conceptual, methodological and policy approaches have been suggested. Some of these are the need for technology and industry gearing for change; integrated systems and transdisciplinary task force/team work approach; the different levels of entry in science and technological self-reliant capacity building; science and technology financing; upgrading traditional technologies; changes in institutions and structures etc. A few key result areas with a different concept and approach like the alternate pathway for industrialization through a coupling of local biomass with technology advances, setting up a cluster of industries around each plant using the concept of "leaf to root" as an industrial raw material etc. A novel concept of international co-operation is contained in the possible international movement of Technologies for Humanity.

131. The task thus appears to be bigger than ever before and in facing this task, what has UNIDO done? A few outstanding examples may be cited below.

132. In the field of technology policy and planning UNIDO has done a yeoman's service, UNIDO's Programme of Technological Advances proved to be timely and valuable to developing countries. Developing countries are alerted and awakened to the potentials and limitations of technological advances, the policy implications and the need for quick policy response to the socio-economic impact brought about by technological advances. A national policy framework has been suggested for specific sectors like microelectronics, biotechnology etc.

133. UNIDO has done much work in the field of choice and acquisition of relevant technologies. Services in regard to technology information, awareness, assessment, technology registries, TIES system of information exchange on technology transfer contracts, negotiation and consultation guidelines have indeed helped developing countries a good deal.

134. In the field of science and technology infrastructures, the concepts of setting up transdisciplinary core groups for technology assessment, for research and development in biotechnology, microelectronics, allowing them to grow into a centre of excellence or advanced institute may prove practical, timely and less costly.

135. Much needs to be done in human resource development. The inclusion of a component for financing R+D; training, retraining, on-the-job training etc. in aid programmes, joint industrial venture projects and the like, if implemented, would greatly help.

136. International co-operation efforts do need a new look. It is important that weaker countries take full advantage of the emerging technologies. For this purpose UNIDO succeeded in getting 36 countries to agree on setting up an International Centre for Genetic Engineering and Biotechnology. There are similar proposals for microelectronics, biomass conversion, materials sciences etc. for national/regional networks and/or international centres. Another concept is to mobilize the international scientific community and funding sources to accept Technologies for Humanity as an international movement to improve the quality of life of human beings. An international roster of outstanding scientists and technologists who are willing to help developing countries is also under preparation.

137. This short list is only an indication of some recent initiatives of UNIDO in addition to their continuing presence in various aspects of infrastructure and science and technological competence building in developing countries.

138. It is hoped that this overall review, indicating the place of UNIDO would help international endeavours in implementing the Vienna Programme of Action in the years to come.

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