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**TECHNOLOGY, INDUSTRIALIZATION AND  
DEVELOPMENT**

**Perspectives and Programmes of UNIDO's  
Technology Service**

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## **PREFACE**

### ***UNIDO'S PERSPECTIVE***

UNIDO became a specialized UN Agency in 1986. Since then, new forces and major policy changes in the global economy have transformed the roles of governments, enterprises and industrial institutions as well as the pattern and conditions of production and the flows of trade, investment and technology. Most developing countries as well as the countries in transition in Europe and Central Asia have shifted from import substitution, state ownership and regulatory industrial policies towards export-oriented, competition-driven policies. The emphasis is now on investment promotion, technological and organizational innovation, privatization and market-led development. At the same time, industrial growth is seen as a prime means of moving towards countries' socio-economic goals. Increasingly, countries recognize the potential of industrial growth to reduce poverty, enhance the status of disadvantaged groups and prevent environmental damage. Equitable and sustainable development is interdependent with industrial development.

UNIDO has responded to these changes as well as the change within the UN system itself by adopting five development objectives which reinforce UNIDO's close linkage to the development goals of developing countries themselves. These five objectives provide a coherent conceptual framework for UNIDO's services, and directly relate UNIDO services to those provided by other United Nations and bilateral development agencies. The five interrelated industrial development objectives are as follows:

- Industrial and technological growth and competitiveness;
- Development of human resources for industry;
- Equitable development through industrial development;
- Environmentally sustainable industrial development; and
- International cooperation in industrial investment and technology.

The last objective identifies the need for new and strengthened forms of international cooperation through cross-border flows of industrial investment and technology, and anticipates the future opportunities for global partnership which arise with such flows. Thus, international cooperation in industrial investment and technology is one development objective, which additionally does contribute to the attainment of the first four development objectives above.

The Investment and Technology Promotion Division (ITPD) has been charged by UNIDO with the responsibility for promoting international industrial cooperation both between developed and developing countries, and among developing countries, with particular emphasis on investment and technology flows. It also has the responsibility for providing technical cooperation and advisory services in order to strengthen national capabilities which support investment and technology development. ITPD aims at better integrating UNIDO

activities in the mainstream of international industrial cooperation. Thus, assistance is provided to countries in designing and formulating investment and technology partnership initiatives, and through the organization of partnerships and consultations between various entities from developed and developing countries. Special emphasis is placed on activating economic cooperation between developing countries and technical cooperation between developing countries, i.e. ECDC/TCDC mechanisms in facilitating partnerships and consultations. ITPD also acts as the focal point within the UNIDO Secretariat with regard to these ECDC/TCDC mechanisms.

The Investment and Technology Promotion Division comprises the Office of the Managing Director and three services:

- i) Investment Service,
- ii) Technology Service, and
- iii) Industrial Cooperation and Consultations Service, including ECDC/TCDC.

The services offered by ITPD have to be viewed within the context of UNIDO's main task, and the activities of other Units of the Secretariat. The main task of UNIDO is to help the industrial development process in developing countries through a sharp focus on the five industrial development objectives as identified above. This entails the delivery by UNIDO of a broad range of services which are conceived and executed through an intradivisional or interdivisional programme containing components which contribute towards one or more of the five objectives. It should be emphasized that these various components do not constitute independent services, but are packaged into coherent programmes of assistance to developing countries. UNIDO's Organization Chart opposite provides a synoptic view of these components and of the possibilities offered by UNIDO in providing coherent and well integrated programmes. These possibilities differentiate UNIDO services from those offered by other UN and bilateral agencies.

Given UNIDO's main task, and within the context of the Investment and Technology Promotion Division's overall service activities in meeting the five development objectives of UNIDO, this brochure presents the perspectives and programmes of UNIDO's Technology Service. It relates these perspectives and programmes to the development goals and difficulties of the developing countries, and identifies ways in which it can be of assistance in confronting the challenges encountered and in seizing the opportunities offered in their industrial development process.

## CHAPTER 1

### ***THE TECHNOLOGY CHALLENGE FACING DEVELOPING COUNTRIES***

The industrial and technological scene in the 1990s is very different from that of the 1960s and 1970s when most developing countries embarked on a strengthening of their technological capabilities. Deregulation and privatization, the global integration of financial and capital markets, shifting comparative advantage and shifting global production platforms, increasing privatization of knowledge and rapid product development/obsolescence, energy and environmental concerns all constitute the framework within which dynamic technological change is taking place.

Worldwide changes set in motion in 1990 took on a particular intensity in 1991, 1992 and 1993, and questions of technology, industrialization, productivity and, above all, competitiveness, now clamour for attention. The major perception is that the application of technological capabilities within business and industry remains central in attempts to expand output, improve export performance and raise standards of living. Industrial development cannot take place without technology. Indeed, the prime mover in industrial growth and development has always been the progress of technological innovation. In this last decade of the twentieth century, technology is even more essential to the growth and competitiveness of a country and its firms; industrial production is increasingly knowledge intensive, and the accumulation of innovation-based advantages is a prerequisite for international competitiveness.

Information- and knowledge-based industries have emerged and expanded and new process technologies have spread widely, resulting in increasingly knowledge-intensive production. A continuing structural shift in major industrialized countries had led to industrial production which is innovation- and skill-intensive, as in electronics, electrical goods, non-electrical and transport equipment as well as to an expanded and more specialized services sector. New information-based technologies have been applied not only in high-tech sectors, but have been used also to enhance productivity and quality in many businesses where technologies are mature and well diffused.

Industrial development cannot take place without technology, and it should be recalled that industrialization itself is a process only 200 years old. While economic theory has long incorporated technology as one of the sources of economic growth, the perception that knowledge embodied in technology is a factor of production, like capital and labour, now has become widely recognized by corporate management and government. In sum, technology is a critical asset for production, competitiveness and long-term growth. Greater and ever more explicit efforts are made by businesses and governments, particularly in the richer developed countries, to build up and preserve technological advantages. These efforts reflect themselves, *inter alia*, in the linkage between technology policy and industrial policy, as well

as in the attitudes of firms and governments towards innovation, technology transfer and diffusion. With the deregulation of economies and liberalization of markets, there has been a surge of foreign direct investment (FDI) to developing countries and to countries in transition. Developing countries as a group received US\$ 74 billion of FDI in 1993, which put their share in global FDI flows over one third and, besides, more than 80 percent of official development assistance disbursements. However, the degree of country concentration is striking: only 10 countries were able to attract 65 percent of all FDI flows to developing countries. This is in stark contrast to just 2 percent going to African developing countries. Ever more, countries want to share in this increased flow of FDI. In general, FDI can combine investment financing with technology, management and marketing knowhow, access to foreign markets, training, etc. Indeed, FDI should be seen in the broader context of technology transfer, which in the decade of the 1990's can cover a variety of innovative forms, including international subcontracting, licensing, research consortia, Build-Operate-Transfer (BOT) arrangements and franchises, strategic company alliances and many others.

To achieve sustained industrialization over a long period of time calls for an ability to adapt to constant change. That ability to adapt, however, has to permeate to all sectors of the economy since industrialization is a process that transforms non-industrial sectors as well: the key lies in symbiosis rather than polarity between industry and agriculture, between manufacturing and services, and between technology and the economy. Within industry, all sectors are subject to the risks and opportunities inherent in change, and all must adapt to the trans-sectoral challenges made by certain generic technologies. For example, the micro-chip and its myriad applications in microprocessor devices have profound implications for the products and production processes of the metallurgical, engineering and chemicals industries. The development or transfer of microprocessor technology is essential if these industries are to meet this trans-sectoral challenge.

In general, developing countries have neither a strong industrial base nor a coherent technological infrastructure. The adoption and use of a particular technology does not automatically lead to economic, social and environmental gains for the community, because of distortions in factor and product markets. Factor and product markets are underdeveloped and often have a weak capacity to respond either to changes in government macro-economic policy or to price signals. Moreover, private costs and benefits often diverge markedly from social costs and benefits because of economies of scale, and of the external costs and benefits associated with education and training, research and development, information and the environment. This provides the economic rationale for government activity in this area, as well as for UNIDO activities in technology. Societies require appropriate structures to acquire, absorb and develop technology, to manage it properly, and to build up domestic scientific and technological competence. These structures and the efficacy of their operation are a measure of a country's self-reliance, and are a reflection of national policies which feature technology within an overall development context. Furthermore, the least developed countries, which almost by definition have hardly any industrial or technological competence, have to pay due regard to technological trends and developments. Domestic technologies, rooted in traditional customs, skills and materials, can often be beneficially upgraded by what modern science and management techniques have to offer. Domestic scientific and technological competencies are needed to import technology and machines which embody technology. Thus all countries require policies and programmes in various activities which

have a coherent orientation to technology. National technology policy must be coherent with industrial policy and overall development policy.

How developing countries and their business enterprises can manage technological change for the benefit of industrial and socio-economic growth in the 1990s, is therefore the central concern of the technology development and promotion activities of UNIDO.

## ***LINKING TECHNOLOGY WITH FOREIGN INVESTMENT***

UNIDO has responded to market liberalization and privatization and to new forms of international cooperation by bringing closer together, within its Investment and Technology Promotion Division, those activities which are directly related both to industrial investment and to technology transfer and promotion. Furthermore, it has launched the Investment and Technology Partnership Initiative to assist developing countries in their efforts to secure and widen investment and technology inflows. These inflows are reckoned not only in terms of individual contracts between two business firms, one domestic and the other foreign. A secure return for all the partners involved can be assured only if a national capability to access such inflows and to utilize them effectively has been created. An integral part of such a capability is the establishment of a conducive investment climate, the generation of matching national investments and the creation of an adequate infrastructure for the utilization of technology in industry. Thus, through its Investment and Technology Partnership Initiative, UNIDO can be instrumental in linking investment promotion with technology upgrading and the enhancement of technological capabilities. Given this objective, UNIDO accords a high priority to ensuring the full integration of the activities of three programmes: Investment, Technology, Industrial Cooperation and Consultations Services, so as to offer comprehensive international industrial cooperation packages. While UNIDO is one of several institutions promoting investment in developing countries, it is the only such institution with a track record in industrial development and technology transfer. Thus, UNIDO emphasizes the linking of investment promotion with technology upgrading and the strengthening of domestic technological capabilities through promoting integrated investment and technology policies. Based on the specific conditions prevailing in different countries, UNIDO can design packages of integrated services for scheduled delivery within the framework of an Investment and Technology Partnership Initiative, in close cooperation with a government, and domestic industrial institutions and enterprises. Elements of the services which can be supplied by UNIDO are shown in Figure 1.

It should be emphasized that, in addition to these services supplied by the Investment and Technology Promotion Division, a range of additional services provided by other units of the UNIDO Secretariat (as shown in Figure 2) can also be supplied as part of the Partnership Initiative. Thus, where the Partnership Initiative requires that the package of services should include, say, the techno-economic review of a country's building materials sector, the services delivered by UNIDO would include the expertise of a building materials specialist and of a country economist, and this would involve close cooperation within the Secretariat with the substantive units specialized in these areas.

The basic aim of the UNIDO Investment Service is to promote investment in the industrial sector in developing countries where private sector enterprises have assumed an important



role in the industrialization process. Furthermore, together with its network of Investment Promotion Service Offices, it assists project sponsors in developing countries in the identification, appraisal and preparation of investment projects and promotes those projects through investment promotion meetings (INVESTMART) and country presentation tours. In addition, the programme provides substantive, methodological and software services in the field of pre-investment and feasibility studies.

UNIDO's Industrial Cooperation and Consultations Service contributes to international industrial cooperation and consultations between developed and developing countries, as well as among developing countries themselves, in various areas of crucial importance to investment and technology promotion. It places special emphasis on identifying opportunities for investment, technology transfer and technical cooperation and encourages, promotes and supports information exchange and concrete cooperation between a wide range of industry-related institutions (e.g. industrial associations, chambers of commerce and industry, financing institutions and professional and trade associations). Assistance in the formulation and conclusion of cooperation agreements in order to establish a basis for viable long-term partnerships is also provided. Special emphasis is given to utilizing arrangements involving cooperation among developing countries as a major tool for industrial cooperation at the subregional, regional and interregional levels; focus is maintained on increasing the awareness of key industrial decision-makers of the opportunities and potential benefits offered by economic cooperation among developing countries and technical cooperation among developing countries (i.e. ECDC and TCDC) arrangements.

## **CHAPTER 2**

### ***UNIDO'S TECHNOLOGY SERVICE: THE OVERALL PROGRAMME***

Technology can be obtained from a number of sources, domestic or foreign. Sources include relatively free goods such as published literature and research papers, as well as copying and imitation; through the purchase of know-how, technical processes and equipment; through participation in the design, construction, management and operation of enterprises; and through specialized education, training and technical assistance. A critical aspect of access to those sources is the extent to which absorption can take place, and the structure of incentives and competencies governing the behaviour of suppliers and receivers. Access to these sources is also governed by the policies and strategies of governments, institutions and businesses, all of whom depend on timely and accurate information. The aim of the UNIDO technology programme is to provide this information, advice and technical assistance which responds to the goals of a nation's technological system:

- Management of technological change - technology policy and management by governments, institutions and businesses;
- Stronger national technological capabilities possessed by policy-makers, institutions and businesses, including the capabilities to identify the implications of new and emerging technologies, including environment-related technologies, and to access, adapt or develop such technologies;
- Stronger technology acquisition capabilities through improved access to foreign technologies, and development of capacities to identify sources of technology and to facilitate their efficient transfer.

UNIDO delivers assistance to developing countries in achieving these goals via an array of advisory services and technical assistance, together with the information arrangements shown in Annex I. The UNIDO Secretariat's technology programme focuses through specialized units on key areas of major concern to the government and corporate management with the following objectives:

#### ***TECHNOLOGY PROMOTION***

- To sensitize developing countries to the importance of identification, development, innovation, adaptation, promotion and application of technologies that are appropriate to their respective needs, resources and levels of development;

- To assist developing countries in the development and diffusion of appropriate technology as well as the proper utilization of the relevant technological services, including the strengthening of their domestic technological infrastructure and its links to industrial production, especially in the least developed countries;
- To promote and assist in the development of capabilities in specific generic technologies - informatics, biotechnology and genetic engineering and other newly emerging technologies - in the developing countries through international and regional centers and networking arrangements, so as to build long-term capability and facilitate participation in these areas.
- To assist developing countries to formulate and implement technology policies and technology management and commercialization measures which are internally consistent and interact coherently with industrial policies and competitive realities.

### ***TECHNOLOGY ACQUISITION***

- To assist in the process of technology acquisition and transfer with regard to the identification of technology sources and the promotion of technology business, e.g. through TechMarts, and in cooperation with investment promotion activities;
- To conduct advisory and training activities aimed at improving negotiators' knowledge of the technology market, to increase their awareness of alternatives, and to enhance their capacity for successful negotiation;
- To monitor technology developments and technology transfer trends, to carry out studies and surveys and implement technical assistance projects related to new and innovative forms of technology transactions such as BOT (Build-Operate-Transfer) and strategic alliances.

Each area above provides practical outputs of significant relevance to the operational needs of industry. The outputs provided in these key areas also take into account different levels of development, including that of the least developed countries. Outputs include policy and management advice, international cooperation networks, ad hoc information, directories, guides and manuals, and the range of information products shown in Annex I.

## CHAPTER 3

### ***TECHNOLOGY PROMOTION***

This programme assists in the development and diffusion of technology and technological services leading to a coherent basic technological infrastructure; promotes and assists in specific generic technologies; and promotes the building of awareness in developing countries to the possibilities offered by appropriate technology that is sustainable at various levels of development.

#### ***STRENGTHENING DOMESTIC TECHNOLOGY***

This part of UNIDO's programme aims to assist developing countries in the development and diffusion of technology well-matched to their socio-economic environment and level of development, and to the economic utilization of their domestic technological infrastructure and its links to industrial production, especially in the least developed countries.

To build up their endogenous technological capabilities, developing countries need to be strong in the basic components of technology infrastructure. Only with institutions or endogenous capabilities such as R&D, quality control and metrology facilities and technological services in place can they develop, adapt and effectively use the best technologies for a given industrial product or process. Such capabilities can be critical inputs to raising the productivity of enterprises, improving the quality and marketability of goods, products and services, boosting exports and fulfilling the customer's requirements. Development of this type of infrastructure has the potential of leading to greater cooperation between manufacturers and paves the way for foreign cooperation through joint ventures, subcontracting and various types of inter-firm agreements at the subregional, regional and interregional levels. In particular, developing countries recognize the need for explicit government action at the level of technological infrastructure: without such intervention, the gains of technology transfer may not be consolidated. The private sector, although increasingly the vehicle for acquiring and supplying technology, typically invests too little in building up its basic supporting elements. Because of economies of scale, distorted markets and economic externalities, private investors cannot capture the economic benefits arising from such investment: the State has a legitimate role in subsidizing such investment.

The Technology Programme supports the creation and strengthening of R&D institutions, improves capabilities to manage R&D and commercialize such activities, and assists in an expansion in the supply of technological services, e.g. standardization, quality control and testing services. Thus, UNIDO reviews government-funded R&D facilities as well as university science and technology activities with respect to their service to industry. It then advises governments and other organizations how such institutions and departments work and their relations with industrial enterprises. Recommendations from such reviews can range

from complete restructuring of an institution to joint research projects with industry (for example, feasibility studies) or stronger links with UNIDO's technical assistance delivery system in order to identify R&D projects otherwise ignored. Furthermore, UNIDO mobilizes international cooperation on R&D in areas of great potential and common interest for developing countries with a view to building up national-level capabilities. Emphasis is also given to the revitalization of existing R&D institutions in view of the changed industrial environment. This more competitive environment demands not only the establishment of a more conducive investment climate for domestic and foreign entrepreneurs, but also the creation of a coherent infrastructure of institutions for the utilization of R&D in industry. Moreover, the creation of global partnerships so as to support collaborative efforts between countries with complementary interests, experience and/or resources is given high priority. These partnerships may take also the form of cooperation agreements between industry-related institutions and associations with the aim of setting up twinning arrangements and multilateral networks. These can serve as umbrellas for innovative schemes of region-to-region cooperation encompassing a broad range of investment and technology cooperation at the policy, institutional and enterprise levels.

Engineering, management and marketing consultancy services are an effective means for developing countries to mobilize indigenous labour, skills and experience in working on industrial projects. Joint ventures of various types have to be promoted and agreed with foreign consulting firms so as to build up domestic consultancies progressively. In practice, it is rare for foreign consulting firms to have all the know-how and expertise to carry out an assignment effectively in any developing country; the physical and natural resource environment, economic and production linkages, as well as the legal and socio-economic standards, in countries of assignment are normally not the same as in foreign firms' home countries. Such domestic consultancies can play a significant role in ensuring the better use of domestic human and natural resources, domestic intermediate inputs and appropriate domestic technologies.

Information is a crucial prerequisite in all stages of technology promotion, development and transfer. In a world characterized by an exponential growth in information and versatile tools to access it, developing country governments, institutions and enterprises need to equip themselves to access technological information, assess and utilize it effectively, and link it to decision-making. In this connection, UNIDO assists governments and their agencies not only to obtain information of crucial relevance in the construction of a domestic technological infrastructure but equally important in the design of domestic information diffusion systems so as to ensure that relevant information is obtained by decision-makers in firms, service institutions and enterprises that comprise the industrial production system. Annex I provides details of UNIDO's information products and services.

## ***PROMOTION OF ADVANCED TECHNOLOGIES***

The purpose of UNIDO's activities in this area is to promote and assist in the development of capabilities in generic technologies.

Advanced technologies can have a two-fold impact on the industrial development of developing countries. Their direct effect is on industry itself, changing both the process of

production as well as the product, i.e. advanced technologies can be the nucleus of new activities and new products. Their indirect impact is on world markets and the inability of developing countries to compete in them through loss of comparative advantage. UNIDO promotes the transfer of advanced technologies to developing countries also because these technologies offer unique opportunities to solve some of their special problems, for example, by applying high science to upgrading local resources. For some countries, they also provide opportunities to make a quantum jump in the development, narrowing gaps between them and the industrialized countries. Governments and enterprises in developing countries lack awareness of both the rapid changes in new and advanced technologies and their implications for their own industries and activities. Their scientists and technologists are isolated from the mainstream and their enterprises can remain with existing technological levels, neither improving their manufacturing capabilities nor cutting their costs.

Recognizing this, UNIDO's primary aims are to draw the attention of governments and industry to what is happening in the new and advanced technologies and to promote responses by them. Through seminars and advisory missions, it sensitizes policy-makers, industrial managers and entrepreneurs, scientists and technologists and stimulates them to formulate policies and programmes. New policies may be called for, or technological strengths may be needed, in order to take advantage of the new technologies. For this, UNIDO promotes centres of excellence, as shown in the box below, and mobilizes the cooperation of individuals and institutions at the cutting edge of a particular technology, using them to provide technical assistance when requested. UNIDO also promotes cooperation in R&D between institutions in developed and developing countries aimed at long-term capability-building in the latter.

#### INTERNATIONAL AND REGIONAL CENTRES OF EXCELLENCE

##### Existing Centres:

- International Centre for Genetic Engineering and Biotechnology (ICGEB), Trieste, Italy
- International Centre for Science and High Technology (ICS), Trieste, Italy
- Centre for Advancement of Solar Energy (CASE), Perth, Australia

##### Centres in Pipeline:

- International Centre for Materials Evaluation Technology, Taejeon, Republic of Korea
- International Centre for Hydrogen Energy Technology (ICHET), Turkey
- International Centre for Advancement of Manufacturing Technologies (ICAMT), India
- Regional Centre for Materials Technology, Syria

##### Proposed Centres:

- Caribbean Regional Centre for Marine Industrial Technology
- Arab Regional Centre for Solar Energy Applications

UNIDO keeps many advanced technologies under review, but directs special attention to certain generic technologies, shown in the following box, that have far-reaching effects on industrial development. UNIDO's Technology Information Service supplies technological and industrial information in each area, monitor trends and develop data bases and networks, as indicated in Annex I.

#### **THE FOCUS ON NEW AND ADVANCED TECHNOLOGY**

- Genetic engineering and biotechnology
- Microelectronics, informatics and telecommunications
- New materials
- New energy technologies
- Marine industrial technologies
- Advanced manufacturing systems

#### ***GENETIC ENGINEERING AND BIOTECHNOLOGY***

Modern biotechnology and genetic engineering have provided tools for dynamic and progressive change over the past 15 years. New technological applications are emerging which provide an array of commercial opportunities in many sectors of significance to developing countries, as shown in the box underneath:

#### **POSSIBLE COMMERCIAL OPPORTUNITIES ARISING FROM GENETIC ENGINEERING AND BIOTECHNOLOGY**

- Pharmaceuticals
- Vaccines
- Diagnostic, prophylactic and therapeutic materials
- Stress-resistant plants
- Animal, marine, plant and microbiological products
- Specialty chemicals and energy production
- Bioelectronics
- Bioinformatics

Although biotechnology holds great potential for meeting basic needs and enhancing global competitiveness, the challenge remains of how to maximize the benefits of biotechnology while reducing its risks. Widespread application of biotechnology requires that some developing countries adopt a policy framework and consolidate their isolated biotechnology capability-building efforts. Countries already having such capabilities seek to move ahead with their own small-scale bio-industries. UNIDO promotes capability-building and safety

procedures for biotechnology research and applications, the consolidation and networking of national, subregional and regional biotechnology programmes, and the establishment of partnerships between developed and developing countries' biotechnology institutions and the private sector.

Biotechnology capability-building addresses two different levels. Technical cooperation and links with the International Centre for Genetic Engineering and Biotechnology (ICGEB), as shown below, strengthen R&D capabilities, including consolidation of dispersed biotechnology-related programmes into national programmes. Particular attention is given to strengthening biotechnology activities in Africa. Under the broad heading of environmental biotechnology, UNIDO works to create greater understanding and appreciation of the need for the applications of biotechnology consistent with safety. UNIDO works with UNEP, WHO and FAO in an informal working group that seeks to promote environmental applications of genetically modified organisms (GMOs) for industrial development in a safe and ecologically sustainable manner. On behalf of the UNEP/UNIDO/WHO/FAO Ad Hoc Working Group on Biotechnology Safety, UNIDO prepared a volume under the title *GMOs: a biosafety manual*. Furthermore, it undertook a project to evolve a set of internationally agreed upon biosafety guidelines for the sound management and uses of biotechnology. Two meetings of experts on biosafety and regulatory issues were convened at which a Voluntary Code of Conduct for the Release of Organisms (GMOs) into the Environment was developed. The final meeting of experts in formulating the Code was held in Trieste, Italy, in 1991 by UNIDO in cooperation with the International Centre for Genetic Engineering and Biotechnology (ICGEB). However, in most developing countries validated systems for risk assessment, risk/benefit analysis, and data on approved testing are not generally available. The provision of such services is quite beyond the financial and technical capabilities of most developing countries eager to develop and receive new biotechnology products. Lack of personnel trained in risk assessment, environmental impact analysis and modelling is an additional impediment to monitoring and ensuring compliance with a regulatory policy.

Consequently, and as part of the development of the Voluntary Code of Conduct, a recommendation for an enabling mechanism was made in the form of the establishment of an International Biosafety Information Network and Advisory Service (BINAS). Realizing that as a UN agency with a mandate to promote industrial development, and recognizing that industry is the major producer as well as the major user of biotechnology, UNIDO, in close cooperation with ICGEB and the Organization for Economic Cooperation and Development (OECD), took steps to strengthen the Organization's capacity in preparation for the anticipated task of implementing the BINAS programme. In 1993, the International Biotechnology Forum, representing major biotechnology companies, established a working relationship with BINAS, while regional meetings and training workshops held in the Russian Federation and the ASEAN region resulted in the creation of BINAS information nodes in the countries concerned. Closer to production operations, training in technology transfer facilitates marketing of research and business development in industrial applications. UNIDO also encourages existing and potential affiliates of ICGEB to become active R&D partners and to develop themselves into regional or subregional centres of excellence. Cooperative research programmes and global networks have been initiated in the areas of lactic acid food fermentation, industrial production of mushrooms, industrial bioconversion of waste materials to food and useful products, marine biotechnology products (e.g. sea-weed processing for agar and biopolymer production), and environmental biotechnology.



Major initiatives, with respect to Biotechnology and Genetic Engineering, are:

- Establishing a new partnership with the International Centre for Genetic Engineering and Biotechnology (ICGEB), its New Delhi and Trieste Laboratories and its Affiliated Centres in 17 countries;
- Facilitating the development of science-based industries in collaboration with new partners in the financial and business communities and with non-governmental organizations (NGOs);
- Promoting biosafety in the release and commercialization of transgenic products;
- Promoting and facilitating a number of international and regional research and development networks on themes of common interest, such as lactic acid bacteria, the bioconversion of waste materials into food and useful products, cassava bioprocessing, marine biotechnology, bioremediation, and molecular inventories of biological diversity;
- Facilitating the setting up of innovative commercial ventures in genetic resources prospecting for developing countries endowed with rich natural resources;
- Helping developing countries to benefit more equitably in biotechnology development by promoting closer international cooperation in the issue of intellectual property rights;
- Keeping developing countries regularly informed of global advances in biotechnology and issues related to their interest through the dissemination of information; and
- Preparing for future trends in biotechnology in areas such as biosensors and bioprocess engineering to promote the growth of biotechnology development in developing countries.

## **INTERNATIONAL CENTRE FOR GENETIC ENGINEERING AND BIOTECHNOLOGY (ICGEB) AND ITS AFFILIATED CENTRES**

Recognizing that the first order of impact of genetic engineering and modern biotechnology is on industry, UNIDO invited representatives of more than 40 governments to consider its implications at a meeting in Belgrade, former Yugoslavia, in 1982. They agreed, in principle, to establish the International Centre for Genetic Engineering and Biotechnology (ICGEB). The Centre was to devote itself to training and research in genetic engineering and biotechnology with a view to enhancing human health, food and nutrition levels and promoting advancement of bio-industries in developing countries.

In 1987, ICGEB became operational, a unique inter-governmental centre engaged in research, development and training in biotechnology and genetic engineering, reaching a high level of scientific competence within a short time. Having attained the required number of ratifications of its Statutes by Member States, ICGEB became autonomous in 1994. The ICGEB has 32 Member States and a total of 49 signatories to its Statutes. Several UN agencies participate with observer status in the meetings of the ICGEB Board of Governors.

The ICGEB Board, made up of representatives of Member States, endorsed the 1994-98 work programme and a budget of US\$ 13.6 million for 1994. Work at ICGEB's components - in New Delhi and in Trieste - includes R&D on diseases such as hepatitis, malaria, AIDS and human papilloma virus as well as pest- and stress-resistant crops, peptide antigens and lignin biodegradation. Some industrial applications have already been developed. ICGEB seeks to develop the results of research into products for use for the benefit of developing countries. A number of industrial enterprises are funding contract research at ICGEB or licensing its products for marketing.

The Centre's programme includes pre- and post-doctoral training of scientists and researchers from Member States to ensure that they have access to the latest genetic engineering techniques. It also supports collaborative research projects at 20 affiliated institutions around the world.

The establishment of the ICGEB and the promotion of centres of excellence were part of UNIDO's integrated programme on capacity-building, involving *technology policy formulation, assessment, acquisition and applications* relating to other technologies and services complementary to biotechnology promotion.

## **INFORMATICS AND TELECOMMUNICATIONS**

Developing countries still lag behind in the field of informatics technology, particularly with regard to industrial applications. Key capabilities are skills, experience and the ability of the local industry to match international standards, development of software and design of applications-specific integrated circuits.

The UNIDO programme emphasizes increased awareness, strengthened national capabilities, regional cooperation, micro-processor application centres, promotion of technology transfer and strengthening or promotion of test facilities. UNIDO provides guidelines for the purchase and utilization of hardware and software, strengthens developing countries' capabilities through micro-processor application centres or core groups, and helps set up software houses and activities for the design of integrated circuits. Studies on software focus on its relevance to developing countries, the approach to software development, and guidelines for software production. Special emphasis is given to computer applications in medium and small-scale industry, this task being performed in cooperation with other UN agencies. The whole programme is guided by the advice of the Consultative Group on Informatics Technology for Development (COGIT). Developments and diffusion of informatics and telecommunications technologies are continuously monitored and reported in a quarterly current awareness newsletter, the *Microelectronics Monitor*.

Although the economic impact of telecommunications is generally recognized, the poor status of telecommunications in most developing countries constitutes one of the major constraints to economic development. Industrial investors increasingly direct their resources to countries with acceptable telecommunications facilities. Technological advances and investment considerations have led to major policy changes with a diminishing role of the state in both the provision of services and manufacture of telecommunications equipment. The private sector is emerging as the lead player in telecommunications.

The UNIDO programme on telecommunications emphasizes the promotion of local manufacturing of telecommunications equipment. While some developing countries are already engaged in manufacturing telecommunications equipment, the far greater majority relies almost exclusively on imports even for simple items which could be locally produced. The UNIDO programme builds awareness on manufacturing opportunities through technological disaggregation of telecommunications systems, identification of potential projects, assistance in undertaking feasibility studies and promotion of technological cooperation, especially on a TCDC basis. To complement the manufacturing activities, UNIDO encourages regional cooperation in the establishment of type approval facilities, standardization, quality assurance, and inter-country R&D programmes. Exchange of information through publication of directories of manufacturers and development of databases for the benefit of regional institutions is also supported. UNIDO also provides guidance to software firms in developing countries wishing to enter into the telecommunications software industry.

## ***NEW MATERIALS***

Materials developments are critically important to developing countries, most of which still depend on export of primary commodities. Materials science will change the structure of the demand for both those exports and processed materials such as steel, alloys, aluminium and other metals. The complexity of the problems in materials synthesis requires a team effort across many disciplines working together in a way that outstrips the resources of many developing countries. Some countries do have policies and a materials strategy that enable them to begin building up materials science and engineering capacities. UNIDO's programme takes a trans-sectoral approach to new materials and addresses, *inter alia*, policy-oriented issues and long-term capability-building in materials engineering. It analyses materials information and monitors technology trends in individual materials.

A major development was UNIDO's sponsorship of the International Centre for Science and High Technology (ICS) in Trieste, Italy, part of whose activities include research and training in new materials. Alongside this, UNIDO is working towards the establishment of the International Materials Assessment and Application Centre (IMAAC) in Brazil. A third institution, the International Centre for Materials Evaluation Technology (ICMET) would make available the more sophisticated and systematized techniques for testing and evaluation required by advanced materials. Another institution, the Regional Centre for Materials Technology to provide a regional focal point and centre of excellence in the Arab World is the subject of a feasibility study.

Strategy advice for government is mobilized on areas such as trends in advanced materials processing, their application and impact on socio-economics development. International cooperation is promoted in technologies related to the design, development, manufacturing and application of composite materials based on local resources, including cooperation within the developing regions of Asia and Africa. Complementing the new materials programme, UNIDO monitors advances in materials and publishes the quarterly newsletter, *Advances in Materials Technology: Monitor*.

## ***NEW ENERGY TECHNOLOGIES***

Energy generation based on biomass, solar, wind and hydropower, already discussed earlier under the heading "Appropriate Technologies", suffers from the shortcoming of storage difficulty. This shortcoming can be overcome by an intermediary energy carrier. As a storable, transportable, pollution-free and readily available gas, hydrogen is now widely recognized as the prime possibility. Hydrogen substitutes for natural gas for heat generation, for gasoline as a transportation fuel, and for convention power generation using fuel cells. Solar, wind or hydropower energy is converted to electricity using solar cells, wind machines or water turbines. The electricity is converted to hydrogen using hydrolysis. Hydrogen, with little or no pollution, no acid rain, greenhouse effect, oil spills, etc. is regarded as one of the safest of fuels. It has the potential additional advantage of local generation in remote regions. Given the global nature of energy and environmental concerns, it is essential that countries cooperate in reaching solutions which are economically feasible and technically realistic.

UNIDO promotes R&D on economically feasible applications of hydrogen energy technologies, and encourages sharing and transfer of technologies that make application of hydrogen a possibility. A key role in UNIDO's efforts is planned for the International Centre for Hydrogen Energy Technology (ICHET) in Turkey, for which US\$ 100,000 preparatory funding has been mobilized. ICHET will link with other centres, including the ICS and the Centre for the Advancement of Solar Energy (CASE) in Perth, Australia, while a proposal has been formulated for the transformation of the Hangzhou Centre of the Regional Network for Small Hydropower, Asia/Pacific, into an international centre. In this connection, the possible social and economic benefits of mini-hydropower are shown in the box below, which demonstrate the multiplier effects of this technological innovation. These benefits also illustrate the important role of the international cooperation development objective in attaining UNIDO's four other development objectives.

#### **MINI-HYDROPOWER PLANTS: THE POSSIBILITIES**

- Domestic production of equipment
- Domestic and rural construction of civil works
- Participation of rural population
- Decentralized management
- Rural production of electricity with its gains to social welfare and rural development.

### ***MARINE INDUSTRIAL TECHNOLOGIES***

UNIDO conceives marine industrial technology as a system of interacting technologies supporting industrial activities based on the sustainable utilization of the natural resources of oceans, coastal waters, and the marine environment in general. The subject is multidisciplinary and based on many technological applications of a range of sciences, e.g. systems for marine environment surveillance, sub-sea technology and marine-based pharmaceuticals. However, developing countries lack the capabilities to exploit the opportunities offered, including those arising from the UN Convention on the Law of the Sea and exclusion economic zones, e.g. hydrocarbon and minerals recovery and the management and harvesting of living resources for industrial uses.

UNIDO's programme focuses on awareness-building, the creation of relevant domestic capabilities, and on the business opportunities offered to coast-owning developing countries. For this, UNIDO mobilizes international cooperation mechanisms for the co-development of technology through joint ventures, research and training and for the identification of new business opportunities in marine industrialization. Thus, UNIDO is actively promoting a Regional Centre for Marine industrial Technology in the Mediterranean and Caribbean region, and looks to establish similar centres in Africa, South-East Asia and the Baltic. Each centre would be linked to a network of industrial and academic contacts in the field, such as the Norwegian Institute of Technologies, the International Ocean Institute in Malta, the

Fritjof Nansen Institute in Norway, the Massachusetts Centre of Excellence Cooperation, the Woods Hole Oceanographic Institution, and others.

Developments in all aspects of the field are monitored, expert group meetings and workshops are organized to provide access to information and experience in industrialized countries, and corresponding studies and being prepared, e.g. technological spin-offs from deep-sea mining to other marine sectors in developing countries, marine electronics and marine materials. The Marine Industrial Technology Monitor is published quarterly.

## ***MANUFACTURING SYSTEMS***

New developments in manufacturing are revolutionizing the way industrial goods are produced, the way in which work is organized, with resulting changes in corporate and middle management and on the shop-floor. In some countries, for example, the multifunctionality of production workers, an essential ingredient of the kanban (just-in-time) system; the keiretsu system functioning on long-term trust rather than contract specification and its attendant litigation; and the grameen system of finance for small scale and micro-enterprises, all provide the possibility for effective adaptation for developing countries' industrialization and production operations. These new arrangements, in combination with macro-economic trends such as the new recognition of macro-economic stability, global production and subcontracting, and sub-regional, regional and international market integration, make competitive capability a critical capacity for all countries. In the 1990s, low wages by themselves are not sufficient to ensure developing countries' comparative advantage.

Thus, developing countries' manufacturers cannot afford a narrow world view that ignores successful change elsewhere in industrial organization and practice. Adjustment to infrastructure and services are ever more essential to become or remain competitive in world markets.

UNIDO's Advancement of Manufacturing programme takes a holistic approach, starting with supportive government policies and access to technological information through to educational and training infrastructure changes, and provision of technical and managerial personnel. The programme features support for a new international centre, studies to define priorities, awareness-building workshops, training and expert group meetings and information dissemination. A key component of the programme is the promotion of an International Centre for the Advancement of Manufacturing Technologies (ICAMT) in Bangalore, India, with the overall task of sensitizing managers in the developing world to the needs, techniques, and business opportunities of advanced manufacturing. ICAMT will be the focal point of a global network of institutions and it will undertake specialized training, studies and workshops, as well as providing back-up support for business and manufacturers' associations.

## ***APPROPRIATE TECHNOLOGY FOR SUSTAINABLE DEVELOPMENT***

Lack of information on the characteristics, availability and profitability of existing mature technology, well suited to domestic needs in many developing countries, can be a barrier to progress. In particular, the blending of modern and traditional technologies to obtain cost-effective appropriate technologies, as well as domestic innovation, adaptation, development, design and manufacture in this area, can make significant contributions to sustainable development. Thus, new and renewable energy sources, often abundant in developing countries, are under-utilized, even by countries which import fossil fuels. Traditional technologies are often characterized by low efficiency, short working life, uneven and non-standard quality: a real need is often to develop technologies that combine human and natural resources to manufacture products for the domestic market: products that are well linked to upstream and downstream economic activities. Furthermore, non-hazardous technologies are mostly developed and designed for industrialized country markets and often require more or less modification and adaptation in design before they can be economically used in developing country environments.

Although the benefits of enterprise-level technological cooperation are widely acknowledged, its practice accords with neither its potential nor, in the case of TCDC, the political support given to it by governments at international fora. Lack of information remains a major problem. Developing country enterprises are unaware of counterparts elsewhere who would be willing to share their technology, know-how and experience; potential donor enterprises are unaware of potential beneficiaries' specific interests. Promotion of enterprise-level technological cooperation is used as an instrument wherever appropriate throughout the technology programme.

UNIDO experts identify and match up enterprises seeking particular technologies with those in industrialized and other developing countries wishing to transfer such technologies. TCDC programming workshops promote preliminary working agreements to exchange experience, share training facilities, cooperate in R&D, and transfer particular technologies among developing countries. Such workshops are usually hosted by a developing country with relative strength in a particular technology, such as electronics and telecommunications in several Asian countries. TechMart meetings bring enterprises together in the context of national or other specialized trade fairs, taking advantage of cooperation offers documented in INTIB databases (see INTIB box below). Similar opportunities are offered at UNIDO INVESTMART meetings, as mentioned under UNIDO's Investment and Technology Partnership Initiative.

## WHAT INTIB OFFERS

INTIB, UNIDO's Industrial and Technological Information Bank, offers information and documentation services in the form of:

- Selected, analyzed and annotated information on 20 industrial sectors on alternative technology based on users' needs and priorities;
- Information to facilitate acquisition of technology;
- Equipment specifications;
- Information on starting small manufacturing industries;
- Advisory services on information policy and design;
- Information on training needs and opportunities;
- Data on research and development activities; and
- Advice on how to contact industrial information experts.

(for details on INTIB, see Annex I)

UNIDO's work on energy-saving technologies focuses on energy sources that are abundant in developing countries - as shown in the box below.

## THE UNIDO FOCUS ON TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT

- Energy-saving technologies:
  - mini-hydro power
  - solar energy
  - biomass energy
  - wind energy
  - hydrogen
- Upgrading and transfer of technology:
  - technologies from UNIDO projects
  - domestic technologies
  - adaptations to domestic environments

The aim is to assist developing countries to develop and utilize their indigenous energy resources, thereby reducing their dependence on high-cost imported fuels. UNIDO disseminates information on energy technologies, especially those relevant to the decentralized, small and medium-scale industry. It promotes local manufacture of equipment and develops information on energy conservation techniques that reduce industrial energy costs. UNIDO also promotes regional and interregional cooperation in the field of energy



technologies, e.g. through a network of mini-hydropower institutions in Asia and its Consultative Group on Solar Energy Research and Application (COSERA).

Appropriate, locally developed and UNIDO-promoted technologies are promoted and developed through the activities shown in the following box:

**PROMOTIONAL ACTIVITIES FOR APPROPRIATE TECHNOLOGY**

- Identification
- Publication, including video tapes
- Workshops, seminars and conferences
- Exhibitions
- Technology fairs
- Advisory and technical assistance services

Appropriate technologies also benefit from advisory services on their development and commercialization through orientation to market demands. UNIDO promotes the transfer of such technologies to other developing countries through ECDC mechanisms and seeks to incorporate local and appropriate technology thinking in universities, R&D institutions, technology parks and incubators.

With locally developed technologies, the focus is on the rational use of R&D capabilities (including linkages between universities and the industrial sector), the interaction of R&D work on local technologies with manufacturing and marketing, the use of local human and natural resources, and the application of concepts of sustainability. Innovation and adaptation assistance includes design and development inputs, preparation of prototypes, testing and pilot plants. Related programme components raise awareness of hazardous technologies and environment-damaging technologies and draw attention to UNIDO-promoted technologies; UNIDO can select technologies that have been proven in its technical cooperation projects. Previous beneficiaries in the latter can often provide the human resources for similar projects in other countries under TCDC arrangements.

At the conceptual level, UNIDO contributes with studies and other activities that help define sustainable technological development with reference to developing country environments. It promotes thereby direct involvement of those countries in shifts in the technology trajectory that would make technology development more relevant to their long-term problems.

Information on cleaner and energy-saving technologies is collected and disseminated from a special database, the Referral Data Base on Energy and the Environment (REED) operated under the industrial information services as shown in Annex I. New opportunities in areas of conventional technology and the challenges they present for developing countries are documented at the sectoral level in sectoral technology briefs and are similarly disseminated.

## **CHAPTER 4**

### ***TECHNOLOGY POLICY AND MANAGEMENT***

UNIDO's Technology Service is also responsible for the provision of assistance to developing countries in the formulation of policies and programmes related to the development and application of new technologies, and the promotion of technologies appropriate to country needs that contribute to sustainable development and assist in commercializing new and traditional technologies suited to market demands. The Service is also responsible for promoting the management of industrial technology, as well as the inflow of technology. The Service emphasizes activities which help in the creation of an enabling environment, particularly the specialized services which are provided to production enterprises by a coherent institutional infrastructure.

#### ***TECHNOLOGY POLICY FORMULATION***

Governments and industrial companies cannot afford to ignore the impact of changing technology. The need, positively to manage technological change, emerged in the 1980s as a major issue in response to the new intensity and speed of technology change. Technology policy is the set of policies, strategies and instruments that guide acquisition, generation and utilization of technologies relevant to industrial activities. Governments respond with explicit legislation aimed at maximizing the benefits of modern technologies and/or reducing their adverse consequences. Some have policy frameworks for dealing with technological development; others rely implicitly or explicitly on a combination of economic or regulatory measures applied to scientific, technical and educational problems in the context of general development plans. Lack of policy or of its implementation leads to major distortions and missed opportunities, skewed industrialization patterns, little diffusion of technological development in the economy as a whole or products and consumption patterns at odds with development needs.

An integral part of technology policy are the economic and institutional steps to ensure dynamic interaction between technological and industrial development. Technology policy should also be part of a framework for national action to strengthen technological capabilities and to manage technology generally. Such a policy framework typically has three components: policies, programmes of action and institutions/industrial companies. Policy incentives are like valves that open up or shut off national resources and energies. Action programmes create the resources and energies according to the lead given by policies. Institutions and industrial companies are the instruments of implementation. Policy frameworks must accommodate different entry points for a range of technologies, beginning with a minimum level of awareness generation, continuous monitoring, critical and relevant technological intelligence, identification of needs and the ability to assess, select, negotiate and utilize technology.

## MAJOR ISSUES IN TECHNOLOGY POLICY

- Selection and acquisition of technology;
- Technological innovation;
- Basic technological infrastructure;
- New and emerging technologies;
- Linkages with macro- and micro-economic environment;
- Relationship between government bodies and management of technical change;
- Relationship between business firms (state owned and private) and technical change; and
- Human resource development.

The technology policies of many developing countries are in disarray. Some are unmatched with governments' economic policies in areas such as debt servicing, privatization, and the promotion of direct foreign investment. Technology policies have often not responded to the emergency of new technologies and to the pace of technological change itself. R&D policies are often outmoded, lacking the involvement of newly liberalized private sectors, and the interdisciplinary approaches required by new techniques are ignored as are the technologies required to confront pollution. Above all, there is often a failure to comprehend the challenges and opportunities offered by changing comparative advantage, shifting production platforms and the global integration of markets.

UNIDO focuses on communicating what technology policy really is and how it performs in its two major roles - as an important ingredient of development, and as a basic capability that each country has to develop. UNIDO's principal aim is to systematize and place the growing body of knowledge on technology policy at the disposal of decision makers in governments, service institutions and the production sectors. Its programme of activities includes

- (i) studies identifying key policies in the 1990s, case studies and guidelines;
- (ii) advisory services for surveys and analysis of national level needs and capacities;
- (iii) assistance in formulating technology policies that are coherent with economic and industrial policies;
- (iv) establishing or rebuilding institutions or focal points for technology policy in relevant ministries and agencies;
- (v) training services and facilities; and
- (vi) linkage with the network of cooperating technology policy institutions and research groups.

## **TECHNOLOGY MANAGEMENT**

Management of technology is the set of concepts, skills, techniques and practice required for the implementation of policies for the development and use of technology. It spans the interface of science, engineering, economics and management, with execution taking place in government, institutions and agencies, as well as in production. Within governments,

management of technology involves the implementation of planning and policy decisions, with regard, for example, to import and tax policy, technology regulation, public expenditure on technology services infrastructure and the interpretation of decisions on resource subsidies for particular industries. Technology management for R&D institutions should focus on such issues as business applications of institutions' output, work priorities, and staff motivation.

Important technology management instruments include national monitoring and information systems, together with arrangements for the provision of information in useful form and the identification of information users and industry/technology councils for channelling advice from specialist technical committees. Institution building can create or revitalize research institutions, especially in new technical areas, and provide for the training of managers, engineers and technicians. Special arrangements, including technological, financial, management, marketing and other services can be provided for the small-scale sector. In most developing countries, the implementation of national policy decisions regarding technology is carried out by firms, especially by their engineers, when they select, acquire, further develop, design, and bring into production various technologies. The text box below summarizes these business activities:

#### **BUSINESS ACTIVITIES IN MANAGING TECHNOLOGY**

- Providing technical information;
- Providing equipment for R&D, design, etc.;
- Providing technical experts (foreign, domestic);
- Training;
- Solving financing issues;
- Technology analysis, including monitoring, forecasting;
- Strategic planning;
- Technology evaluation, development and acquisition;
- R&D management; and
- Patenting, marketing and protection of patents.

UNIDO concentrates on awareness building, technical advisory services and an integrated approach to education in technology management. Together, the aim is to build up government-, institutional and enterprise-level capability in the context of research, teaching material development, communications and networking, and technical assistance, with a clear understanding of the different responsibilities at each level. An initial group training programme in three parts is offered for joint participation by trainees from governments, institutions and enterprises. It is distinguished by its focus on integrating technology management at these different levels. The training programme draws on teaching materials, concepts, pedagogy, and the experience with other UNIDO training programmes in technology transfer, acquisition and negotiations, financing, technical information, R&D management, investment planning, sectoral industrial development and industrial restructuring.

## CHAPTER 5

### **TECHNOLOGY ACQUISITION AND NEGOTIATION**

For most developing countries, industry is upgraded technologically largely by acquisition and transfer of imported technology. Extensive knowledge and application of skills during the negotiation process are therefore vital if such acquisitions are to be achieved on equitable terms. Furthermore, recent developments in the international arena, the rapid technological advances and emergence of new technologies, the trend towards new modalities of technology transfer, foreign investment and strategic partnerships, the emergence of liberalization regimes and changing approaches to intellectual property, signify a dramatic change in the international technology market. These developments present additional challenges. In particular, developing countries lack awareness of the opportunities and alternatives particularly with respect to accessing new technologies. There is also a want of infrastructure, human resources and information on the availability of technology and skills that facilitate successful technology transfer. There needs to be better coherence between industry and domestic R&D institutions to make better use of domestic capabilities.

In this context, the Technology Acquisition Unit within the Technology Service, provides a package of interrelated programmes, activities and tools aimed at:

- assisting developing countries in gaining access to technology and promoting technology transactions, e.g. through techmarts;
- assisting in building capacities (at the institutional level and at the enterprise level and at the human resource development level) conducive to increased and more effective technology flows; and
- supporting technology transfer operations (and investment operations) through advisory services, training programmes, technical documentation, guidelines and other specialized tools such as expert systems.

Among the above mentioned programmes, activities and tools, reference can be made to the following:

- (i) **TechMart:** A business forum where small and medium-scale industries can find, offer, negotiate and eventually acquire and sell the type of technology which is suitable for their industrial operations. TechMart provides project promoters and entrepreneurs with a unique setting for the conclusion of technology and joint venture agreements. The advanced circulation of a compendium of technology offers and requests enables prior assessment of technologies of interest paving the way for more immediate decisions concerning the implementation of technology transactions. Expert legal advice on technology acquisition,

technology display, individual business meetings and seminars are regular features of TechMart.

(ii) **Capacity Building and Training on Technology Transfer Operations:** A programme which creates and strengthens the capacity and competence at the institutional, the enterprise and the professional levels to deal more effectively with technology transfer operations. It involves systematic training to increase awareness of acquisition issues including recent developments affecting access to technologies by developing countries and to enhance negotiation skills. It also involves an organized approach towards establishing sustainable indigenous capacity to conduct national training programmes on technology acquisition and negotiation on a self-sufficient basis.

(iii) **Manual on Technology Transfer Negotiation:** The cornerstone of UNIDO's capacity building programme on technology transfer operations. The Manual is to date one of the most comprehensive bodies of knowledge addressing the various issues that a technology buyer is likely to be faced with in identifying, evaluating, selecting and negotiating for technology transfer, including information on alternative forms of technology business, traditional as well as new forms. It is the consolidation and systematization of the knowhow, knowledge and experience acquired by UNIDO over years of implementing training programmes on technology transfer negotiation in developing countries and is so structured for pedagogic use as well. The Manual was finalized in cooperation with the Licensing Executives Society (LES) ensuring balanced approach to technology transfer negotiations and wide dissemination.

(iv) **Build-Operate-Transfer (BOT) Programme:** A major concern of UNIDO, both reflected in the guidelines on the development, contracting and negotiation of BOT projects and in the technical assistance projects on BOT is to elucidate on how developing countries can take advantage of the BOT scheme as a means of accessing to technology and know-how for building public infrastructure; as a mechanism to strengthen their capacities in such areas as engineering, consultancy, equipment manufacturing, management; and as a scheme for opening opportunities for financing public infrastructure and involving private sector in economic development. In addition to the preparation of Guidelines, and based on an increasing demand, UNIDO is developing a programme on BOT which includes such elements as awareness building and capacity building as well as technical assistance and advisory services to the implementation of BOT projects.

(v) **Expert System on Contract Drafting and Negotiation:** A response by UNIDO to the constantly increasing demand for assistance in the contracting and negotiation for technology transfer. The Expert System, which will come as a package of the knowledge system, a software, advisory and training service, will have a data bank of clauses and contractual structures relating to different types of agreements and different sectors, and information on the legal requirements of specific countries. It is intended to facilitate negotiations, reduce the time and cost of contract drafting and improve the quality of contracts.

(vi) **Technology and Investment Enhancement Strategy (TIES):** A programme which promotes cooperation, dialogue and policy discussions at regional and international levels among technology and investment institutions as well as user groups of developing countries.

on issues pertaining to and influencing technology and investment flows. While providing a forum for countries to exchange and share information on technology and investment related trends and developments, TIES serves as an avenue for mutual learning as it draws upon the diversity of experiences, perspectives, visions and needs perceptions of the various participants in the network; and a platform for deliberating on the implications and deriving appropriate strategies in response to the constantly changing international technology and investment scenario. TIES also provides an effective institutional basis for promoting cooperation and improving understanding between parties to technology and investment transactions whether coming from developing or developed countries.

(vii) **Studies, Guidelines and Publications:** Studies, researches and working materials on the emerging patterns and features of international technology flows including new technologies and alternative forms of technology business and their implications for developing countries; and guidelines for improving national capacities in technology acquisition. These are intended to keep developing countries abreast with developments in the international technology transfer arena; informed sufficiently enough to enable the formulation of appropriate policy and institutional responses; and guided in their acquisition and negotiation processes.

The TIES Newsletter, a quarterly publication of recent news and developments in the fields of technology and investment both at the national and global levels, has been a key dissemination mechanisms for much information which UNIDO either generates or has access to.

## **ANNEX I**

### **UNIDO'S INDUSTRIAL INFORMATION PROGRAMME**

UNIDO's Industrial Information Programme, part of the activities of the Information and Research Division, undertakes the development of regional, subregional, national and sectoral (e.g. energy, environment, informatics, new materials and biotechnology) information networks with a view to

- (i) securing developing countries' access to specific information on the advanced and appropriate technologies;
- (ii) helping developing countries select technologies; and
- (iii) helping potential investors to identify investment opportunities in developing countries.

The networks are designed to facilitate and accelerate the cost effective flow of relevant information to users in developing countries of UNIDO's Industrial and Technological Information Bank (INTIB), and to promote UNIDO activities and services. The programme assists developing countries to directly access information sources and networks, thereby increasing the capability of developing countries to use modern communication techniques for information access and analysis of techno-economic information gathered. It aims towards establishing a network of monitoring support with governments, national scientific and technological development institutions and industry in developing countries.

The programme emphasizes the improved timeliness and quality of information needed by industrial decision-makers through:

- (i) four computer-linked INTIB regional networks;
- (ii) a number of subregional and national networks, and international sectoral networks in the fields of environment, energy, informatics, new materials, food technology, and biotechnology in cooperation with substantive units of UNIDO, including the Division for Investment and Technology Promotion;
- (iii) development of a referral information system on sources of industrial and technological information through a decentralized inquiry service to small and medium enterprises;
- (iv) expansion of the TCDC-INRES information referral system on training opportunities, expertise and technologies available in developing countries; and



- (v) enhancement of relevant operational databases on Research Institutions and Directories, Guides to Information Sources, Technology Opportunities (derived from TechMart activities), Industrial Development Abstracts of UNIDO, and other databases described below.

Other activities include:

- (i) training of trainers in modern information handling;
- (ii) upgrading information handling and resource management capacities and capabilities on selected information centres;
- (iii) preparing training packages for industrial and technological information analysis;
- (iv) organizing "TechMart" (Technology Market - Technology Transfer Fair for Developing Countries) events to facilitate information exchange and sales transactions on technologies available for transfer; and
- (v) disseminating information on investment opportunities and technology availabilities for potential investors through the INTIB network.

## ***UNIDO TECHNOLOGY PUBLICATIONS***

UNIDO printed publications supporting the technology management, promotion and acquisition programme include newsletters, serials and special reports, directories and abstracts.

### **Newsletters**

- *TIES Newsletter* issued quarterly (in English), the TIES Newsletter contains news and developments in technology acquisition, negotiations on transfer of technology, investment, legislation, publications, and from the UNIDO Technology and Investment Enhancement Strategy (TIES);

### **UNIDO's Programme of Technology Monitors**

The concept of monitoring technological advances as such stems from the Vienna Conference on Science and Technology for Development held in the summer of 1979 and was further considered by the General Conferences and the Industrial Development Board, the governing body of UNIDO. The aim of this programme is to sensitize developing countries as to the potentials and limitations of technological advances for developing countries and to help them strengthen their technological capabilities, as appropriate.

UNIDO began this task by issuing first the *Microelectronics Monitor* in December 1981, followed by the *Genetic Engineering and Biotechnology Monitor* in February 1982 and later on the *Advances in Materials Monitor* and the *Marine Industrial Technology Monitor*. New

titles to be published during 1995 include *High Technology Spin-Offs Monitor* and *Environment Technology Monitor*. The Monitors purport to be no more than bulletins of current awareness aimed at a target audience in industry, government and the scientific and technological community in developing countries. As such, information of potential interest to developing countries is presented without evaluation or recommendation.

One reason for the popularity of the Monitors from the point of view of the developing countries is that these newsletters are often the sole source of information available to them on the topics covered. The Monitors are in fact unique throughout the publishing world, whether developed or developing, in presenting a wide coverage of information in a well condensed and sorted form that is easily available. This fact has been often noted by editors and publishers alike, as well as by well-known personalities in the scientific world. Scientists working in research rely on the Monitors for information to keep abreast of new developments, while entrepreneurs, or prospective entrepreneurs, need them for development to the commercialization stage.

The Monitors also provide information on various projects UNIDO is promoting for the benefit of developing countries. Important feedback from readers on progress and developments considerably assist in UNIDO's formulation of technical cooperation projects. Contacts through various networks launched and maintained by UNIDO are strengthened and broadened.

#### Current Monitors:

- Microelectronics Monitor
- Genetic Engineering and Biotechnology Monitor
- Advances in Materials Monitor
- Marine Industrial Technology Monitor

#### Scheduled for 1995:

- High-Technology Spin-Offs Monitor
- Environmental Technology Monitor

#### Guidelines for Entrepreneurs

- **Sectoral dossiers.** Detailed specialist-level information for technology decision-makers in industrial sectors and sub-sectors, e.g. iron and steel; emphasis on the impact of new technology on developing country operations (available at INTIB nodes only);
- **Technological Information Packages.** Compilations of collected material giving basic information on technological choices in selected areas, with emphasis on experience of developing countries, e.g. mini-steel, cement or fertilizer plants. Describes raw material preparation, production and processing methods, machinery and equipment requirements and covers technology, economic and financial aspects of particular projects. Includes lists of process and equipment suppliers, and a bibliography;

- **INTIBNET.** A quarterly newsletter in English for INTIB National Focal Points; (controlled circulation).

### **Guidelines for Government and Enterprise Policy- and Decision-Makers**

- **Technology Trends.** Trends in processes, equipment and the industrial sector; trends in national policy; technology flow and collaboration; market trends; institutional linkages, government-university-industry relationships, R&D arrangements; manufactures market strategies;
- **Monograph Series on Regulatory Rules and Practices on Transfer of Technology of Selected Developing Countries.** Provides information on jurisprudence and administrative practices relating to technology promotion and acquisition in selected developing countries;
- **Guide to Guarantee and Warranty Provisions in Transfer of Technology Transactions.** Provides practical guidance to technology recipients on the legal, technical, economic and managerial questions relating to guarantees and warranties;
- **Guides on new and innovative modalities of technology transfer, e.g. Guidelines on Build-Operate-Transfer (BOT) Development, Negotiation and Contracting** identifies critical issues arising from BOT projects and suggested approaches;
- **Manual on Technology Transfer Negotiations.** Comprehensive coverage of subjects that entrepreneurs, decision-makers and government officials dealing with technology transfer are likely to confront during the various phases of the technology transfer process. The manual is designed as a teaching aid, a training tool and a working reference for negotiators;
- **Model Forms of Technology Transfer Agreements.** A compilation of agreements recommended by the national authorities of selected countries. The model contracts serve as a guide for entrepreneurs and government officials engaged in negotiations for technology transfer;
- **Sectoral Directories of Technological and Related Institutions.** Lists of mainly developing country organizations, covering areas of interest, staffing, budget, publications and joint projects.

### **UNIDO INFORMATION SYSTEMS AND DATA BASES**

Technology-related information is held by INTIB in the following systems and databases:

- **IDA - Industrial Development Abstract** is the main source of information on UNIDO's technical cooperation, studies and other activities on industrialization over the years. The database contains over 20,000 fully indexed abstracts of UNIDO documentation, including major studies and reports, reports resulting from UNIDO's

technical assistance activities, reports and proceedings of expert working groups, workshops and seminars, and publications in series. Although based on an on-line UNIDO mainframe database, selections of records are available on diskette for PC use, together with user-friendly search software. This PC version contains records sorted by industrial sectors and year of entry (1980-1992), each with about 700 records. The software also permits printed versions of the database to be produced with full indexes.

- **IRS - International Referral System.** Since it is sometimes necessary to direct entrepreneurs to external sources of information, UNIDO has promoted a new type of cooperation to provide more effective and efficient services to help more customers from developing countries, via a new International Referral System. Queries received by INTIB are redirected to a range of well targeted specialized industrial and technological information sources which respond directly to the enquiry. These sources are member organizations capable of responding to a precise enquiry regarding a raw material, a technology, a supplier, a potential partner, a product or a manufacturing process.
- **REED - The Referral Database on Energy and Environment** is the core of UNIDO's energy and environment information programme and its institutional memory for industry and environment, and energy efficiency activities. The whole system contains 11 record types: institutions, projects, experts/consultants, bibliographic information, meetings, training, information sources, technology descriptions, industrial process descriptions, waste stream descriptions, and environment audits.
- **Micro-METADEX PLUS™** contains information from the world's leading metallurgical database (METADEX), the Materials Basic File and Engineering Materials Abstracts. It was developed under a license agreement with Materials Information (ASM International of the USA and the Institute of Materials of the UK) to give PC-based access to materials data to users in developing countries.
- **TSDB - Technology Supply Data Base** contains technology offers and requests, and joint venture opportunities, from a large number of countries, categorized by industrial sector. Information is currently updated when preparing TechMarts.

## **FOR MORE INFORMATION**

If you would like more information on the UNIDO Investment and Technology Promotion Division, contact:

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Information on specific aspects may also be obtained from:

- **Technology Advisory Service**  
Chief, Technology Acquisition Unit  
(phone: 21131-3729, fax: 2195332)
- **Technology and Investment Enhancement Strategy (TIES)**  
Chief, Technology Acquisition Unit
- **Informatics and Telecommunications, New Technologies, Appropriate Technologies, Biotechnology, Genetic Engineering and the ICGEB**  
Chief, Technology Promotion Unit  
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- **Technology Management and Policies**  
Chief, Technology Promotion Unit  
(phone: 21131-3729, fax: 2195332)

Information on specific information products and on information training and assistance from:

**INTIB and the Industrial Inquiry Service (IIS), Technology Publications, Databases and Information Products**  
Chief, Industrial and Technological Information Section  
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