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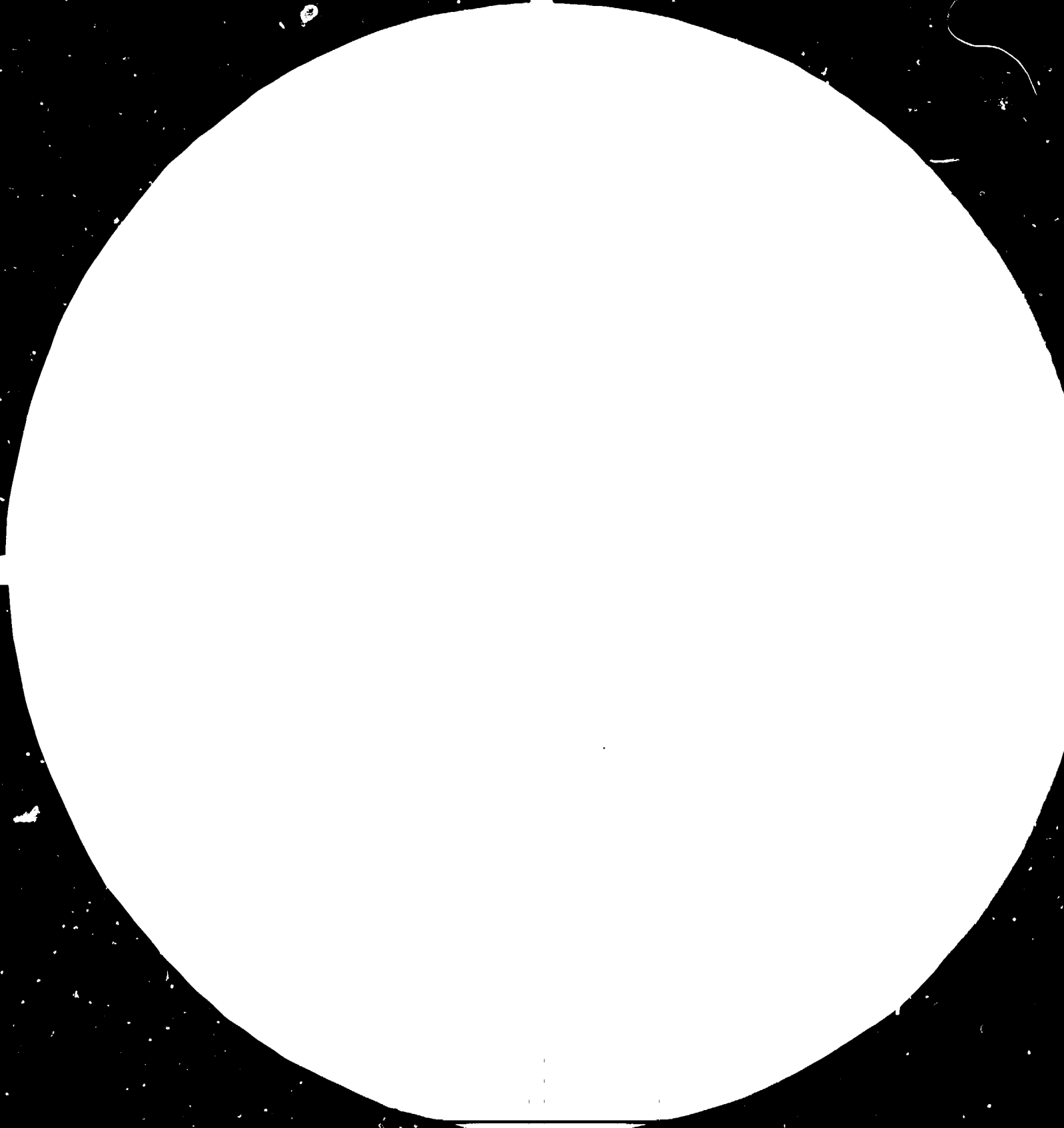
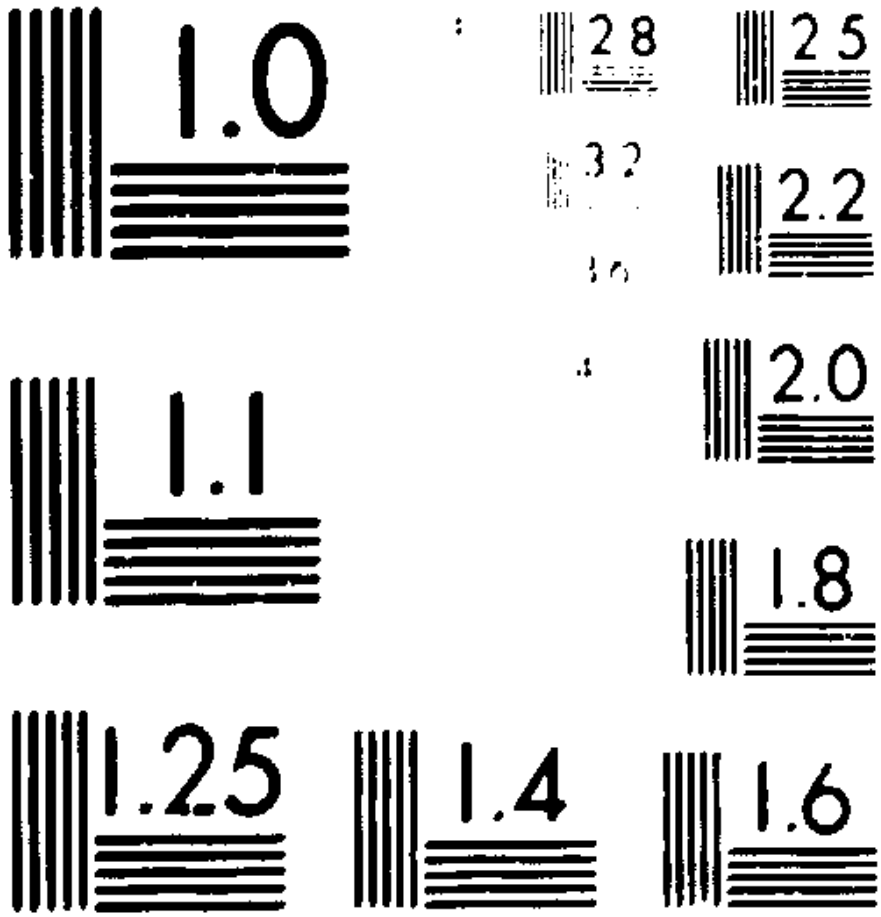
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org





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Mutual Co-operation of Developing Countries in Technology * and Human Resources Development for Industrial Development in Developing Countries.

By

Prof. Y. Nayudamma
Vice-Chancellor
Jawaharlel University, New Delhi

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** IDC: Institute for Developing Countries.

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1. Introduction

Science and technology (S/T) are one of mankind's m main enterprises. There is no escape from the accelerated effect and massive impact of S/T on our outlook, life styles, social, political and economic structures. The greater the capacity to generate and utilize S/T, the faster the progress of a country. But it should however be made clear that S/T are not a magic wand of development process.

Almost all advanced technology originates in industrialized countries (IC) which account for 96% world's scientists and R & D expenditures of which 51% go for defense, around 25% by TNCs for private gains and only 1% for research of problems related to developing countries. World's largest number of patents are in industrialized countries and TNCs. The patents granted in developing countries are only to create moncpolies. Technology knowledge is power and this power is held by few, who dictate the terms and choose the people to give. Technology import has not proved to be the quickest route, neither the development model of industrialized countries is the only model for developing countries to follow. In fact, technology developed in industrialized countries is not suited to meet the

basic needs of the poor people in developing countries. For developing countries' specific problems, there are no specific technologies developed in industrialized countries. The indiscriminate import and utilizing it without adaptation has also created distortions in the socio-economic fabric of developing countries.

There is, therefore, no choice for developing countries except to develop local competence and self-reliance in S/T. Self-reliance is not self-sufficiency. It is the ability to 'discern' - ability to collect information, analyse, choose and implement. It is the freedom to make and implement decisions. The concept of self-reliance demands national commitment and political will.

Collective self-reliance among developing countries is to complement and supplement competence of each country, to reduce time and money taken to build local S/T capacity, to improve bargaining capacity, to examine implications of emerging technologies, to take collective policy action and to respond readily to social changes brought about by technology.

Self-reliance in S/T would mean building up structures, institutions and competence in total S/T spectrum covering

- Basic and applied R & D institutions;
- Educational and Training institutions;
- S/T policy integrated with national development policy;
- Identifying S/T gaps, set priorities, assign tasks to S/T teams;

- Set up and strengthen registration, deposit, review, evaluation and approval of technology transfer agreements in public and private enterprises;
- Information, technical assessment, evaluation negotiation, legal contracts;
- Unpackage the technology package;
- Analyse, arrive at alternatives and choose;
- Adaptation, improvement, absorption and utilization of technology;
- Technology transfer and delivery systems;
- S/T and future;
- S/T and social values;
- S/T and involvement of the generators/users, people, policy makers, scientists, industrialists, bankers.

2. Present Status and Gaps in S/T Capabilities in DCs

A brief survey of the present status of S/T capabilities may give a clue to the gaps that exist and the steps to be taken for achieving national and collective self-reliance in the different components of S/T spectrum.

2.1 Selection of Technology

Several countries do have information systems and services but the gaps still persist. These are:

2.1.1 Information Base

- Lack of information about where to get it from (information intelligence);
- Lack of information of what is new and what impact such

emerging technologies might have (awareness intelligence);

- The information collected is mostly of a documentary rather than of processed nature responding in a direct and practical manner to development needs in various sectors.

2.1.2 Evaluation

- Knowledge is one thing. Wisdom is another. Wisdom is the ability to apply knowledge to a given situation. Information is one thing. Information intelligence is another. The ability to analyse, assess and evaluate information is the need to arrive at alternatives and technological options open for a decision maker to decide;
- Similarly, awareness intelligence is needed about the emerging technologies and their social impact;
- Evaluation should cover both imported and indigenous technologies;
- The information is then processed and evaluated to arrive at an appropriate technology 'mix' for each country to suit the country's goals, priorities and criteria for priorities. But the selection is also conditioned by other factors like foreign investment and credit facilities;
- As development is a transdisciplinary process, it needs a transdisciplinary team containing technologists, economists, policy makers, planners, industrialists, bankers, financial and management experts to evaluate and arrive at development alternatives. Only a transdisciplinary team could examine the alternatives and arrive at an approximate mix of technologies;
- There is an urgent need in developing countries to train

people in developing these skills and to work as a trans-disciplinary team.

2.2 Acquisition of Technology

- Developing countries are yet to develop necessary capabilities to define adequate specification of the technological services required, to negotiate terms and conditions to avoid excessive cost and restrict conditions in technology contracts;
- Gap exists in the ability to analyse and unpackage the technology package;
- The regulatory agencies could contribute not only to limit the size of payments and restrictive clauses but also to help developing indigenous capabilities in associating indigenous consultants, in studying the technological implications of foreign investment policies, etc. The monitoring and follow up of imported technology however are still not the strong point of such regulatory agencies in developing countries;
- Exchanging information and co-operation of developing countries in this area is attempted by UNIDO through its TIES programme and through arranging meetings of representatives of Licensing Executive Society and Technology Registry Groups. Much more needs to be done in this area.

2.3 Adaptation and Absorption of Technology

- As stated earlier, few technologies are transferable whether indigenous or imported without adaptation to social and cultural milieu. The undesirable consequences of uncritical

wholescale absorption of unmodifed techniques imported, have only resulted in perpetuating dependence on foreign technology;

- Therefore, local competence has to be built to adapt and absorb technology through competent researchers, engineers and technicians in industry, industrial research institutes and consultancy engineering firms;
- Developing and strengthening capabilities for technological services is essential. Such services range from macro and micro level planning and project identification, feasibility studies, plant specification, detailed engineering desings, civil construction, machinery installation and commissioning, start up and operation of plants, introduction of quality control, standards and concepts of productivity;
- The most significant gap is in detailed engineering and designing and sectoral consultancy services, making the disaggregating technology packages difficult;
- Money is paid to import technology but little or no money is provided by developing countries to adapt, absorb and improve the imported technology. This is a fundamental lacuna.

2.4 Generating Technology

- Some countries have the necessary infrastructure and trained personnel to conduct research and generate technology, but indigenous technology so generated remain unutilized;
- Some issues still remain unresolved, like how to make indigenous research relevant to national needs instead of

internationally fashions; the linkages between industry and production system and developing a common industry - research culture; improving traditional technologies by weaving in modern methods and techniques into traditional tapestry and commercialisation of local technologies; technology policy, industrial policy and incentives loaded in favour of utilizing indigenous technology, etc.;

- Indigenous technology utilization is ultimately related to domestic demand and preferences and the creation of a culture in which innovation and technological opportunities are seized for production purposes is needed;
- Yet another major problem is to develop and disseminate technologies for rural development, for the majority of people live in rural areas;
- How to increase the awareness and S/T absorbing capacity of the rural people on one side and the leaders and administrators on the other and how to inculcate scientific attitude as a way of life is an equally important issue.

3. Basic Policy Issues

Co-operation among developing countries must differ qualitatively in concept and pattern from the co-operation between industrialized countries and developing countries. The concept of donor-acceptor must be replaced by the concept of equality, equity, shared values, ideals, mutual interest and non-exploitative character, bearing in mind the stage of development and overall capacities of each country.

Will and commitment is a pre-requisite for such co-

operation. The spirit of partnership, mutual understanding and working together harmoniously as a team are essential ingredients. But how to bring about these equations is not easily answered.

Co-operation should be not only technical or commercial co-operation but it should be co-operation for overall growth and development of each developing country.

Choice of technology - labour or capital intensive, simple or sophisticated, traditional or emerging technology - will depend upon the development goals and priorities based on focal social values of the society. Alternative development styles require alternative technologies. If technology is an instrument of domination and disparity between 'have' and 'have not' countries, it is equally true between haves and have-nots within a country.

The kind of development, technology, directions and priorities must be arrived at by national consensus involving all the people representing the relevant sectors like government, industry, research and development, banking and labour and the people at large who are to be the beneficiaries. Full involvement of the concerned people in the planning process from the very beginning and arriving at an agreed plan is an assurance for its successful implementation. Otherwise plans remain paper plans.

The basic objective of co-operation in S/T among developing countries is to further the national and collective self-reliance of these countries, developing local competence to identify problems, generate technologies, design solutions, determine policies, be responsive to local, cultural, economic

and social sensitivities and bring about self-sustaining solutions to relevant local problems.

The concept of collective self-reliance among developing countries is to find means to expand the total resources flow, not simply change their proportions. It is not a substitute or a competitor but a complementary to bilateral, multi-lateral and global programmes.

Co-operation among developing countries for national and collective self-reliance is imperative to (a) pool the resources and share the experience and expertise (b) share the power and responsibility among the countries of the world (c) bring about new international economic order, changing the present international system loaded in favour of industrialized countries in regard to access to information and flow of technology, credit and control of markets, commodity prices, etc. Developing countries cannot continue to be recipients of technologies that are often unsuitable, supplied at inflated prices and under restrictive conditions.

4. Basic Constraints

The main obstacles to S/T development, which are to be overcome and which require continued attention and investigation regarding their causes and consequences in developing countries are as follows[4]:

(1) lack of an effective science and technology policy;

(2) obstructions to self-reliant development;

(3) lack of research and development in industrial sector;

[4] Pugwash Newsletter, Vol. 18, 1 br 2, 1980, p.9.

(4) absence of linkages betwen R & D laboratories and industry;

(5) scarcity of technical staff at the intermediate level;

(6) inadequacies of the education system;

(7) absence of S/T in economic sectors;

(8) lack of S/T information systems;

(9) inappropriate administrative machinery in S/T institutions;

(10) lack of a code of conduct for the operation of TNCs;

(11) lack of co-operation among developing countries having problems of similar nature;

(12) failures of industrialized countries to set up appropriate mechanisms and positions for S/T personnel of developing countries;

(13) failure of developing countries and industrialized countries to counteract brain-drain both internal and external, etc.

The countries that have a colonial past also suffer from other constraints:

(1) The colonial administration is based on mistrust. Horizontal transfer of industrial technology from one industrial firm to another in the country has not found favour. A local firm may not trust another local firm but both get the same technology for the same product from a foreign firm;

(2) The colonial dependence extends to the thinking that "what is foreign is best: what is urban is good and what is rural and traditional is bad";

(3) Further, it suits the investor in developing countries to produce and sell, with ease and quick profit, products

with an international brand and therefore only looks for foreign technology;

(4) The selection of technology is also circumvented by such factors as foreign investment and credit facilities from suppliers of equipment;

(5) Harmony, team work, co-operation cannot be said to be watch words of all developing countries, particularly those with a colonial past whose policy was to divide and rule. How to inculcate the spirit of working together in harmony and co-operative endeavour is a major issue;

(6) There is an intellectual dependence. The elite in developing countries are more at home in industrialized countries than with their own people and the decisions are made by the elite as conditioned by the western training and temperament and not in consonance with the wishes, needs and priority of the majority of the people.

(7) Lack of local competence and innovative attitudes in developing countries is also partly due to colonial past.

If S/T has to be responsive to local cultural sensitivities, the relation between technology and culture has to be analysed from several alternative perspectives. Technology tends to homogenise culture and 'modernization' and thus through technology comes 'westernization'. The influence of the combination of technology policies and cultural heritage as well as appropriate cultural conditions for technological development have to be examined carefully.

Technology policy for what and for who?

It is necessary to integrate S/T with national development goals and priorities. Technology tasks should be

cleary defined to serve the specific priority needs of the majority of the people.

The cluster of technology policy instruments cover:

- Industrial programs and policies;
- Legal, administrative, institutional structure to shape industry to grow;
- Incentives, controls;
- Venture oriented banks, risk capital, capital for adaptation and improvement;
- Promoting S/T in state enterprises;
- Support services such as standards, engineering, consultancy, information, technology acquisition, adaptation, diffusion, delivery, extension, etc.;
- Linkages S/T with industry, education, users.

If self-reliance is the goal, self-reliance of every individual by conferring him with competence, confidence and right to work must be achieved. Employment generation should be the goal.

An integrated systems approach is called for rural development and improvement of the living and working conditions of the large percentage of people that live in rural areas in most developing countries. High level intellectual inputs are needed to solve the low level problems on the ground. One should not be led by the garden path of the so-called village, rural and appropriate technologies, though one should certainly use simple technologies where they are effective.

S/T decisions in developing countries should by and large relate to environment, ecology, employment, equity, energy and efficiency.

A careful look at S/T to be an effective tool for development calls for a three tier system of organization:

(1) High Level Intellectual Inputs: Centres for Development Alternatives (CDA) may be set up where transdisciplinary groups work out development alternatives, provide alternative choices for the decision makers for taking an autonomous decision making. Such a group may also help to arrive at technology choices integrated with national needs and priorities with the capabilities of technology assessment, acquisition, adaptation, generation, relevance, etc.;

(2) Development/Technology Delivery System: It is not enough to generate or acquire technology. It is necessary to deliver it at the doors of the people that need it. For this purpose voluntary agencies that have the desired S/T competence on one hand and confidence of the people on the other may be utilized. Voluntary agencies have the added advantage of getting things done efficiently at less cost and time as compared to bureaucratic governmental machinery. An umbrella agency also may be set up to look into the needs of the various voluntary agencies.

(3) Each agency may take advantage of unemployed uneducated/ /educated youth technology transfer agents. This would not only give them jobs or self-employment but also the feeling of participation and pride of achievement.

If technology is for the good of the people, people should be involved in the process. It is the people that should have a social control over technology. This demands

that all the actors in the game should be made aware of technology change and its social impact. The actors are decision-makers, industrialists, financiers, the generators of S/T, the communicators and extension workers that bring S/T to the people. To create a thirst for S/T in people, scientific attitude should be inculcated and scientific temper should become a way of life for the joy of participation and pride of achievement in the adventure of science and technology.

The growth of effective S/T planning, management and implementation is a task of utmost priority to developing countries.

5. Precondition for Increased Science and Technology Co-operation Among Developing Countries:

- Political will and commitment to national and collective self-reliance;

- Spirit of mutuality of interest, equity and mutual trust;

- Respect for cultural, political, social differences and respect for national sovereignty;

- Compatibility, team work and willingness to share;

- Clear understanding of the tasks of a co-operative endeavour and who does what and who gets what benefits at the very beginning;

- Faith in and commitment to the cause and use of science and acceptance of science and technology as an essential instrument for socio-economic development;

- Developing national science and technology compatibilities and technical manpower for effective co-operation and collective self-reliance in science and technology;

- Annual expenditures of at least 1 percent of GNP by 1990 by each developing country on R & D;

- Economic co-operation among developing countries (ECDC) through technical co-operation (TCDC);

- Setting up of a nodal organizational and management structure, involving national and regional science and technology focal points to coordinate ECDC programme;

- Setting up of an appropriate national documentation and information system to facilitate exchange of information and matching the talents with the tasks of co-operative endeavours;

- Identifying national focal points to provide for a specific framework for concrete co-operative arrangements backed by financial allocations;

- Identify specific science and technology areas of mutual interest;

- An analysis of the reasons for lack of innovati in developing countries with a view to develop indigenous science and technology capabilities;

- Display of vision and wisdom by not being attracted by short term benefits offered by the developed world;

- Not waiting for the outcome of North-South dialogue but to use North-South co-operation;

- A clear understanding of the fact, that salvation

for any country is only through local competence innovative attitudes and problem solving capabilities with an ability to identify problems, design solutions, determine policies and bring about self-sustaning solutions;

- Long term plans for co-operation for sustained industrial and technological growth;

- Continuous search for improved means, mechanisms, new avenues and methods of co-operation and to accelerate the tempo of co-operation;

- Common approaches for critical problems of mutual interest like population, food, etc.

- Willingness to utilize complementary industrial and technological capacity within the developing countries instead of running to industrialized countries;

- Common policies and measures for industrial processing of raw materials in developing countries and to achieve integrated rural development and self-sufficiency in food;

- Willingness to share resources, finances, technology and technical manpower and to compensate for resources transfer;

- Coordination of educational and manpower planning;

- A thorough survey of supply side and an indepth investigation revealing the full potentialities and complimentairities of existing institutions and resources.

6. Common Areas for Co-operation

The areas for co-operation among developing countries are indentified as follows:

- Policy making, financing and co-operation;
- Infrastructure, human resources and research and development linked to production;
- Choice, acquisition and transfer of technology and information;
- Activities promoting a more equal role by women in science and technology; and
- To promote science, technology and the future.

The action efforts may be made at the national, joint national and international level through bilateral or multilateral programs, through the UN agencies, regional and global collaborative action programs and a new international initiatives.

The Interagency Task Force on Science and Technology for Development has set up four working groups to formulate specific and concrete proposals for joint activities of various UN agencies in the areas of:

(1) Early identification and assessment of emerging science and technology and global network of technological information;
(2) National Science and Technology policies and plans;
(3) Upgrading of traditional technologies;
(4) Science and Technology and the productive sector, commercialisation of R & D and acquisition and transfer of technology.

Developing countries face several common problems. These are:

Population, poverty, employment, ecology, energy, efficiency, better utilization of local resources, food sufficiency and

food security, nutrition and eradication of tropical and water born and related diseases, basic engineering industries like machine tools, fertilizers, drugs. These problems demand scince and technology solutions.

Science and technology capability building includes training of personnel, basic and applied research, finances for and management of research and development, industrial technology design, engineering and consultancy, execution of projects, joint research, development and production projects and setting up of joint ventures, etc.

7. Avenues, Means, Mechanisms and Methods of Co-operation

Mechanisms

7.1 Setting up and Networking of Institutions:

Co-operation is to supplement and complement each other's competence. Each country may build competence in an area and scale the highest peak in the area. With each country having a peak, in region there would have been several peaks and collective networks. Each country then is independent in one area and yet interdependent on other countries for collective self-reliance. Each country has then the pleasure and pride of sharing for mutual benefit and bring the countries together. Regional and international networks in chemistry, physics, biosciences, etc. exist;

- Networks can also be with national educational and/ or research institutes dealing with the same subject, e.g. all the leather or food research institutes in the region and

in the world;

- Network of professional (technical) organizations like Academies of Science and Engineering, Institutions of Engineers, Engineering and Consultancy firms, etc. national, subregional, regional and global, may offer technological services for flow of technology, consultancy, setting up pilot projects, plants, etc, particularly in high investment areas;

- Similarly, other network could be considered, e.g. networks of (a) public industrial enterprises; (b) information systems, technology banks, technology registries, technology manpower banks; (c) product oriented R & D institutes like leather, paper, food, etc, (d) Training of S/T personnel at different levels; and (e) Centres for Development Alternatives, Technology Delivery Systems, Institutes for Integrated Rural Development;

- Yet another way is to have a National Centre of Excellence in basic or applied research, acting as an international centre catering to the needs of the other developing and even developed countries. The existing centres may be upgraded and strengthened for this purpose. Even here the concept of each country being independent in one area and yet interdependent in another area still holds.

7.2 Concept of Twining:

An advanced centre in one country may be twined to a smaller centre in another country acting as an elder sister to it, transfering and building the competence of the smaller centre.

7.3 Concept of Collaborative Specific Goal Oriented Projects:

Where technological tasks are delineated and each task assigned to a competent team in different countries.

7.4 Jointly Set Up Institutes - Regional/Subregional:

- Educational Institutes;
- R & D Institutes - basic and applied;
- Vocational training, polytechnics, etc.;
- Information base;
- Joint industrial projects and market sharing to stimulate industry, trade and market;
- Joint manufacturing facilities for small machine tools, agroindustries, fisheries, renewable energy, equipment, educational aids, etc.;
- Joint co-operative endeavours for popularisation of science;
- Joint capability to monitor and evaluate technology perspectives and advances; and their potential impact on society to suggest policy actions to respond to technology changes;
- Joint institutes in areas of innovation and research in advanced engineering, technologies, like biotechnology, micro electronics, etc, to reduce time and costs;
- Joint industrial venture sharing capital, experience, labor, resources. One country may contribute to capital, another to technology and technical manpower or labor and a third contributing to natural resources.

7.5 Global/Regional Centres

- Nonaligned Centre for S/T information is being set up for compilation and dissemination of information or existing

capabilities in the different sectors of technology, availability of such technologies, conditions of sharing and transfer of technologies, to maintain updated compendium of technicians and experts in diverse fields in developing countries and the terms of their availability, etc.;

- TCDC - RCTT (Regional Centre for Technology Transfer) - to undertake programs and projects on technologies that are benefitial to developing countries;
- Advanced International Centers for Biotechnology, other material sciences, electronics, space and renewable energy, etc.;
- Setting up regional Multipurpose Training-cum-Demonstration and Pilot Project (Plant) Production Centres in selected areas like agro-industries;
- Setting up regional industrial estates and co-operative ventures in small and medium scale industries;
- Setting up institutes of Technology and Institutes of Management, Administration, Financial Management, etc.

7.6 National Centres

Each country may set up a National Centre of Excellence which is however open to all other countries, more particularly to developing countries. This may prove to be a much more efficient system as compared to global and regional centres.

7.7 ECDC/TCDC:

A close examination is about the effective functioning of ECDC/TCDC in or outside the UN umbrella.

7.8 Sharing:

Sharing of experience, expertise may be done in the following areas to the best advantage of the co-operating countries:

- Formulation, orientation and sharing of experience in S/T policy, integrated with national policy and S/T programs integrated with development goals and social values;
- Development alternatives and alternative technologies;
- Identification of technology needs and matching them with technology talents, facilities and funds;
- Methods and mechanisms of collection, retrieval, analysis of S/T information, evaluation and selection of technology, unpackaging of imported technology package, technology assessment, awareness intelligence of emerging technologies;
- To ensure technology supplies conform to agreed norms;
- Experience in R & D generating technology;
- Experience in S/T institution building;
- Measures to check brain-drain;
- Product, process design, adaptation for indigenous production.

7.9 Exchange of:

- Exchange of information and experience in S/T competence building;
- Established capability to give and receive;
- Information about S/T capacity in industry, development experience, negotiating power for acquisition of technology, technology registry, etc, terms of licensing;
- Exchange or barter of technology, materials and funds;

- Exchange of scientific and medical equipment, prototypes, pilot plants, etc;
- Scientific journals, research reports, etc;
- Information regarding role of TNCs in developing countries;
- Exchange of experts and skills;
- Exchange of technology profiles in areas of common interest like water management, power projects, natural resources survey, etc.

7.1o Mechanisms:

- Organize meetings to exchange views and arrive at plans of co-operation - for Ministers in charge of S/T and industry, Heads of S/T Institutions, industrialists, etc.;
- Each country may state one successful and not so successful experience in S/T co-operation in DCs to recognise weaknesses and strengths, opportunities and threats (SWOT Analysis) and to improve upon the present modes and mechanisms of co-operation;
- Each country may set up industrial and technology co-operation program;
- Set up a clearing house for information and for matching the pairs for co-operation;
- Bilateral/subregional/regional/global co-operative exchange programs;
- Triparty meetings with UNIDO and developing countries;
- Consultative meetings organized by UNIDO, UNCTAD, etc.;
- Voluntary organizations assisting joint ventures in industry, in R & D and indigenous S/T competence building efforts;

- Industrialized countries supporting R & D projects in developing countries;
- Setting up a Third World Resource Centre to critically study and counter the intelligent moves of industrialized countries against the interests of developing countries;
- Converting braindrain into brainbank utilizing the nationals abroad and their expertise, talents, training and savings in the country's development process;
- Setting up national nodal/focal points for exchange of information, identification of needs and established capacity to give and receive and to coordinate the various co-operative programs;
- Setting up venture oriented finance corporations with risk taking capacity;
- Setting up multinational technology generation and transfer corporations like TNC among the developing countries;
- Setting up S/T industrial parks individually and jointly by developing countries;
- Setting up joint facilities for natural resources, survey, resources development, etc.;
- Promoting developing alternative technologies relevant to development goals of developing countries;
- Providing incentives/awards/rewards systems for S/T innovations that help developing countries development programs.

7.11 Measures to Strengthen Co-operation Among Developing Countries in Science & Technology

Here is a detailed account of the measures to strengthen co-operation in the areas of:*

* ND/ST/82/DOC 1.

(1) Compilation and dissemination of information;

(2) Formulation of co-operative arrangements through creation and strengthening of network of institutes in S/T and through intensification of exchanges involving experts;

(3) Flow of technology in areas such as setting up of demonstration pilot projects/plants, exchange of prototypes, scientific equipment consultancy services and assistance in manufacturing facilities;

(4) Co-operation in areas of technical innovation and research in advanced technology;

(5) Co-operative efforts in enhancing negotiating power of developing countries in regard to industrialized countries technology supplies; and

(6) Organizational and financial matters for promotion of ECDC in S/T.

8. Human Resources Development

Technology is generated and used by human resources; hence strengthening technological competence should be viewed within the overall context of human resources development.* A balance has to be stuck between long term and short term educational and training programmes for the acquisition of required knowledge and skills.

Education, training and research are to be distinguished, and among themselves should cover the needs extending from illiterate rural population upto high level policy makers.The skills and knowledge to be created or upgraded

* UNIDO Doc.Part II. ID/Conf/4/7. p. 71.

will relate not only to the production process but also to the whole process of competence building in the total S/T spectrum that includes information, technology policy, planning, acquisition, adaptation, generation and utilization.

For knowledge base, higher education and long term courses are the needs. For skill formation, short term courses may be run, but training of personnel through their participation in actual execution of projects is more effective.

Long term courses would be dealt with by the universities, R & D institutions, administrative and management institutes, polytechnics, etc, giving degrees and diplomas.

Short Term Courses cover:

8.1 Training of information scientists and engineers;

8.2 A multidisciplinary task force consisting of engineers, technologists, entrepreneurs, economists, social scientists, administrators in the areas of:

- Technology awareness;
- Technology assessment;
- Technology and future;
- Development alternatives and alternative technologies;
- Emerging technologies and their likely impact;
- Evaluation,negotiation, selection and acquisition of technology;

8.3 Conduct of research, adaptation and generation of technologies, management of R & D institutions, evaluation of research projects and research results, commercialization, extension, liaison;

8.4 Design, Production and Productivity;

8.5 Standards, quality control;

8.6 On the job, in plant training for engineers and skilled workers,

8.7 Training of managers, entrepreneurs;

8.8 Science communicators, popularisation of science.

9. Present Status

The present S/T education and research system modelled on the industrialized countries pattern has produced neither the right type of manpower nor developed the innovative attitudes and local problems solving capabilities. Further, utter neglect of traditional technologies and indigenous skills have undermined the confidence of the people and alienate technologies to tackle grassroot problems.

Even in countries where the good infrastructure facilities exist for S/T education, research and development, improvement in the economic well-being of people has not materialised; instead, the gap has only widened between the urban and elite and the rural poor. Obviously, there is a mismatch between educational objectives and social needs.

Employment opportunities commensurate with knowledge and skills of trained personnel are still quite limited resulting in unemployment, underemployment and braindrain. Much worse, posts remaining vacant on the one side and uneployment on the other coexist. There is thus a mismatch between the university products and industry's needs.

Add to it, about 25 per cent of the top S/T graduates produced by some of the best institutions in developing

countries leave the country every year. Those that stay in the country are reluctant to make a career in S/T; instead, they go for management and administrative courses commanding higher salaries and status. The loss of the potential for innovative technology embodied in this sort of internal and external braindrain - not only has a great social cost but is to be taken as a defeat of the very purpose of education.

Today industry's involvement in higher education is limited and the total technical manpower employed by industry is small. The major employer is the government where scientists and technologists are always kept on the tap, while civil servants are on the top.

The desirable ratio of technicians to professionals should be around 5:1; this ratio is seldom achieved and the link between them is also missing.

As regard engineers, technologists and scientists in most developing countries, there is both paucity in numbers and less than full utilization of their capabilities. The technicians do not get the necessary status and recognition.

There is a lack of adequate manpower planning. No doubt manpower planning is difficult since the data are unreliable and uncertain and since our understanding of the dynamics of socio-political economic system is meagre. Forecasting becomes an inexact exercise.

10. Issues

The patterns of education in developing countries prompt one to ask the following questions:

- Is the education relevant to the present or future needs of the developing countries?

- Are we training the right number in right areas where people are required?

- Are we training people to be teachers? Researchers for industry or management?

- Are we honoring our technicians, technocrats and scientists enough?

- Why do the trained people go for employment largely in government, and not in the industries?

- Is our education designed for enterpreneurship and selfemployment?

Technology change brings about social change. Thus technologists and engineers become change agents. You can not be an instrument of social change unless you are involved with the society.

S/T institutions would do well to accept 'Public Service' as one of the major functions and Extension Service as a Third Dimension in addition to training and research. Extension service will help to get into the real world, to learn live problems, to get the feedback, to make public and industry aware of the technical institutions and their capabilities to build linkages, to help mobility of personnel in research, training, industry and field activities.

'Continuing Education' should be accepted as an essential activity of S/T educational system and of the industry. It is said that engineering is a 'learning' profession rather than a 'learned' profession. It helps vertical, horizontal, occupational mobility, to improve job performan-

ce and to ensure against technological obsolescence.

Human resources development should cover the needs of the illiterate rural population too. Where education and development are linked, formal and nonformal education, schools, colleges, mass media, radio, video, TV, satellite, cinema, library, science museums, etc, should form a total network of educational means and media to develop the 'complete' man. Popularisation of science is a must to inculcate scientific temper. Education would then be related to real life problems and aspirations of rural people and linked with health, agriculture, food, family planning, rural industry, community living, etc.

The school would then become a hub of change.

Technical education is primarily governed by the need of the industry. Close inter-action of the two is mutually beneficial.

- It is time for industry to realize the need for its greater involvement in education, particularly higher education;

- It is necessary to assure industry's involvement in technical education and research, too. Tax on industry may be imposed for education and research purposes;

- All developmental projects and industrial expansion projects should be linked up with an induction of competent trained technologists and engineers;

- Both public and private enterprises may be asked to institute technical manpower audit to ensure proper development and utilization of technical manpower;

- All possible avenues should be explored to obtain

firm linkages between research and industry. These may include setting up S/T parks, industry sponsored or owned research centres in and around the university campuses, sponsor research projects, exchange of trained personnel, joint development of curriculum and educational programs, etc.;

- Universities must also give up their ambivalent attitudes and take up socially relevant research which may call for a multi-disciplinary group activity. There is a need for change in value system, recognition pattern of academic work and legitimization of developmental work. There is also a dire need for curriculum review and for redesigning the courses to include relevant and emerging areas e.g. biotechnology, genetic engineering, micro-electronics, natural sciences, life sciences, environmental sciences, etc.

Education should change in content, form and method to bring about a social change and improvement of quality of life for the bulk of people. It is now accepted that education should be linked to development, that higher education must be for the development of a 'full', 'complete', well balanced man and that the university must provide development leadership, in addition to its traditional roles.

Human resources development should be viewed far beyond the confines of conventional manpower planning. Technological manpower should be viewed as technological improvement of a variety of occupations, and not simply as a set of specialised technical sources.

Technological competence has to be viewed and planned, not merely as a matching input in a productive process, but as an infrastructure asset or 'external economy' to be

provided ahead of demand in all pervasive way.

A large population can be a source of strength rather than a handicap if they possess the capabilities for improving their economic well-being. A small increase in productivity of large number of people is more important than a large increase of productivity of a small number of people. Technical education should be viewed in this light.

To improve productive capacity of each person, several steps may be taken, e.g. large scale training of artisans, improvement of traditional tools, techniques and technologies, vocational orientation to school curricula, rural orientation to engineering and diploma courses, problem oriented approach of research institutes to traditional technologies and rural development problems, etc.

Growth points for technological capabilities reside in certain sectors like agriculture, transport, agro processing industries, engineering industries, electric power, etc. The job training in these areas in the schools, in the field and in the industry establish the very essential skill base for technical progress.

Mobility of technical manpower and skills is important for the diffusion and growth of technological skills.

Education policy should be linked with industrial, S/T and other national policies. Such a policy should include introduction of vocational content in the school curricula, development oriented technical education at university level linkages with industry and user, together with measures to mobilise and utilize scientists and technicians in the problem of developing country's technological capabilities.

11. Role of Academic and Professional Societies

Academies and professional societies may play an important role in human resources development. Their role could be:

- To promote relevance and excellence in its profession;

- To protect and promote the best interests of its members;

- To make their presence felt in decision/policy making, providing objective analysis of important issues and express them freely and frankly;

- To work towards the creation of indigenous competence and infrastructure and create an environment conducive to the relevant research and utilization of research results;

- To transform value system so that work on development programs get importance, prestige and financial support;

- To help in curriculum development to develop new educational programs, in employment and manpower planning, organizing study circles, quality circles, identifying technology gaps, in evaluation and accredition of institutes, departments and programs, in publishing journals, in setting up consultancy firms, etc.;

- To form interdisciplinary groups to make an objective indepth study in technology assessment, technology and the future and in identifying technology tasks, in generation, acquiring, adapting, improving and utilizing technologies;

- To provide facilities for free flow and mobility of people between teaching, research and industry;

- To disseminate information and popularise science;

- To promote regional and international co-operation, looking for and opening up new opportunities for joint endeavours with other developing countries;

- To ensure work ethics and professional ethics.

12. Co-operation Among Developing Countries

The philosophy, methods, means and mechanisms of co-operation among developing countries have been discussed earlier. This equally applies to the sector of education, training and research.