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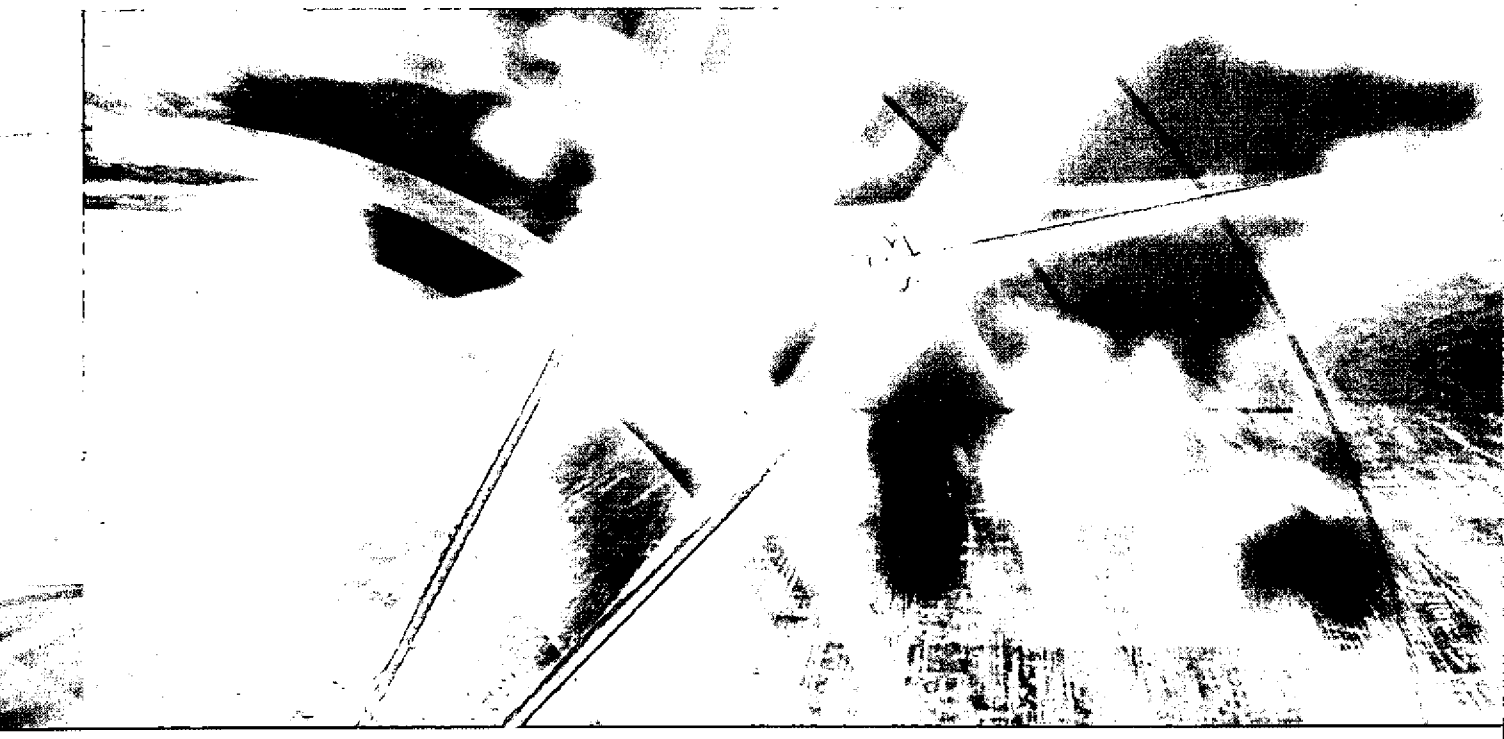

Enhancing Developing Countries' Ability to Absorb and Master Technology

UNITED NATIONS
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UNIDO's Contribution to Technological Development: Enhancing Developing Countries' Ability to Absorb and Master Technology

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Introduction to the UNIDO Industrial Promotion and Technology Branch

Technology Paper Series

The UNIDO Industrial Promotion and Technology Branch Technology Paper Series (TPS) provides a means for: stimulating policy thinking; improving policy orientation among policy makers; assisting in the management of science and technology policy craft in industrialisation; and disseminating current thinking on technology, and its industrial dynamics, in broad relation to the economic development. Attention is paid to developing countries (DCs) and transition economies (TEs). The predominant orientation of TPS will be Science and Technology (S&T) policy, policy management, co-ordination dynamics of knowledge-based and public-private partnerships in relation to the role of technology in the industrialisation strategies of DCs and TEs.

The effective, and efficient, management of the policy and structural dimensions of technology, broadly encapsulating trends in innovation, R&D and science is increasingly viewed as crucial to economic development. The systemic aspects of national technology management in terms of incentives, institutional generation of knowledge and flows of technology (and investment) present policy challenges to DCs and TEs.

Strategic decisions at government level concerning the articulation of policy instruments, and co-ordination of supporting institutions with respect to economy-wide technological enterprise are vital to creating competitiveness, sustaining total factor productivity growth, and cohering the national system of innovation. Furthermore, the social capital – public sector as well as private sector – dimensions of the S&T intellectual infrastructure of DCs and TEs present opportunities for science and technology to be harnessed more productivity for socio-economic advance.

The editorial board of TPS will welcome working papers, and work in progress, on aspects of technological development in DCs and TEs. The expectation is that submissions will focus on technology policy – craft, analysis, formulation and implementation – in relation to economic development manifest as higher levels of technology intensity in manufacturing industry. TPS will be published electronically on the UNIDO website as well as in hard copy form.

Contents

List of Abbreviations

AAITPC	Asia-Africa Investment and Technology Promotion Centre
BEST	Business Environment Strategic Toolkit
CALICO	Calico Printers Co-operative Society
CAPTECH	Capacity building for technology and absorption
CFC	Chloro-fluoro Carbons
COTEX	Consortium of Textile Exporters
CMMS	Computer-based Maintenance Management System
DC	Developing country
FDI	Foreign Direct Investment
FIT	Financial Improvement Toolkit
HIAST	Higher Institute for Applied Science and Technology
HFC	Hydro-fluoro Carbon
IAPT	Institute for Auto Parts Technology
ICAMT	International Centre for Advancement of Manufacturing Technology
ICMB	International Centre of Medicine Biotechnology
IPA	Investment Promotion Agency
ISO	International Standards Organization
ITCs	International Technology Centres
ITMIN	Industrial Technology and Market Information Network
ITPO	Investment and Technology Promotion Office
LDCs	Least Developed Countries
MCCT	Measurement Control Chart Toolkit
MVA	Manufacturing Value Added
NCPC	National Cleaner Production Centres
NIS	Newly Independent States
ODS	Ozone Depleting Substances
PADs	Project Allocation Documents
R&D	Research and Development
S&T	Science and Technology
SHP	Small Hydropower
SMEs	Small and Medium-sized Enterprises
SPC	State Planning Commission
SPXs	UNIDO Subcontracting and Partnership Exchanges
TE	Transition economies
TNCs	Transnational Corporations
TQM	Total Quality Management
TÜV	Technische Überwachungs-Vereine
UNEP	United Nations Environment Program
UNIDO	United Nations Industrial Development Organization
US-AEP	United States-Asia Environmental Partnership

Preface

This paper sets the scene by addressing and assessing in broad terms UNIDO's contribution to technological development in terms of enhancing developing countries' (DCs) and transition economies' (TEs) ability to absorb and master technology.[1] The paper reviews technical co-operation activities since 1997. The paper is organized as follows: Section 1 – Methodology – describes the approach used to capture a qualitative assessment of UNIDO's contribution to technological development. Section 2 – Conceptual Approach – lays out the frame of reference for thinking about UNIDO's contribution by indicating the prerequisites for absorbing and mastering technology. Section 3 – Background and Strategic Issues – provides a global background from which UNIDO's contribution may be viewed in relief. Section 4 – UNIDO and the Challenges of Development – gives a perspective on the dynamics of technology's contribution to industry in order to solve global problems at the local level. Section 5 – Landmarks in the Evolution of Mandates, Resolutions and UNIDO Actions – records the landmarks in the UNIDO's evolving mandates and international resolutions for UNIDO's technical co-operation activities. Section 6 – UNIDO's Contribution to Technological Development – presents achievements as the impact of actions in aggregate terms of direct and indirect programmatic contributions to technological development in DCs and TEs. The section highlights different aspects of the technology theme running through the field application of service modules in terms of assistance for embedding skills development, institutional capacity building, diagnostic work and policy advice. The section also suggests areas for improvement. Section 7 – Concluding Remarks – points to the challenges ahead with respect to the role of technology in industrial development. The paper is limited in scope and is concerned more with absorption and mastering technology, that is the learning and adoption aspects of technology. It is focused on the last quinquennium.

[1] See UNIDO Yearbook of Industrial Statistics (2003) for a taxonomy of industrialised and developing countries, and countries with economies in transition. The term developing countries refers generally to Non-OECD countries.

Abstract

This paper on UNIDO's contribution to technological development is presented in terms of the policy challenges to, and pragmatic solutions for enhancing developing countries' ability to absorb and master technology. It necessarily focuses on the substantive activities of UNIDO over the period 1997-2003. These activities delivered at different levels of governance in recipient economies are intended ultimately to change conditions at enterprise level. It is enterprise that generates the surplus value to be applied throughout the economy to meet the development goals of reducing poverty in keeping with the Millennium Development Goals and improving the quality of life for citizens.

The paper provides a broad view of UNIDO's programme effectiveness in selected areas and emphasises the importance of technology promotion in industrialisation. The paper does not attempt to depict the entire landscape of UNIDO's activities. It is deliberately selective to bring into bold relief key aspects of that landscape. A social capital perspective – knowledge based learning experience framed by routines and norms – is used to appreciate UNIDO's contribution to assistance regarding absorption and mastering of technology in developing countries within the Organization's evolving mandates.

Strategic issues and the challenges of development provide the background for viewing the impact of UNIDO in the areas of skills development, institutional capacity building, diagnostic work and policy advice that is related to issues of technology. UNIDO's contribution to technological development is presented by combining aspects of substantive programmes and specific illustrations to animate the text.

The concluding remarks of the paper take the opportunity of drawing attention to perennial challenges of financing, management and systems. The concluding remarks also look forward to some complex international policy and diplomacy issues concerning science and technology and the competitiveness that the issues involve.

1. Methodology

In order to set the scene appropriately, and fully appreciate progress and challenges since 1997, the paper is based on a combination of reviewing existing recent summative evaluations of UNIDO activities, carrying out semi-structured interviews within the Organization's Programme Development and Technical Cooperation Division, and analysing a matrix of variables from substantive programmes[2]. This analytical approach was supported by selective reference to the UNIDO Project Data Base. Apart from indicating broad aggregate figures, statements on individual project budgets are avoided.

It is important from the outset to refer to the perennial challenges of measurement and causality. From a purely statistical perspective; metrics, criteria and instruments for measuring output face continuant arguments of validity, reliability and repeatability. The paper is a qualitative assessment intended to provide a broad view of UNIDO's programme effectiveness in selected areas and the importance of technology promotion. It cannot depict the entire landscape of UNIDO's activities. Instead, it chooses to indicate major points and bring into relief key relationships in that landscape.

The paper draws selectively from UNIDO's projects and enabling services[3]. It illustrates some of the conceptual issues of selected activities, their principal absorbing and mastering technology outcomes, the manifestation of the activity (actual and expected impact), and contribution to technological development (impact on the economy). Some of the selected examples are components of integrated programmes that bring the advantages of cross-fertilisation to UNIDO's enabling services.

[2] See Appendix II

[3] Appendix III – Selected Examples Of UNIDO's Contribution to Technological Development: Enhancing Developing Countries' Ability to Absorb and Master Technology

2. Conceptual Approach

Building sustainable technological capabilities is a long-term, costly and risky learning process. Success manifest at national economic level depends largely on enterprises' ability to accelerate acquisition of technologies that are new to the firm, upgrading over time and creating new technology within a coherently incentivised national system of innovation. Using technology efficiently requires learning new skills and organisational techniques, as well as marketing and supply chain management that become embedded institutionally and organisationally. Therefore, the broad understanding of innovation and assistance to S&T policy craft, manifests in significant part as the absorption and mastering of technology, has evolved to capture more factors and social dimensions.

Within the framework for considering S&T policy craft there has been noticeable progression from an engineering ("hard") orientation to a social capital ("soft") perspective[4]. Social capital in this context is broadly defined as the confluence of structural formalities (roles, rules, procedures, networks) that facilitate coordination efforts; and cognitive formalities (attitudes, beliefs, norms, values) that affect interdependence, between and among actors[5].

Absorbing and mastering technology may be viewed therefore as a knowledge-based organisational learning experience that is increasingly institutionalised and networked. It is in essence social capital in action. Learning involves processes of capability enhancement through learning by doing, learning by interacting, learning by monitoring, and learning by formal training. The learning process has difficult and complex trajectories. It is the heart of the process of industrial innovation and development. At minimum, therefore, absorbing and mastering technology involve organisational and entrepreneurial processes that are:

- Didactic problem generating and creating solutions;
- Primarily occurring within enterprises, enacted by economic agents;

[4] Dasgupta P., Serageldin I., (Eds), Social Capital: A Multifaceted Perspective, World Bank, Washington D.C., 2000.

- Interactive exchange relationships between enterprises and actors in the environment;
- Spatially distributed and networked experiential learning[6];
- Interactive exchanges of codified and tacit knowledge, without fully contingent contract protection;
- Interdependent between firms and actors; and
- Precursors of an innovation system[7]

A social capital view of absorbing and mastering technology enables a sharper appreciation of the role UNIDO plays in helping to fuse two ideas – innovation as determined by research and interaction between economic actors and enterprises; and knowledge as crucial to fostering innovation – for the benefit of developing countries.

Within this sharper view it should be stated that the policies for technology promotion associated with UNIDO enabling services may take on the forms below (or a mix of them):

- Implicit technology promotion in which technology promotion is a component (non-core activity).
- Explicit technology promotion – in which technology promotion is a core activity.
- Embodied technology promotion – in which technology promotion is operationalised as equipment and process acquisition.

In relative terms, enterprises (in developing countries) generally start on the trajectory of industrial learning and innovation by importing new technology and then, though externalities and spillovers, absorb and master its underlying principles, elements and processes. How much they invest in this process depends on the price signals and incentives offered by markets and policy, their access to complementary support services, and their strategic intent.

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[5] Uphoff N., Understanding Social Capital: Learning From the Analysis and Experience of Participation, in Dasgupta P., Serageldin I., (Eds), Social Capital:A Multifaceted Perspective, World Bank, Washington D.C., 2000.
[6] Von Hippel E., 1988, The Sources of Innovation, OUP Oxford.
[7] Equist C., Johnson B., 1997, Institutions and Organizations in Systems of Innovation, in Edquist C., (ED), Systems of innovation: Technologies, Organizations, and Institutions, London, Printer Publishers/ Casell Academic pp.41-63.

A variety of support institutions, including international organisations can reinforce the enabling environment that helps enterprises to meet the information, skills, finance and other needs that are difficult to satisfy in markets. The institutional apply of industry associations, export agencies, productivity centres, technology information centres, metrology, standards, testing and quality control centres, R&D laboratories, and cluster development institutions, together create a business environment rich in data, information, statistics and knowledge (DISK) on new technology. This is absolutely essential for supporting technological innovation and learning by firms. This institutional array is viewed by UNIDO as a crucial component of a national innovation system.

3. Background and Techno-strategic Issues

The present setting of intensified globalisation and accelerated technological progress in new areas of knowledge makes the role of technology crucial in achieving sustainable industrial development and in reducing poverty and marginalisation. With economic and business competition constantly taking new forms and with new products, processes and services becoming the main drivers of competitiveness, countries must be internationally competitive if they are to increase their prosperity. Few developing countries have succeeded in doing so, by graduating from their low-income status. Others, a disappointedly large number, have at best retained at the same position in global income distribution; at worst slapped down the ranks with lower GDP per capita. The lower income status ultimately represents weaknesses in using technological knowledge institutionally to solve socio-economic and industrial challenges.

The UNIDO Industrial Development Scoreboard[8] reveals wide dispersion in indices of competitive industrial performance and pronounced dynamic differences in structural factors (skills, technology, infrastructure, etc.) among countries. Industrial activity and technological

capabilities are concentrated in a few leading industrialised and developing economies. Most developing countries continue to lag behind in respect to technology for industrialisation. The Least Developed Countries (LDCs) are technologically weak and extremely vulnerable.

By attending to structural factors, countries can improve their competitive industrial performances. Countries need to engage in deliberate efforts to build their policies, skills, technological capabilities, infrastructure and institutions in order to engage in the production of relatively more complex activities that use technologies effectively and efficiently. According to the UNIDO Industrial Development Scoreboard, domestic technology and foreign technology particularly through Foreign Direct Investment (FDI) and licensing – have powerful influences on industrial performance.

Notably:

- Domestic technological effort (measured by R&D financed by enterprises) is statistically the most significant driver of industrial performance. This highlights the need for domestic technological effort even at low levels of industrial development.
- Since 1980 particularly, access to foreign technology through in increased flows of FDI has grown in significance due to the increasing role of spatially distributed *yet* integrated production systems and networks that are governed by Transnational Corporations (TNCs) as "global factories".[9] Although FDI inflows account for a relatively small share of total global investment, FDI is highly concentrated in advanced technology components and products, relative to the domestic sector levels of industrial development.[10]
- The ability to undertake domestic technological effort and leverage foreign technology effectively depends on the available national technological capacity and capability. This

[8] Competitive Industrial Performance Index in UNIDO Industrial Development Report 2002/2003.
[9] See Buckley P., 2003, Round-table 5: Promoting investment in developing countries (with special reference to Africa): Challenges, opportunities and experience, Keynote speech & paper, UNIDO General Conference, 1-5 December 2003.

means that skilled manpower, domestically- and internationally-oriented communications infrastructure (in the broad sense of distribution, logistics and transactions), and supporting institutions are crucial.

Thus, among the key strategic challenges facing developing countries today is: How to meet intensified global competitive pressures and, at the same time, avoid the 'low road' of development (for example by reducing wages, devaluing national currencies, disregarding labour or environment regulations, etc.)? This 'low road' is, in the long-term, incompatible with growth at higher levels of competitiveness and sustainability. Achieving sustainable industrial competitiveness in a world with increasing trade in intermediate goods; and greater volumes and variety in trade merchandise requires using technologies efficiently and effectively. It requires adapting processes and improving products, and moving up the value chain into relatively more sophisticated manufacturing activities that are geared to the interstices of the globally integrated production system. This is the 'high road' to sustainable development.

Economic growth and associated technological progress are widely accepted as basic to poverty reduction. It is also widely accepted that economic growth, such as that experienced by the industrialised countries is predicated by structural dynamics with three fundamental dimensions or factors: physical and human capital formation; and technological innovation. The coherent application of these factors to production creates economic growth. Of crucial importance in this process is the role of government in influencing the rate and direction of technological innovation. UNIDO with its services is geared to assist developing countries, inter alia, by enabling them to more accurately identify determinants of technological innovation, and to absorb and master technology.

The key strategic policy response to increasing competitiveness for developing countries is to improve elements of their innovation and learning system and, more importantly, to formulate coherent strategies for industrial and technological development.

[10] See Dunning J.H., 2000, The eclectic paradigm as an envelope for economic and business theories of MNE

This has been done effectively in some South and East Asian economies and the results have been spectacular.

The high road to development and improved competitiveness, exemplified by South and East Asian economies, can be reached through a concerted innovation and learning strategy for industrial restructuring and upgrading. Such strategy should be designed, developed and implemented by the government and private sector in partnership but with a view to enabling the private sector to perform. At the core of this strategy is a national vision of the path to be followed, one that is premised on an exercise of foresight for both internal and external factors with respect to technological needs assessment.

The primary responsibility for ensuring conditions conducive to innovation and learning falls on the policy makers in developing countries. The international community also has a clear responsibility to assist developing countries in addressing the growing structural gaps and assuring that developing countries are not denied access to the prerequisites of industrial development.

4. UNIDO and the Challenges of Development

UNIDO – United Nations Industrial Development Organization – is a specialised agency of the UN with a mandate that encapsulates the specific objective of improving the standard of living of citizens in its member countries through industrialisation. UNIDO is the singular worldwide multi-lateral organisation mandated to deal with industry within a development perspective. UNIDO applies its enabling services in a non-profit, neutral and specialised manner that customises technical co-operation to the needs of DCs. UNIDO operates at three levels of intervention: the Governmental/Policy level, the Institutional level and the Enterprise level. The ultimate targets of its services, applied at several levels to the structures of governance within an economy, are the industrial enterprises of a country. It is

activity, International Business Review, Vol. 9, pp. 163-190.

industrial enterprise that constitutes the significant driving force of technology and innovation in application to industry. This approach is encapsulated by UNIDO's corporate strategy[11].

While government articulation of policy and management of policy implementation attempts to enhance conditions to support industrial development and economic growth in order to contribute significantly to the process of poverty reduction; it is enterprise that creates factor productivity growth and the surplus value gained through trade for such goals to be attained. In this, the development and transfer of technology is central to any degree of industrial development.

UNIDO assists developing countries in this process through activities designed and operationalised to foster technology transfer, market access and investment across industrial functions pertinent to manufacturing, environmental to energy efficiency.

UNIDO enhances and assists to the collaboration of government, institutions and the enterprise of the private sector to create competitiveness and the sustainability of productivity growth in industrial production. The Organization promotes through several modalities and enabling services – including explicit technology promotion – progress towards a better-rebalanced, socially equitable and environmentally friendly industrialisation for developing countries.

Technology is herein defined as the purposeful accumulation of science- and engineering-based techniques, and the application of production processes and knowledge for meeting social and economic ends. In this context, the explicit and tacit aspects of modern technology are embodied in plant, tools and equipment, licenses, drawings and accumulated experience etc. It therefore includes 'software' such as the technological capabilities of people and firms with respect to the operations, quality control and productivity improvements, technology innovation, factory organisation, information flows, intermediating linkages with

[11] UNIDO, *Operationalizing UNIDO's Coroprate Strategy: Services and priorities for the medium term 2004 – 2007*, Vienna: UNIDO

other firms and institutions, and management that are intrinsic to the micro-economics of industrial organisation.

The inherent activities of technology suggest that markets for technology are imperfect and especially so in developing countries. Absence of efficient price mechanisms, intermediation, coordinated national systems for innovation and managing technology give rise to the central issue of how to get local enterprise to innovate and solve local problems. This innovation at local level should not be confused with an exclusive focus on 'high' technology. UNIDO supports developing countries to create and sustain well-balanced national innovation systems; and to open channels for their industrial enterprises to access technology, to innovate at increased levels of effectiveness and thereby improve the chances of supplying MNEs, and hence moderate or overcome market failures in technology.

In the emerging architecture of the international economic system of increasing integration of cross-border production that is articulated by industrial enterprise from advanced countries, the challenges of development many poorer countries face are concisely framed by the Millennium Development Goals (MDGs) declared in 2000 by the UN. The National Agenda 21 process of each country's nation-wide strategies for sustainable development indicates these challenges further. Within UNIDO's field of competence, these challenges are manifested as gaps that are widening between those who have access to technology and those who do not. There is an industrial technology gap, information and communications technology gap, a health technology gap, and an environmental resources technology gap.

In developed countries the broad range of technology and the prosperity and comfort associated with it are within easy reach of most citizens. For the nearly three billion people

living on less that $2 per day[12], available technology, access to it and the rate of change of access is far too low. This threatens seriously the attainment of MDGs for many countries.

Furthermore, technology is not given; it is the outcome of myriad convergent efforts. It is path dependent and driven by different motivations along different trajectories within public and private sector investments. When policy enables FDI, technology diffusion and innovation within the economy to be successfully managed overall, the result can be significant. This is illustrated by the share of manufacturing value-added (MVA) held by developing countries that has grown from about 11% in 1975 to about 22% in 1998[13]. This said, the distribution of MVA among developing countries is highly asymmetric with the lion's share to Asia. Asia accounts for 13% of global MVA, Latin America and the Caribbean 6.4%, Sub-Saharan Africa 0.7%, and Middle East and North Africa 1.7%. A major problem to be addressed therefore is the exposure of local enterprises in developing countries to the market forces of national and international competition, and the role of industrial technology in enabling them to survive, manage and indeed exploit that exposure.

5. Landmarks in the Evolution of Mandates, Resolutions and UNIDO Actions

Assessing UNIDO's contribution to enhancing developing countries' ability to absorb and master technology, and the view of the assessment should bear two things in mind: first, the evolution of the Organization's mandates and international resolutions. Secondly, not everything that can be counted counts and not everything that counts can be counted[14]. This is simply because technological development is the outcome of complex, emergent and intractable interactions between economic actors collaborating and competing to advance their enterprise. Many of the interactions are non-lineal and the study of their economic predictability is complicated.

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[12] Carlos A. Magariños, Marginalization Versus Prosperity: Improving the Creation and Distribution of Gains Brought By the Process of Globalisation, 2000, UNIDO.
[13] UNIDO, 2002, Industrial Development Report 2002/2003, table A 2.1, p.149.

A short review of landmarks for UNIDO's actions and enabling services to developing countries is apposite. The Lima Declaration and New Delhi Declaration[15] made the enduring case to place industrial technology and its acquisition at the centre of economic strategies for developing countries to contribute to global manufacturing value-added. These two important declarations were linked by the seminal event of the Vienna Conference on Science and Technology for Development held in August 1979. This conference, in its recommendations, laid out a path for UNIDO to follow in its services to developing countries. The Vienna Conference recommended, *inter alia*, that each developing country government should design a national policy for science and technology. Such a policy would need to cover planning and budgeting, management and coordination, stimulation and promotion, and the execution of coherent scientific and technological activities relevant to defined socio-economic development objectives.

The Third Session of the UNIDO General Conference in 1989, in according particular priority to the environment and technology transfer, anticipated the role of UNIDO as one of the four implementing agencies of the Montreal Protocol on substances that deplete the Ozone layer. This role has become a major conduit for contributing to developing countries' ability to absorb and master technology.

The special emphasis by the evolving mandates on the role of women in enterprise, attention to Africa, and the role of private sectors in the LDCs culminated at the Seventh Session of the General Conference in 1997 with UNIDO's increased orientation to cleaner sustainable industrial development. The technological dimensions of this orientation to environmental sustainability cut across UNIDO's enabling service modules, as well as sectoral support. The operational manifestation of this technological theme is visible in UNIDO's technical co-operation performance[16]. UNIDO's General Conference of December 2003

[14] UNIDO, Annual Report, 2001.
[15] Lima Declaration, March 1975; New Delhi Declaration, February 1980.
[16] See UNIDO, Annual Reports 1999, 2000, 2001, 2002, 2003.

reaffirmed the crucial role of technology and its economy-wide diffusion in industrial development. The new emphasis on the mutually reinforcing linkages between investment and technology marks the increasing recognition that technological engagement with the world economy is indispensably related to the ability of developing countries to attract and retain higher levels of FDI, as well as increases their export trade.[17]

These mandates inform UNIDO's continuing technologically oriented enabling services. They confirm that the role of technology in industrialisation provides the means to achieve progress in the productive integration of developing countries into the global economy, to reduce poverty and thus meet the Millennium Development Goals.

6. UNIDO's Contribution to Technological Development

Given the critical role of technology in achieving sustainable industrial development and the need for government policy to support technological development, an intergovernmental body like UNIDO can provide international public goods that promote technological development. UNIDO technical cooperation and global forum activities remain the core of UNIDO's multi-faceted contribution to international efforts of assistance to DCs. Technical cooperation experience and data inform the debate on industrial development that takes place in the global forum. The global forum, in turn, plays a critical role in improving the quality of UNIDO assistance.

Absorbing and mastering technology is ultimately the outcome of many path-dependent decisions at enterprise and firm level[18]. Many dynamic factors internal and external to the enterprise impinge on the firm's decision structures and consequently its decision-

[17] See Buckley P., 2003, Round-table 5: Promoting investment in developing countries (with special reference to Africa): Challenges, opportunities and experience, Keynote speech & paper, UNIDO General Conference, 1-5 December 2003.

[18] It is difficult to account for "the non-rivalry of innovation and the associated inter-firm "spillover" of knowledge creation when using firm-level panel data alone." [Van Leeuwen G., Linking Innovation to Productivity Growth Using Two Waves of the Community Innovation Survey, OECD, STI Working Paper, 2002/08, JT 00130428, 20/Aug/2002]

making concerning technology[19]. Fundamentally, absorbing and mastering technology depends on the firm's technical capacity and management capability. It is beyond the scope of this paper to delineate the managerial economic theories of, and market signals pertinent to, decision-making. Suffice it to say that the firm's perception of its competitiveness and the competitive pressures it faces influences whether it invests in progressive efforts and uses its energies to absorb and master technology.

UNIDO's interventions may be viewed as one set of factors that can be crucial in this perception. UNIDO recognises that, in addition to an enterprise's internal capacity and capability, absorbing and mastering technology depends on the policy environment, incentives, external resources, cost pressures and regulations.

Three outstanding features of UNIDO's interventions with respect to public goods and enhancing developing countries' ability to absorb and master technology are visible from reviewing and analysing recent material and research. First, UNIDO directs its interventions as 'points of pressure'. That is, for example, where and when enterprises admit that pressures to reduce energy costs, to respond to current regulations, and to anticipate future higher resolution regulations are forcing them to accept learning and adaptation (the prerequisites to absorbing and mastering technology) to meet those pressures. Secondly, UNIDO directs its interventions to overcome barriers, for example, implementation costs and lack of technical skills, to adopting alternative technologies. Thirdly, UNIDO directs its interventions at nodal points of industrial sector supply-demand chains, networks of related and supporting industries and government policy. This third feature accentuates the importance of the role of public sector science and technology policy and bears witness to the fact that many technologies now available for use in civilian and commercial applications had their genesis in government-funded research programmes and technology development strategies[20].

[19] UNIDO, 2002, Assessing the Uptake of Environmentally Sound Technology.
[20] See J. Sachs, The Essential Ingredient, New Scientist, 17/Aug/2002, pp.52-55.

At the aggregate level of UNIDO technical cooperation delivery of just below US$ 95 million (2001) approximately 39% was dedicated to international protocols, agreements and conventions; 19% to environmentally sustainable industrial strategies and technologies including quality standardisation and metrology, 20% to investment related technologies promotion, 10% to institutional capacity building including networked industrial statistics and information, and 2% to industrial policy advice. Agro-industries take up the remaining 10%. Technical co-operation delivery in 2002 and 2003 in the same areas was funded from different sources as depicted in Table 1.

Table 1: Expenditure, 2002 to 2003 (in millions of US$)

	2002	2003
Technical cooperation programmes		
UNIDO regular budget	1.6	4.7
UNIDO/core funds	3.3	3.0
UNDP-administered funds	0.1	0.1
Industrial Development Fund (IDF)	18.4	21.2
Montreal Protocol	27.8	32.8
Self-financed trust funds	2.3	5.3
Third party-financed trust funds	15.0	12.0
Global Environment Facility		9.9
Other trust funds	13.1	5.6
Total technical cooperation programmes	81.6	94.6

Source: Appendix A, Table 1, p. 71, UNIDO Annual Report 2003, Vienna: UNIDO

UNIDO's contribution to technological development is manifest also at the level of industrial employment. It is learning and its application to work that demonstrates ultimately absorption and mastering technology. It is necessary here to emphasize that technology, and its use varies in intensity across industry in developing countries. It is therefore vital to avoid equating technology with 'high-tech'. It should be borne in mind also that it is more useful to refer to the state of development of a particular industrial sector or sub-sector simply because one can

find relatively advanced industries in developing countries and relatively backward industries in more developed economies.

Appendix I presents, in aggregate, UNIDO's contribution in terms of objective indicators that communicate assistance to developing countries' technological development.

The profiles of capital investment raised, tonnes of Ozone Depleting Substances (ODS) eliminated by embedding alternative, and cleaner, production technologies; and the Small and Medium-sized Enterprises (SMEs) started and subsequently expanded, indicates salient features of UNIDO's contribution to technological development. Implicitly this suggests a contribution to the ability of developing countries to absorb and master technology.

At the level of the firm, as the ability to absorb and master technology is a direct function of internal division of labour, UNIDO's intervention resulting in the expansion of SMEs should be seen as a crucial contribution to technological development. In developing countries the division of labour in SMEs is minimal – expansion of SMEs therefore leads implicitly to increased technical specialisation.

Skills development, institutional capacity building, diagnostic work and policy advice in relation to technology are interdependent, although they may differ in their actual and expected impacts. These four factors are also infused at times sequentially, and at other times concurrently, into the fabric of local industrial life in developing countries. UNIDO's integrated programmes recognise this and exploit the resulting synergies.

6.1. UNIDO and Skills Development

It is acknowledged widely that development depends significantly on the growth in the SMEs' part of the economy and their contribution to job creation[21]. In developing countries, across a number of current UNIDO service modules (and hence projects), skills development is being enhanced across a range of enterprises. At one extreme, in terms of SMEs absorption

of technologies, one example in Ethiopia is expressed as training in 'paperless' office techniques. This combines simple logistics with business development services and counterpart computer maintenance services as well as online networking.

At a more advanced level, and addressing specifically the gender issue, the rural and women entrepreneurship development programme by providing manuals for technology development on the one hand, and pilot production units on the other hand, is adding directly to the social capital formation in the agro-business sector of several African countries. One particular outcome of note is the embedding and improvement of skills in product packaging – an essential requirement with respect to the access to sophisticated international markets. Box 1: Cluster Development in Jaipur, India, and Box 2: Boost to Djibouti's fishermen, illustrate some of the dynamics at work in the skills development that is vital to absorbing and mastering technology successfully.

BOX 1: Cluster Development in Jaipur, India[22]

Colourful hand-block printing enjoys a long tradition in Jaipur, the commercial capital of Rajasthan, where approximately 550 small and very small artisan firms engage in both hand-block and screen printing and provide employment to almost 10,000 workers. The ability of the local artisans to penetrate profitable national and world markets has been severely constrained. Consequently, the artisans were locked in a vicious cycle of price competition leading to falling labour standards and mounting degradation of the environment.

The solution was seen as an action plan (developed by cluster stakeholders with UNIDO support) to enhance the design and production skills, improve the marketing

[21] In the EU small businesses with 10 or less employees (also a feature in developing countries) are responsible for about 33% of jobs [UNIDO, US/GLO/94/009, ODG/R.14, 27/Oct/1999].
[22] UNIDO, 2005, The UNIDO Cluster/Network Development Programme: India, Available at: http://www.unido.org/en/doc/4308.

capabilities of the firms with specific attention to developing the product image (including a common quality brand). The result of UNIDO intervention:

- Manufacturers joined an export consortium – Consortium of Textile Exporters (COTEX) – to realize common objectives. Artisans relying previously on traders for marketing organized the Calico Printers Co-operative Society (CALICO) to expand their market both domestically and internationally.
- A training program was launched to strengthen the marketing competence of CALICO members.
- A demonstration fair was arranged in Jaipur to 'showcase' the artisans' newly acquired skills.
- Several training courses (on design, marketing and merchandising) were organized in collaboration with key Indian technical institutes.
- Participation in national (New Delhi) and subsequently international fairs (in Florence and in Osaka) was arranged so that artisans could assess their capacity to manage sales and marketing meetings with potential international buyers.
- Common quality branding was created to identify traditional Jaipur products that satisfy strict standards of product quality and production techniques.
- Structural problems are now tackled through collective ventures planned and implemented by the cluster actors themselves.

Significant outcomes include the following: traditional conflicts (usually price driven) have disappeared. Local producers have learned to trust each other, to compete in terms of product differentiation and to cooperate efficiently with their local partners (small and medium size enterprise support institutions, providers of business development services). Initiatives to enhance technological competence (introduce new production technology, improve inventory management, reduce drudgery)

decrease pollution (waste processing, cleaner production technology) and increased access to credit (mutual credit guarantee schemes), have become widespread. Furthermore, several producer associations, and self-help groups, have been established within the cluster. They assist significantly in providing a forum for a sustainable cluster-wide governance framework.

BOX 2: Boost to Djibouti's fishermen[23]

There are no large-scale fisheries in Djibouti. Hook and line, and only to a lesser extent gill and throwing nets, are used to carry out much of the fishing, which basically fulfils subsistence functions. One could hold the view that fisheries play only a limited role in Djibouti, considering its low contribution to the overall GDP. However, from a socioeconomic viewpoint they are locally quite important.

Against this background UNIDO was asked by Djibouti's Department of Fisheries to address the fishermen's problem of costly engine and boat repairs. Both partners joined hands in addressing the situation: UNIDO established a repair facility consisting of a secure storage unit and two enclosed engine repair bays each equipped with workbenches and mobile engine repair trolleys. The Government of Djibouti constructed an open-sided building on the new fishing quay in Djibouti's Port de Pêche as its in-kind contribution.

The long-term sustainability of the workshop is assured by a close partnership with the fishing associations, as well as the private and the public sector. Two technicians who were trained by UNIDO on engine and boat repair will manage the facility. Altogether, 500 poor fishermen and their families will benefit from the project as the workshop ensures the sustainability of their livelihoods through regular repair and maintenance at the least cost.

At the other extreme, in the range of enabling services, firstly, the network of cleaner production centres – enabling more efficient levels of production technologies to be internalised by enterprise managers and engineering staff – is creating an available base of richer skills in China and India. In India, local service providers are able to perform in-plant process audits in three sectors: chemical dyes and intermediate chemicals; auto plants supply; and co-generation. The progressive reduction in energy costs accompanied by higher levels of factor productivity and hence lower volumes of in-bound production factors is enabling leading and next-tier enterprises in India to operate at higher levels of competitiveness.

Secondly, specific managerial techniques available from UNIDO as methodologies and tools that facilitate an understanding of the relationships between FDI, regulation and targeted technology acquisition in business partnership programmes[24] are enabling SMEs to 'plug' into the domestic as well as the cross-border networks of TNCs. Considerable levels of technological capacity and capability are required to supply the regional and global production and marketing networks of TNCs. Augmenting local enterprises to become preferred supply partners in the geo-economically distributed stages of transnational production requires implicit and explicit technological upgrading to meet progressively higher quality standards of manufacturing and delivery[25]. UNIDO's finely calibrated methodologies for, and management of, 'match-making' permits local enterprises to proffer their firm specific advantages at costs that render engagement with TNCs mutually profitable. The resulting industrial organisation outcomes over time encapsulate the setting of production and quality standards at progressively higher levels by TNCs to which local firms must rise or risk losing market share. Box 3: Industrial Technology and Market Information Network in Sri Lanka, and Box 4:

[23] UNIDO, Annual Report, 2004.

[24] UNIDO Subcontracting and Partnership Exchanges (SPXs) and comprehensive 10-step approach to enabling and managing business partnerships [Business Partnerships for Industrial Development, Vienna, 2002].

[25] Meeting this requirement can be facilitated to a large extent by developing countries investing their policy environment with support mechanisms for technology foresight programmes. [UNIDO, Regional Conference on Technology Foresight, Summary Report, Vienna, April 2001].

Achira production mini-chain, portray the potential that well-organised interventions to enhance managerial skills can create.

BOX 3: Establishing the Industrial Technology and Market Information Network in Sri Lanka[26]

The Industrial Technology and Market Information Network to support small- and medium-size enterprise development has been established in Sri Lanka, with support from UNDP and UNIDO. Sri Lanka's SMEs lack access to information on national and international markets and technology. To enhance competitiveness and attract foreign investors, it was necessary to improve the flow of industrial information, by developing an information and communication technology infrastructure, to facilitate production, investment, export and decision-making processes.

The Industrial Technology and Market Information Network (ITMIN Ltd.), established as a commercial provider of services related to the information and training centre in 1996 was set up as a public limited liability company with public and private sector shareholders.

ITMIN Ltd.'s 62 staff provides information services on technology transfer, business intelligence, electronic publishing, market surveys and investment opportunities. Clients include the Australian High Commission, British High Commission and British Council, Citibank Ltd., Development Finance Corporation of Ceylon, Eveready Battery Co. Ltd., Forbes and Walker Stock Brokers, Germanischer Lloyd, Glaxo Wellcome Ceylon Ltd., Hong Kong and Shanghai Banking Corp. Ltd., James Finlay and Co. Ltd., Lanka Refractoriness Ltd., Malaysian High Commission, Mitsubishi Corporation, Ministry of Industry and Development, Securities and

[26] UNIDO, 2005, Sri Lanka: Establishment of the Industrial Technology and Market Information Network, Available at: http://www.unido.org/en/doc/3625.

Exchange Commission of Sri Lanka, Shell Gas Lanka Ltd., Sri Lanka Ports Authority, Planters Association of Ceylon, Stafford Group of Companies and Waldock Mackenzie Ltd.

Significant results: 850 accountants, diplomats, lawyers, doctors, engineers, marketers and clerks trained in computer/information technology and the Internet. 1,200 subscribers use ITMIN Ltd. as an Internet service provider.

BOX 4 : Achira production mini-chain[27]

Traditional achira biscuit production—hardly known outside the departments of Cundinamarca, Huila and Tolima—is one of the small local business chains supported by the UNIDO integrated programme for Colombia. Achira producers were not organized and the product had a very limited market.

The main problem was to overcome the limitations of production based on micro-productive entities scattered throughout three large departments, as well as the difficulties of creating a sustainable institutional capability.

Through the UNIDO project, a national financial institution opened special credit lines for the producers. To ensure increased productivity, a manual for processing the achira rhizome was elaborated. Starch quality improved through technology development and implementation.

A particular achievement was bringing together all interested parties and newly established national and regional committees. After investing resources in a successful coordinated effort, the producers today manage the market supply more efficiently.

The results of UNIDO intervention:

- National and regional inter-institutional committees established.
- Integrated management technologies developed and implemented.
- A new achira variety developed.
- Impurities reduced by 50 per cent.
- Packaging improved, ensuring product durability.
- Marketing strategy elaborated, market expanded.
- Four new products developed and marketed.

As a result of increased production, the number of people employed in the achira mini-chain has increased by 30 per cent. The product can today be bought in supermarket chains throughout Colombia. Initial steps for exporting have been taken, with exports already taking place to the United States and promotional steps under way with Canada, Cuba and Ecuador.

In terms of skills development and 'pure' technology, UNIDO's work particularly since 1994 in implementing Montreal Protocol strategies, at company and enterprise level; and energy efficiency services since 1992 are robust examples of services crafted to enable developing countries to absorb and master technology.

Two features of the Montreal Protocol work are notable. First, the medium of technical training on the physical chemistry and industrial chemistry of ODS provides a direct means for absorbing and mastering technology. This skills training involving advanced industrial hazard operability and hazard analysis is transferable across a broad variety of process industries. Any 'brain-drain' from enterprises that may occur (within the country) is a contribution to the positive spill over dynamics of the domestic economy and translates into net gains for the country in the calculus of resource allocation efficiency. Secondly, the

[27] UNIDO, Annual Report, 2003.

necessary transfer of a wide-range of alternative equipment requisite for industrial processing and compressing of non-ODS fluids must be associated with engineering and equipment life-cycle maintenance and repair. It is the collective of mechanics, technicians and engineering managers who are ultimately responsible for equipment upkeep. The fact that China has begun to carve out a significant market niche in the production and export of non-CFC refrigeration products is in no small way due to the enabling services performed by UNIDO for Chinese refrigerant enterprises under the Montreal Protocol arrangements[28]. Box 5: A Typical Montreal Protocol UNIDO Intervention in China, illustrates the inherent learning and innovation that constitutes UNIDO's contribution to enhancing developing countries' ability to absorb and master technology. The results can be impressive when expressed in commercial terms.

BOX 5: A Typical Montreal Protocol UNIDO Intervention in China[29]

Aucma Group is a 100% Chinese state-owned enterprise established in 1988. Today, Aucma is the largest freezer manufacturer of the country. As a freezer business expanded the company extended its production range to air conditioners, dishwashers, electric heaters and other electrical goods. In 1995 the annual chest freezer production amounted to 650,000 units, which represented a 24% market share in China. The export volume was limited to a few thousand units yearly and they were sold exclusively in developing countries. The number of Aucma Group's employees is about 8,000 people.

Prior to the UNIDO project CFC-12 was used as a refrigerant and CFC-11 as foaming agent for the insulation of freezers.

[28] See UNIDO 2001 Annual Report for expenditures and projects specific to China, CFCs and the Montreal Protocol on Ozone Depleting Substances.
[29] UNIDO, 2005, Ozone Friendly Industrial Development, 10 Years of UNIDO in the Montreal Protocol, Available at: http://www.unido.org/doc/11120.

Non-ODS technology selection.

In close consultation with UNIDO and Government, Aucma decided to select long term alternatives, i.e. cyclopentane insulation foam blowing and HFC-134a refrigerant.

UNIDO's intervention.

The existing vacuum pumps and charging machines were retrofitted, six new production line leak detectors were purchased.

As a result of improved productivity through reorganisation and rationalization of the foaming department only seven of the five foaming machines were converted to cyclopentane, two old machines were disposed. Two mixing units, cyclopentane storage facilities were installed.

Procuring and installing cyclopentane monitoring and alarms, safety ventilation, nitrogen neutralization and automatic fire extinguishing systems ensured the safety of the flammable cyclopentane technology. All equipment in the hazardous parts of foaming lines was designed, manufactured and installed as explosion proof, existing equipment were properly modified. All new equipment and the complete manufacturing line were inspected and their conformity with the latest industrial safety standards was certified by TÜV Germany.

The first batch of freezers was redesigned with the assistance of a refrigeration institute from UK. The engineers of Aucma were trained in redesign. Up-to-date laboratory equipment was provided to enable fast and reliable redesign of the products.

Training of operators and maintenance staff in best operating and maintenance practices as well as up-to-date safety philosophy and methods were also carried out in Europe and on site.

Impact.

Apart from the 708 tonnes of CFCs phased out, skills development in plant and

production areas of environmental working conditions, occupational health and safety, as well as design, production and maintenance was improved.

Annual production was increased from 650,000 (1995) to 1,003,000 (2001) units.

Exports to developed countries increased from a few thousands to 170,000 units in 2001 and, under an agreement with General Electric, 500,000 freezers were exported in 2002.

The quality assurance procedures and quality of the products were strengthened; Aucma received ISO 9001, ISO 14,000 and ISO 18,000 certificates.

Regarding UNIDO's enabling services for improving energy efficiency, a significant example of skills formation in absorbing and mastering technology is provided by processing in the glass materials industry in India centred around Firozabad. Upgrading of core skills in vitreous materials handling through different phase transformations and production stages as well as advancing product design skills over the decade 1992-2002 has resulted is over 400 craft artisans trained and higher quality output for about 70% of all ornamental glass manufactured in the country.

The economic impact of the skills development component of absorbing and mastering technology of the above selection from UNIDO's programmes is necessarily felt over the longer-term. While difficult to capture concisely in absolute figures, the impacts are manifest in terms of market access and trade at enterprise and ultimately at balance-of-payments level, but they obviously differ in intensity across the different countries and different projects within UNIDO programmes.

A short review of some other concrete results and their economic impacts will serve to illustrate. With respect to the SMEs and skills development in Ethiopia, absorbed technology and embedded training has enabled the recipient host to start marketing its services and charging its customers user fees. Thus the host has created revenue streams for further

business expansion, employment growth and contribution to local authority fiscal well-being. In developing countries with highly localized economies, the externalities created by such revenue streams go beyond the financial and monetary and assist in fixing self-interest exchange relations.

Furthermore, it is widely accepted that economic activity that involve women in developing countries have wide impact on poverty reduction in terms of greater household income, lower fertility rates and higher female literacy rates. The economic impact of rural and women entrepreneurship (especially in matriarchal social settings) through enhanced access to markets again represents crucial revenue streams. The associated positive impact on nutritional quality and levels should not be ignored.

The economic impact within developing countries with enterprises pursuing cleaner production is implicit in the increased competitiveness that higher standards of production and lower levels of pollution bring. The crucial issue concerning economic impact is, of course, externalities and the steady incremental progress that is made by enterprises within UNIDO programmes. Such economic impact would need to be viewed through the twin lenses of the 'Rio' Earth Summit in 1992 and 'Rio+10' (The World Summit on Sustainable Development, Johannesburg in 2002). That the Asian Development Bank should initiate in 1998 a Regional Technical Assistance Programme in conjunction with UNIDO, UNEP and US-AEP[30] is testament to the economic value ascribed to the importance of cleaner production and cleaner technologies to developing countries[31]. According to the Asian Development Bank, as the requisite poverty alleviating capital stock is yet to be built in most of the developing countries, UNIDO's cleaner production programme for transferring technologies is seen as crucial to reaching goals in public health, business productivity and market competitiveness.

[30] United States-Asia Environmental Partnership.
[31] Asian Development Bank, Guidelines: Policy Integration and Strategic and Action Planning For the Achievement of Cleaner Production, ADB, April 2002.

The economic impact of absorbing and applying masterfully methodologies and managerial tools to enhance the quality of investment negotiation outcomes is given, for example, by host authorities being enabled to increase the number of 'expressions of interest' from investors during investment promotion events[32].

As an expression of South-South collaboration, the UNIDO Subcontracting and Partnership Exchanges (SPXs) have economic impacts in terms of contracting. Designed to build up technical information systems and exchange networks to facilitate developing country domestic investors in supplying parts for the global production of TNCs, a 1997 survey found that all registered firms had been consulted at least once in 1997 and 66% of registered firms had concluded at least one contract in 1997. This performance would not be possible without UNIDO's "assistance to potential subcontractors/suppliers/partners in organizing production associations agreements with main-contractors"[33] that enables absorption of various technological capabilities. It is envisaged that, along with technical support, economic impact of this type of UNIDO intervention could expect between 50-100 national contracts and 25-50 per year in developing countries.

The economic impact of skills development in relation to technology transfer within the implementation of Montreal Protocol can be extensive. This is because this type of project implementation is a highly specific process involving the following: purchasing technology/equipment; designing non-ODS product(s); installing non-ODS technology/equipment in developing country production facility; adapting non-ODS technology/equipment to local environmental conditions; training local engineers, technicians and mechanics for non-ODS technology/equipment maintenance and repair; destroying CFC related technology/equipment to prevent back conversion.

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[32] The Burkina Faso Investment Promotion Unit created in 1999 identified 50 investment projects of which 21 attracted international investor 'expressions of interest' at the 2001 Invest in Burkina Faso Investment Forum. [UNIDO Annual Reports 1999, 2000, 2001, 2002, 2003]. Eight of these expressions are now in the process of being translated into concrete investment projects by French and UK companies.

[33] UNIDO, SPX Success Stories 2001, p.2; 60 SPXs operational in over 30 countries.

One of the many examples from China in this area serves to illustrate absorption and mastering of technology [See box 5]. Aucma Group, under a UNIDO programme has converted to non-ODS refrigerant use and refrigerator products. In absorbing and mastering non-ODS technology, annual production has expanded by 11% per year in the five years to 2001 to over one million units. A shift in market focus from domestic to export has occurred with an agreement to supply General Electric with 500,000 units in 2002. Hand in hand with adopting the new technology, enhanced quality assurance and quality control systems have won ISO 9,001, ISO 14,000 and ISO 18,000 certification – testimony that non-ODS technology has been absorbed and mastered.

In the process of absorbing and mastering technology it is important to emphasize that skills development is indispensable. However, it is a necessary, but insufficient condition. The sufficient condition is provided by the convergence of three other factors: institutional capacity building, diagnostic work and policy advice. It also is important to indicate that whereas skills development is relatively easy to foster and see, for example, in terms of direct training; institutional capacity, diagnostic work and policy advice as ingredients of strategy to absorb and master technology are harder to foster. This is to be expected as the developmental returns to robust and healthy institutions capable of appreciating the strategic implications of diagnostic work, and hence of designing good policies, is high.

6.2. UNIDO and Institutional Capacity Building

Where as skills development emanates from, and is associated with, the more tangible assets of UNIDO's programmes; institutional capacity building emerges from the more tacit aspects – even though an institute or institution may be formally established as part of a programme or project. It is widely accepted that formalising institutions and encapsulating them in buildings does not necessarily mean a working and competitive institution. What is much more important is the mandate for, and the effective managerial and efficient decision-

making structures within, the organisation that is formally the institution. In other words, an organisation that does the right thing, and does that thing right – in a timely manner – this part of absorbing and mastering technology is therefore associated more with conceptual issues and networking functions that underpin the activities performed.

As an illustration – investment cycle and technology promotion networking aims to create links among various domestic actors characterized as knowledge-based institutions (science and technology, R&D centres, university departments, chambers of commerce, industry associations, and government institutions and strategic units in ministries for example). The linkages are meant to express well-articulated communications and timely coordination. It is this orchestrated flow of intelligence - the coherent capture and exchange of data, information, statistics and knowledge – that constitutes the institutional capacity building.

National and international networks of Investment and Technology Promotion Offices (ITPOs) and Technology Centres, the Investment Promotion Agency (IPA) Network in Africa[34] and Asia-Africa Investment and Technology Promotion Centre (AAITPC)[35] for example, provide developing countries with outreach relations. Such relations assist in invigorating their communications and coordination efforts at sourcing technology, attracting investments and facilitating trade. Network management can be supported by a variety of software methodologies including CAPTECH Manual Training and Technology Needs Assessment. A second illustration, one of explicit high asset specific technology promotion that creates linkages is provided by the Institute for Auto Parts and Machine Tools Technology (in India). The institute, having set up a number of satellite training centres, manages capacity building among the centres, to enable accelerated absorption and mastering of technology through design development; manufacturing; and metrology.

[34] UNIDO – Africa Investment Promotion Agencies Network was launched in 2001.
[35] Asia-Africa Investment and Technology Promotion Centre, Kuala Lumpur, Malaysia, established 1999 with support of the government of Japan.

Indications are that this particular example of UNIDO intervention has been particularly beneficial to the host. First, evidence that the Institute for Auto Parts Technology (IAPT), in Ludhiana (Punjab), has been incentivised by lack of government funding to survive, by becoming market oriented and demand-driven as well as performing fee charging subcontracting for local industry, indicates that machine tool technology and its management has been sufficiently absorbed and mastered at a requisite level. Secondly, evidence that this advantageous outcome is being transplanted from the domestic to the international – bringing in six African countries (including Ghana, Nigeria, Tanzania) into the orbit of the IAPT – points to South-South cooperation in technology transfer from which valuable lessons of experience can be learned.

Referring to the more tacit nature of institutional capacity building, two further examples of UNIDO's intervention stand out. First, the technology management (and foresight – with respect to NIS) programme is aimed specifically at creating the right institutional conditions for innovation to occur. In this respect, attention is focused on the managerial dimensions of the firm, in relation to government and knowledge institutions, and the need to transform firms into learning organisations. This requires the redesign of internal systems of communication and reward to discourage risk aversion on the one hand and, on the other hand, encourage collaboration with other firms. Secondly, an example from a 1992-2002 programme in Syria serves to illustrate how success can breed success. This is provided by the formation of a lead team, housed by the Higher Institute for Applied Science and Technology (HIAST), to champion country-wide implementation of Computer-based Maintenance Management System (CMMS) for industry. As a result, more enterprises, seeing the higher levels of competitiveness imparted to their competitors by CMMS software are requesting implementation of CMMS and associated methodology in their manufacturing.

In both these examples it is not the physical attributes of the institution that is important, but the managerial attributes of institutional processes that UNIDO's assists in

improving and accelerating towards a greater capacity for innovating. Box 6: National Cleaner Production Centres (NCPCs), provides a measure of this managerial dimension of institutional capacity building. Analysis of cleaner production options[36] indicates that out of 56 production technology changes (input materials, process, by-products, product modifications) identified, 30 (53,6%) were implemented. More importantly, in all but one case the technology transfer was endogenous and localised. This localisation is powerfully suggestive of absorption and mastery of technology at a particular level.

BOX 6: National Cleaner Production Centres (NCPCs)[37]

The joint UNIDO/United Nations Environment Program (UNEP) sponsored national cleaner production centres enable developing countries to promote, gain access to and use cleaner production technologies.

The NCPCs build capacity within a country to permit for the adoption of cleaner production. These centres are part productivity centre ("environmental control" is not unlike quality control) and part extension service (focused on specific skill needs of enterprises).

In 1995, UNIDO began NCPC programmes in Brazil, China, the Czech Republic, India, Mexico, Slovakia, the United Republic of Tanzania and Zimbabwe. As of 2001, 23 centres have been founded.

The total budget allocated since 1991 amounts to approximately $21 million, with 85 percent from donor countries, 10 percent from multilateral organisations and the remaining portion from countries with the centres. UNIDO acts as the executing

[36] In-Depth Evaluation of Selected UNIDO Activities on Development and Transfer of Technology: The UNIDO/UNEP National Cleaner Production Centres (NCPCs), US/GLO/94/009, ODG/R.11, 27/Oct/1999, Table NCPC 2, p.19.

[37] UNIDO, 2005, The NCPC Programme, Available at: http://www.unido.org/doc/5133?language%5fcode=en.

agency with the UNEP Industry and Environment Program Activity Centre providing methodology and information. An NCPC should eventually offer the following services:

- Seminars to raise awareness of cleaner production.
- Training in cleaner production methodology.
- Dissemination of technology information needed for in-plant assessments.
- Technical assistance, including in-plant cleaner production assessments.
- Advice on financing and funding sources for cleaner production.

The results of this network of NCPCs are:

- Over 400 in-plant demonstrations in 15 countries.
- Over 1,000 engineers and technicians trained in cleaner production.
- 24,000 participants in awareness-raising workshops and seminars on cleaner production.

In reflecting international obligations on the environment, UNIDO's assistance in the establishment of the international centre on Small Hydropower (SHP) in China is noteworthy. An international focus by the centre permits two main activities. International experience is fed into the technical work of the centre and diffusion of the technology can occur resulting in economies of scope, for example in the area of turbine technology. Diffusion of technology enables those enterprises that are sufficiently aware to grab a higher position on the competitiveness ladder. At sector and industry level, even though there may be firm entry and exit, this results in the overall competitive profile of the industry being raised with consequent higher returns.

Lastly, the establishment of the bio-medical centre for repair and maintenance of medical equipment in Bosnia is a good indication of UNIDO intervention leading to

absorption and mastering technology. Advances in medical equipment have been broadly characterized by increased use of disposables and by a change from mechanical instruments to electronic diagnostic and monitoring sensor equipment. The knowledge embedded in medical equipment has increased considerably therefore. Maintaining such equipment requires higher levels of capability that can lead to gains across the sector.

In each example, the institutional capacity building creates a process leading to absorbing and mastering technology at a level higher that would have been the case otherwise. Of course, in any assessment, there is the counterfactual position in that we do not know what indigenous processes or pressures might have occurred without UNIDO's intervention.

The economic impacts of institutional capacity building are more difficult to ascertain especially when UNIDO programmes are designed within specific time frames and post-intervention monitoring is seen as the primary responsibility of the host beneficiary. Nevertheless, a qualitative view may be taken. The network of promotional agencies involved with investment is a key element in improving the investment climate of host countries and increasing FDI to firms through joint ventures for example.

An important economic impact of the Indian Institute for Auto parts and Machine Tool Technology lies in the institute becoming market oriented – which implies greater competitive effectiveness – and adding value to local industry through sub-contracting. This intermediation, in industrial organisation terms, means that customers can reduce their cost profiles (and/or increase the quality of their inputs) and use savings to expand their business.

The diffusion of technology that is common to these examples of institutional capacity building, notwithstanding differences in factor efficiencies, assists in raising the profile of the production frontier for the industry sub-sectors concerned.

6.3. UNIDO and Diagnostic Work

From the outset, it is necessary to point out that the diagnostic work performed in UNIDO programmes has two aspects. UNIDO staff perform diagnostic analyses using a portfolio of methodologies; and UNIDO contracts international and, more importantly, national experts (using national knowledge-based institutions) to carry out diagnostic work. The results of the latter are that benefits of the learning process (new experiences, new methodologies and outcomes) are captured by national expertise and remain available for further use in the country long after the project or programme is completed. As understanding complex system dynamics of interacting managerial and technical forces is key to absorbing and mastering technology, adding value to national experts is a sure way to enhance developing countries' capacity to compete. It needs to be borne in mind that the intensity of diagnostic work differs among programmes and projects.

UNIDO's recent "Technology Transfer Initiative: Assessing Needs – Promoting Action" combines a web-enabled approach to technology needs assessment and analytical methodologies applied at national, sectoral and enterprise levels with proven technology promotion techniques, and investment and technology promotion networks. The initiative aims to identify national and sectoral technology priorities, develop the corresponding techno-managerial capabilities and upgrade technology transfers in order to facilitate trade. On the basis of findings from needs assessments, UNIDO will assist developing countries to choose specific technology acquisition strategies and the development trajectory best suited to the country and the needs identified.[38] UNIDO will subsequently provide enabling services to develop capacity, promote matchmaking and alliance-building cooperation at policy, institutional and enterprise levels. Box 7: UNIDO Technology Needs Assessment indicates analytical approach and outcomes.

[38] Alternative trajectory choices include technological upgrading through switching between options such as the network effects of a national innovation system; championing national enterprises to engage with multinational enterprises; and championing promising local firms to engage in supply global production networks.

BOX 7: UNIDO Technology Needs Assessment[39]

UNIDO has developed a set of Technology Needs Assessment (TNA) tools to enable countries to audit their current technological capabilities in order to identify strengths and weaknesses at the nation, sector and enterprise levels. The tools are based on research into successful technology transfer and acquisition in developed and developing nations. Three levels of TNA developed by UNIDO deal, in turn, with:

- National Technology Needs Assessment focuses on technology policy formulation and execution at the macro level;
- Sector level TNA takes a similar approach for the industrial sector level and for technologies which cut across specific sectors; and
- Enterprise level TNA provides a detailed approach to auditing the capabilities of business firms, as firms are ultimately responsible for technology acquisition.

The tools can be applied either by a developing country representative or in partnership with UNIDO. The Technology Needs Assessment is designed to:

- First, to map out the overall technology capability level;
- Second, to profile the capabilities of developing countries showing strengths and weaknesses;
- Third, to assess the effectiveness of current mechanisms for technology acquisition; and
- Fourth, to provide valuable information to help select technology priorities within a coherent strategy for technology acquisition and upgrading.

[39] UNIDO, 2002, UNIDO Initiative on Technology Transfer for WSSD: Assessing Needs – Promoting Action, Vienna.

Diagnostic work is common to UNIDO's programme and sub-sector, enterprise level diagnostics occur predominantly in the cleaner production, energy efficiency and Montreal Protocol areas. This in contrast to policy level diagnostics that tend to underscore investment and technology promotion activities and sector level diagnostics that characterises SMEs and agro-industry.

Diagnostics enable a comprehensive 'mapping', using a variety of instruments and methods, of the vectors in enterprise and sector level industrial input-output relationships and production structures. The value of diagnostics to developing countries for absorbing and mastering technology, lies in the ensuing knowledge of emergent patterns of strengths and weaknesses as well as critical success factors in industry competitiveness pertinent to the enterprise, cluster or sector. A particular example, which involves internalisation of diagnostic techniques for product re-design, and manufacturing re-engineering is provided by a demonstration project to assist SMEs in the agro-business sector.

A significant example is provided by the cleaner production component of the integrated programme for Ethiopia. The combination of an 'Energy Management Consulting Team' formed to manage an 'Energy Conservation Data Bank' suggests the practical use of diagnostic 'maps'. Other examples are provided by UNIDO's Strategic Research arm, which has recently shifted its focus to those low-income countries close to the danger of permanent marginalisation from the global economy. The development of research frameworks that are eventually communicated to governments for action assists in improving the analytical base for policy design to increase the technological orientation of the economy. Box 8: Quality Management and Productivity Improvement, provides an illustration of the analytical and diagnostic applications available to enable firms to boost their manufacturing competitiveness.

BOX 8: Quality management and productivity improvement[40]

The UNIDO Quality Approach enables enterprises to support self-sustained and continuous improvements. This self- is achieved through UNIDO delivering a range of enabling services that:

- Build institutional and human capacity for implementing quality management methodologies and systems (TQM, ISO 9000/2000, SPC) through practical demonstrations in groups of enterprises.
  - Results lead to improvements in quality and productivity.
- Promote productivity by establishing Regional and National Quality and Productivity Centres. These act as 'one-stop-shops' for advancing productivity and quality in manufacturing sector by supporting management upgrading in supply chains, and policy-related government bodies.
  - Results lead to enhancement of manufacturing practices, process and competitiveness.
- Improve industrial capability and capacity through the application of UNIDO Business Excellence Software packages - Pharos (Business Navigator) suitable for SMEs, BEST (Business Environment Strategic Toolkit) and FIT (Financial Improvement Toolkit) and MCCT (Measurement Control Chart Toolkit) for monitoring calibration of equipment and carry out simple Statistical Process Control.
  - Results lead to improved business strategy and increase in enterprise competitiveness.

From in-plant 'walk through' audits and monitoring to supporting National Agenda 21 implementation, diagnostic work imparts capability to groups of national institutions used for research, analysis and interpretative reports. When related to the wider national system of

[40] *UNIDO, Annual Report, 2002; UNIDO, Annual Report, 2003.*

innovation, and institutional management of the orchestrated flow of intelligence to the policy community, diagnostics become crucial to expanding a country's ability to handle technology over the long-term. The Gurgaon City Project in India – supporting the National Agenda 21 Strategy – illustrates the point.

The direct economic impacts of diagnostic work are difficult to measure but are felt as an outcome of implementing the results as managerial and technical plans of action. In UNIDO's engineering oriented enabling services this can be expressed as increasing compliance to environmental protocols resulting in reductions in energy and other input costs, as well as increases in the quality of management and manufacturing outputs, at enterprise level.

6.4. UNIDO and Policy Advice

UNIDO's explicit policy advice recognises the comprehensive and crucial role of technology in socio-economic development. In a world where production is increasingly globalised and networked and in which economies are increasingly 'borderless', socio-economic progress equates in significant part with maintaining and increasing employment, and enhancing the quality of life through higher manufacturing value added activities. Quality of life depends on two critically important factors. First, being globally competitive and thus improving productive sector efficiency, and expanding exports while growing domestic markets in liberalised trade conditions. Secondly, ensuring that acquired technology is effectively absorbed mastered and applied sustainably across a broad scope of economic activities.

National technology policy therefore represents a collective response to the need to build on these factors. Technology policy is largely concerned with ensuring that firms are able to innovate in the broad sense and improve their technology over the long-tem. Drawing on the empirical experience of developing countries, the UNIDO approach addresses two basic

issues. First, technology access and secondly, technological competence needed to manage, operate and renew acquired technology.

Technology access concerns the ability of national innovation system[41], and individual firms to acquire available expertise and knowledge (codified as patents, drawing, data, instruction manuals and/or embodied as plant, equipment, materials). *Technology competence* concerns the human capital that encapsulates the managerial and operational capability to master the steep learning curves associated with technological change. Technology learning curves are primarily what separate technology from other factors of production. Technology can rarely be bought off the shelf and applied instantly because it is a complex of shared, proprietary, tacit and embodied knowledge that requires experience to use and needs a setting that encourages a culture and processes of innovation.

Technology access and competence, as well as the ability and speed to climb technologies' learning curves, broadly distinguish developing and industrialised economies. In general, most developed economies no longer give the responsibility for technological development solely to the private sector and market forces.[42] Developing countries therefore need an explicit technology policy and a functioning national innovation system that is consistent with their economic development goals.

UNIDO technology-related policy advice, based on a continuous monitoring of technology, addresses the needs of developing countries for competitive industrial production on a sustainable basis. Input from the countries' enterprises, academia, R&D institutions, technology centres, development-financing institutions, and other institutions that form the

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[41] National Innovation Systems comprise the whole complex of public and privately owned physical infrastructure, institutions and systems that support and develop productive-sector innovation. *Physical* infrastructure - institutions, laboratories, technology parks etc. *Technological* infrastructure - technology diffusion schemes, mechanisms to create technology-based firms, technology transfer incentives. *Human development* infrastructure - post-graduate research programmes and training systems. *Financial* infrastructure - loans for technology acquisition, adaptation and application.

[42] In 1999 EU Governments spent an average of 47% GDP and throughout the during, the 20th century, average share of OECD Governments' spending rose from 12-5% to approximately 50% [Martin Wolf, 2001, Will the nation-state survive globalization?, Foreign Affairs, Vol. 80, No. II; and Antonio Alfonso, Ludger Schuknecht and

national innovation system are vital to articulating coherent advice. UNIDO's explicit technology interventions are calibrated to the technological capabilities of the particular country. In this connection, UNIDO's Competitive Industrial Performance Scoreboard plays an important role in suggesting the specific focus for UNIDO action.

UNIDO's contribution to assist developing countries strengthening their capabilities in absorbing and mastering technology is animated at the following levels of intervention[43]:

- *At policy level*, technology foresight permits stakeholders to define strategic development directions, guide innovation policies and set up supporting infrastructure;
- *At institutional level*, creation of international technology centres (and where necessary 'high-tech' parks) and networking them, through technology road-mapping, with the national innovation system is instrumental in bringing a culture of innovation to business;
- *At enterprise level*, efforts are focused on building capacities in managing technology. Crucial is particularly the complementary internal generation, and external acquisition, of technology.

A significant development is the UNIDO Technology Foresight Programme initiated in 1999 with the *Technology Foresight Initiative for Latin America.* Following awareness building, information dissemination and networking, UNIDO is now focusing its support on textiles, fishing, wood & furniture and new materials. A *Technology Foresight Regional Initiative for Central and Eastern Europe and Newly Independent States (NIS)* addresses common issues related to regional development with special focus on biotechnology and environment technologies. Recommendations from the Industrial Development Board[44] support the extension of technology foresight to other regions. In different countries, technology foresight activities are

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Vito Tanzi, 2003, Public sector efficiency: An international comparison, European Central Bank, Working Paper No. 242, July, Annex table C, p. 32].

[43] A proper articulation of the national innovation system requires a comprehensive inclusion of science and technology into the economic and social life of a country. Conceptually the levels of intervention described here refer to Sábato-Botana triangle in which the vertices correspond to the main actors of the above interrelations.

being increasingly integrated with policy making. Box 9: Technology Foresight For Policy Making gives a brief overview of this particular enabling service.

BOX 9: Technology Foresight For Policy Making[45]

Technology foresight exercises, performed with the private sector, are valuable to comprehend global trends. Technology foresight enables firms and the government to formulate detailed strategies.

The focus of these exercises is that the objective relates to steps to catch up with the global technological frontier, not steps necessary to remain at the forefront of the frontier. Developing countries require foresight in relation to existing industries, and industrial activities for which potential competitive advantage is within grasp. They require foresight about technological trends, and about changes in the international order of economic activity.

Technology foresight exercises are not simply about external factors or global trends. They are also fundamentally about internal factors that are assessing a country's industrial strengths and weaknesses in sufficient detail to ascertain where changes are required. Indeed, in developing countries much of the work most useful for foresight exercises goes into developing a vision of a future in which existing resources are used with greater productivity.

UNIDO's 'trademark' International Technology Centres (ITCs) – sources of policy advice – are unique institutional mechanisms to promote international collaboration through transferring and diffusing technological innovations. UNIDO is the sole UN agency with this type of mechanism encouraging industrial investments and supporting North-South and South-South technology flow and global forum activities to assist in bridging the technology

[44] General Conference Nine, 2001, Resolution No.2 On the Medium-term Programme Framework 2002/2005.

gap. ITCs are integrated with programmes of ITPOs. BOX 10: Results of Policy Implementation, illustrates UNIDO's contribution.

BOX 10: Results of Policy Implementation[46]

Case 1. Transferring technology to secure employment and the environment (India)

In 2001, the International Centre for Advancement of Manufacturing Technology (ICAMT, Bangalore, India) implemented a project for technology upgrading of foundry industries in Agra City, India. The transfer of new technology (costing US$150,000) and its application in 100 foundries will eventually secure 10,000 jobs for local people.

Case 2. Technologies for the poor in Africa (South-South)

ICAMT, UNIDO and India have launched a technology transfer and investment promotion project for producing cost-effective building materials (from recycled agro-industrial by-products) for affordable housing in Africa. Machinery transferred to African partners has generated employment (100 skilled, 220 semi-skilled & 600 unskilled workers). The project is being developed into a South-South technology transfer and co-operation programme linking Asian, African Latin American and Caribbean countries.

Technology policy advice has also been implicitly provided by UNIDO through programmes such as the National Cleaner production Centre Programme and the Montreal Protocol Programme. These have contributed to the technology policies through global forum activities and advice on policy regarding environmentally friendly production and the phasing out of ODS in keeping with national and sectoral strategies. UNIDO's Agro-industries interventions have resulted in technological modernisation in developing countries by, for

[45] UNIDO Annual Report 2002, and UNIDO Annual Report 2003.
[46] UNIDO, 2005, UNIDO Helps South-South Knowledge and Technology Transfer, Available at: http://www.unido.org/en/doc/4348.

example, strategic development of agro-machinery; formulation of food sector policies; and creation and institutionalisation of professional associations.

Box 11: Policy Advice to Developing Countries, provides a brief overview of the range of UNIDO policy interventions assisting developing countries to absorb and master technology.

BOX 11: Policy Advice to Developing Countries[47]

Noteworthy, direct policy advice, provided through technical assistance projects in cooperation with other UN agencies, worth mentioning are:

- Design of a new policy and institutional framework for technology access and application in Ethiopia during the post-civil war transition (1993);
- Action programme for science and technology policy in Zambia (1994);
- Formulation of a national programme for scientific and technological development in Bolivia (1996);
- Elaboration of science and technology policies for Namibia (1996);
- Review of the national technology policy in Colombia (1998);
- Technology Policy Framework for Fiji (2000);
- Policy framework for creation of knowledge-base industries in the Moscow Oblast (2001) and technology policy review in Lao (2002).

[47] UNIDO, Annual Report, 2002; UNIDO, Annual Report, 2003.

7. Concluding Remarks

Overall, across UNIDO's programmatic delivery of enabling services can be seen to be adding to developing countries in significant ways[48]. The implementation of Montreal Protocol activities averaging US$ 32 million per year indicates broad impact within a highly specialised area. In contrast, the delivery of SMEs and women's entrepreneurship at just below US$ 6 million per year represents a niche where impact is more narrowly focused[49]. Additionally, the number of expert group meetings (symposia, seminars, workshops) that provide the public goods of data, information, statistics and knowledge over a wide range of industrialisation themes has increased from 95 (1999) to 111 (2001). In 2000, the total number of in-plant group training sessions was 140[50].

However, in a qualitative assessment of UNIDO's contribution to technological development that is necessarily selective, successes in the period 1997-2002 often point to areas where improvements can be made. In reviewing the material available, three main areas where improvements could be made may be identified in UNIDO's contribution to developing countries ability to absorb and master technology: namely within the financial and managerial systems.

The challenge of finance is always to do more with less; and this demands a relentless improvement in recipient's performance in terms of the financial efficiency of programmes and projects. With respect to the formal transfer of skills through training, clearly budget increases to augment the throughput of trainees from developing countries – when accompanied by performance appraisals that go beyond learning in the class room and extend to the workplace and associated with 'refresher' programmes – will enhance capability.

Regarding management, as a specialised technical cooperation agency UNIDO appears oriented naturally to engineering, products and techniques. This orientation is manifest in

[48] See UNIDO, Annual Report, 1998, Success Stories, pp. 27-38.
[49] UNIDO, Annual Report, 2001.
[50] Not including training within UNIDO-executed field projects.

approaches and implementation of agro-industry, cleaner production, energy efficiency and Montreal Protocol Programmes. Management is a part of this approach. Nevertheless, it is increasingly recognised that industrial development and absorbing and mastering technology is as much (if not more) to do with effective and efficient managerial processes[51]. This increasing focus on management would need to be supported by transforming the diagnostic work performed by national experts and national institutions in developing countries from discreet intervention to a continuous process[52]. This is not to say there is an absence of management in programme or projects[53].

As far as systems are concerned, a distinction needs to be made between those related to UNIDO's internal Project Allocation Documents (PADs) and those concerning field management of projects. There is an argument for more robust integration of system analysis and project management tools to enable improvements in the execution of organisational strategy during a UNIDO intervention at enterprise level[54]. Such an approach would assist in better appreciating how things change through time with respect to UNIDO projects taking into account internal feedback effects within the system of project[55]. Without going into overburdening detail, and despite the problem on agreeing on metrics (measures of effectiveness), a systems analysis approach would reveal, evaluate, qualify and quantify programme (project) wide impacts. There are indications that such thinking is taking shape in the form of UNIDO's web-based Technology Needs Assessment Tools[56].

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[51] See In-Depth Evaluation of Selected UNIDO Activities on Development and Transfer of Technology: The UNIDO/UNEP National Cleaner Production Centres, US/GLO/94/009, ODG/R.11, 27/Oct/1999. For the view that "Success at company level depends also on the level of management in the company... (therefore)... a certain level of management and financial stability should be a prerequisite for any intervention."

[52] Soltero C., Waldrip G., 2002, Using Kaizen to Reduce Waste and Prevent Pollution, Environment Quality Management, Vol. 11, No.3, Spring, pp.23-38.

[53] Refrigerant management plans have been a consistent part of Montreal Protocol implementation.

[54] Integrating System Analysis and Project Management Tools, International Journal of Project Management, Vol.20, No.6, August 2002, pp.461-468.

[55] Casado E., 2002, Thinking Outside the Lines, Intelligent Enterprise, Vol.5, No.11, June 28, pp.40-45.

[56] UNIDO, Technology Needs Assessment, launched at the World Summit on Sustainable Development, Aug/Sept 2002, Johannesburg, South Africa.

Looking forward, the role of technology in the development of society is likely to assume greater importance due largely to the increasing power of its driving forces that are science and innovation, to shape economic and social relations. In developed countries concerns are more likely to be cast in terms of understanding technology and its ethical choices; in developing countries concerns, no less pressing, are more likely to be framed by issues of access and equity.

Four emerging policy issues for governments need addressing. First, in the technology area of health and life sciences, authorities are likely to focus on regulation regarding, for example, gene therapy and recombinant DNA technology; with developed countries paying attention to the ethical domain and intellectual property rights while developing countries pay attention to basic hygiene. Secondly, in the area of technology material sciences, the advent of nanotechnology engineering at the molecular level along with intelligent materials is likely to continue 'dematerialising' the advanced economies. Implications for terms of trade have yet to be fully appreciated and addressed. Thirdly, in the area of the bio-diversity of tropical assets; while the territory may belong to developing countries, the ability to 'map' potentially valuable pharmaceutical 'discoveries' belongs, in the main, to the collective science and technology community (public R&D laboratories, hospitals and private pharmaceutical TNCs) in the developed countries. Questions of collaboration and competition with respect to 'natural heritage' would need to be more openly and fully addressed sooner or later. Fourthly, the long-term delocalisation of manufacturing from the 'Northern' workshops of the world to the 'Southern' workshops of the globalised world economy (Asia and China) and the competitive distribution of global intermediation is among developing countries.

Technology has played a vital role in improving the quality of life for millions of people[57]. There is challenge of bringing the advantages of technology more assuredly to developing countries and assisting the developing countries to use more effectively the benefits

of technology. There is room for cautious optimism that, despite the deliberate pace of progress from Rio to Johannesburg, interventions by UNIDO will continue to have a valuable impact in contributing to developing countries' ability to absorb and master technology.

The seminal 1979 Vienna Conference gave the direction for science and technology policies in developing countries. There is a case for another conference in 2004 to review 25 years of progress, and make new recommendations that are appropriate for the 21st century.

[57] The Economist, Technology and Development Survey. 8/Nov/2001.

Appendix I: Dimensions of UNIDO's Contribution to Technological Development

Dimensions	Year				
	1999	2000	2001	2002	2003
Economy (capital Investment)[58]	$299 Million	$221 Million	$79 Million	$304 Million	$241.2 Million
Environment	3,577 Tonnes ODS[59] Eliminated	4,000 Tonnes ODS Eliminated	2,480 Tonnes ODS Eliminated	3,370 Tonnes ODS Eliminated	5,650 Tonnes ODS Eliminated
Employment					
SMEs started	6,567	563	428	512	434
SMEs expanded[60]	370	1,160	1,306	1,434	1,844
Women enterprises assisted	3,069	1,191	1,207	1,609	2,003
Jobs created	4,200	5,000	2,737	4,782	4,551

Source: UNIDO Annual Report 2003

[58] Investment generated.
[59] Ozone Depleting Substances.
[60] As the ability to absorb and master technology is a function of enterprise level internal division of labour, the expansion of SMEs represents a crucial contribution to technological development

Appendix II: Qualitative Assessment of UNIDO Contribution to Enhance Developing Countries' Ability to Absorb and Master Technology

Matrix for identification of UNIDO contribution

Categories of support	Conceptual issue of the activity performed	Period of implementation (1)	Promotion level (2)	Manifestation of the Activity (Actual & Expected Impact)	Contribution to Technological Development (Impact on the economy)	Responsible unit	Comments
Skill development							
Institutional capacity building							
Diagnostic work							
Policy advice							

(1) A: Last five years or B: further past

(2) Promotion or intervention levels:

Implicit technology promotion (I): technology promotion is done as component of a TA activity. Example. CETIC programme in Brazil

Explicit technology promotion (E): technology promotion is the core of the TA activity, basically related to capacity building in this field. Example.: technology transfer and negotiation or technology management training programme

Embodied technology transfer (EMB): equipment or pilot plant is provided/transfered to host country. Example: base project of Montreal protocol.

Appendix III: Selected Examples of UNIDO's Contribution to Technological Development: Enhancing Developing Countries' Ability to Absorb And Master Technology

Selected Programme/Project Activity	Conceptual issue of the Activity Performed	Absorbing and Mastering Technology Outcome	Manifestation of the Activity (Actual & Expected Impact)	Contribution to Technological Development (Impact on the economy)
TEST (Transfer of Environmentally Sound Technologies)	Transfer of Environmentally Sound Technologies.	***Skills development***	Trained company employees; Trained consultants.	Richer skills base and externalities.
Industrial Promotion and Technology	Technology Acquisition and Negotiation; Linkages between Investment and Technology Promotion.	***Skills development***	Persons trained; institutional capabilities of programme countries strengthened; technology acquisition contracts negotiated.	Conclusion of industrial partnerships for joint ventures, transfer of technology, market access, management and technical expertise.
National Cleaner Production Centre Programme	Cleaner production and related preventive activities.	***Institutional capacity building***	NCPC established and operational; Centre staff trained.	Local transfer of technology 'software' more significant than transfer from abroad leading to strengthened local technology networks; externalities captured locally.
Technology Management Programme	To update technological knowledge of managers of SMEs.	***Institutional capacity building***	3-4 training courses per year in developing countries and countries with transitional economies.	Accelerated innovation in general and product development in particular.
Establishment of International Centre on Small Hydropower (SHP) China	Centre established and operational, management support.	***Institutional capacity building***	Staff training on operational systems carried out.	SHP technology diffusion
Establishment of bio medical centre for repair and maintenance of medical equipment in Bosnia	Establishment of institute.	***Institutional capacity building***	*Technicians from three hospitals trained in maintenance and repair.*	*Faster response time on approbility of medical assets and* inventory; Reduced medical costs.
Industrial Promotion and Technology	Tools and Methodologies in the areas of technology transfer and acquisition; Computer-based embedded software technology needs assessment (macro, sectoral, enterprise levels).	***Diagnostic work***	Full-fledged training package on technology transfer operations. Methodologies developed for technology needs assessment at national, sectoral and enterprise levels. Increased firm level competitiveness.	Human resources upgrading in technology operations in Asia, Africa and Latin America. Input to national science and technology policy. Higher revenue and profit profile at firm and sectoral level.

Agro - Industry	Vertical integration and supply-chain management of leather industries.	***Diagnostic work***	70 production companies assessed. Strategic recommendations made on improving their design, manufacturing technology and quality assurance.	Improved export potential; reduced production costs; increased competitive product range and niche markering orientation. Declining unit energy costs.
Gurgaon Green City Project in India National Agenda 21 Strategy	National Agenda 21 Strategy - to diagnose problems areas, prioritise options and suggest remedial measures (plan of action) to make Gurgaon a sustainable and green city.	***Diagnostic work***	Diagnostic work and strategic plan of action for thematic areas completed.	Decline of energy use at local level; policy making.
Montreal Protocol	Identification of companies consuming ozone depleting substances.	***Diagnostic work***	Implementation of investment activities phasing out ozone depleting substances.	Compliance with international treaty requirements.
Assistance to set up technopoles/incubators in Tunisia	High-tech parks establishment and operations management support.	***Policy advice***	Creation and development of local enterprises in advanced technological sectors.	The decision by the President of the Republic of Tunisia to set up ten technopoles in Tunisia in the next ten years.
Preparation of the Socio-Economic Development Strategy to the Horizon 2010, Vietnam	Strategic analysis.	***Policy advice***	Policy for international economic and financial integration, rural economic and social development and science and technology and industrial development.	Technology promotion higher up on the policy agenda.
Phasing out phase out the use of CFC-11 and CFC-12 at the Changshu *refrigerating equipment works* (Baixue) Changshu	Technical redesign element of the project covers prototyping, testing, trial manufacture and reliability tests.	***Policy advice***	Phasing out 425.7 ODP tonnes in line with NEPA's ODS phase.	Decline in costs and increased competitiveness.
Agro - Industry	Creation, operation and management support of professional associations (Kenya, Eritrea, Nigeria)	***Policy advice***	Associations (as NGOs) operational and promoting interests of their members.	Improved financial, legal and markering status of private manufacturers.

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