THE INFORMATICS REVOLUTION AND THE DEVELOPING COUNTRIES

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ABBREVIATIONS AND ACRONYMS

CCC Customs Cooperation Council
CCITT Consultative Committee On Telegraphy and Telephony
CIM Computer integrated manufacturing
CMEA Council for Mutual Economic Assistance
EFTA European Free Trade Association .
FALPRO UNCTAD's Special Programme on Trade Facilitation GATT General Agreement on Tariffs and Trade
GTDI Guidelines for Trade Data Interchange (part 4 of UNTDIC
IBI Intergovernmental Bureau for Informatics
ICC International Chamber of Commerce
INTUG International Telecommunications User Group ISDN Integrated Services Digital Network
ISO International Organization for Standardization ISO 7372 International Standard for Trade Data Elements
IT Information Technology
PTTs National authorities regulating postal and telecommunicc ion services
SITA Society International pour la Telecommunication Aerona tique
SWIFT Society for Worldwide Interbank Financial TelecommuU cation
UNCTAD United Nations Conference on Trade and Development UN/BCE United Nations Economic Commission for Europe UPU Universal Postal Union UNWED UN/ECE-UNCTAD Trade Data Elements Directory UNTDID UN/ECE-UNCTAD Trade Tata interchange Directory.

FOREWORD

The informatics revolution is no longer a rhetorical term to describe an impending future phenomenon. It is a very present reality, touching the lives of most of the world's population and, more importantly, giving rise to radical, and perhaps decisive, changes in the prospects they face for the future. It is likely to produce changes in lifestyles, in patterns of economic growth, in education and training needs and methodologies, and in human and social conditions which could be as radical as those produced by the industrial revolution.
The informatics revolution is a product of the rapid development of both computer technology and telecommunications technology, and of the growing integration between the two in networks. The data gathering, storage and analysis capabilities of computers are now readily accessible to sources and users of information throughout the world by means

of telecommunication facilities, including satellites. The development and application of these new technologies have been largely concentrated in the industrialized countries and have proceeded at a pace in excess of the average growth rates of their economies. Indeed, the data communications service industry in western industrialized countries has grown at rates of some 15 to 20 per cent per *year* in recent years.

There has been a proliferation of data networks at the national level, as well as a rapid development of international networks, principally in the private sector. Amongst the most extensive of these are SWIFT, linking more than 500 European and American banks, and SITA, linking more than 200 airlines. A number of public data networks have also been developed, including EURONET, set up by the European Community and run by a consortium of European PTTs, and the Nordic Public Data Network. Many others are in the process of development.

Information technologies have developed at a much more rapid rate than the policies designed to deal with the important issues which they pose for national governments. The very nature of information, combined with the electronic means of gathering, storing and disseminating it, makes it extremely difficult, and in some cases virtually impossible, to contain and control it within national boundaries. Any rapid evolution of technologies can render existing policies and control and regulatory mechanisms obsolete or ineffective within a short time span. Thus, cooperation amongst governments, and between government and industry, is indispensable if they are to ensure the full participation in the benefits made possible by the information revolution while minimizing the risks and dilemmas it poses.

These risks and dilemmas have arisen to date amongst industrialized countries principally in relation to traps-border data flows. Two of the principal issues that have engaged the attention of governments to date to respect of traps-border data flows are the privacy and sensitivity of data, and the dependence of users in one country on reliable operation and standardization of hardware and facilities, tariffs and restrictions in another country. Ownership, and the desire of each country to develop its own capacities in the production of both hardware and software, are ales *c;gnif cantissue+*.

auction of both hardware *and software, are also signiticanr isr*thes*u s.*

issues, they have another concern of a more fundamental nature: the danger that their own cultures, values, national independence and integrity may be seriously threatened as a result of the information revolution. To developing countries, as well as to some industrialized countries, measures *designed* to anticipate, evaluate and mitigate these threats are of particular importance.

While the processes of international consultation and cooperation in dealing with these issues have been initiated in a number of fora, both official and private, the principal progress to date has been made by the OECD through its Working Party on Information, Computer and Communication Policy, which in 1981 produced a set of "Guidelines on the Protection of Privacy and Traps-Border Flows of Personal Data," and by the European Community in relation to the creation of EURONET. Various members of the United Nations family, notably the Financing System for Science and Technology for Development and UNIDO, are also increasingly involved in examining these issues and providing the basis for dealing with them in a more global context.

Many developing countries are well advanced in their knowledge of and capacity to deal with these issues. Virtually all developing countries are now tied into international telecommunication facilities which provide them with the means of access to computerized data networks. Some, like Brazil and India, *are very* much up to date in the development of their own national capabilities, as well as in their participation in the international dialogue and consultations on the issues that concern them.

However, the developing world as a whole is still *very* much in the rear guard of the informatics revolution. For many developing countries it is extremely difficult to keep up with the rapid changes that have been taking place, both in the evolution of information technologies and in the control and use of such technologies by industrialized countries.

Thus, many developing countries find themselves facing the prospect of an important new comparative disadvantage in pursuing their own national development goals and obtaining the growing share of world economic growth which they need to meet the needs and aspirations of their people. It can also create a new generation of dependence

on the industrialized world, arising from the fact that industrialized countries and their multinational corporations have such a high degree of preeminence in the field. Thus, it will be difficult for developing countries to obtain a major share of the research capabilities that produce new technologies, manufacturing facilities, control of data networks and the professional and intellectual skills necessary for leadership in the software aspects of the industry, which are so dependent on education and training and related employment opportunities.

This source of comparative disadvantage comes at a particularly bad time for the developing countries, when most are struggling to reinvigorate the internal economic growth on which their development prospects depend in a world economy that is increasingly competitive. Quite apart from creating a disadvantage *for* these countries in respect of the information industry itself, the information revolution will have a profound impact on virtually all sectors of their economies in which the application of information technologies is becoming an essential element in maintaining efficiency and competitive capacity.

The developing countries cannot escape the need to face up to the challenges with which the informatics revolution now confronts them. While *they* start from a position of comparative disadvantage, there is much they can do to overcome this and, at least in some respects, to develop certain comparative advantages of their own within the industry. Each country will, of course, strive to obtain as much as it can of indigenous manufacturing capacity and to control both the inflow and outflow of information. Their policies in these areas will have to be carefully balanced to ensure that they do not impair their ability to obtain the principal benefits available to them from the employment of the best information technologies in the various sectors of their economy to which these technologies can make a significant contribution. There is a potential policy trap in this dilemma for even the largest developing countries, as few countries in either the developing or the industrialized world are in a position

to enforce highly nationalistic information policies without severe costs to their own capacity to remain competitive.

One area in which the informatics revolution is likely to have a profound impact on developing countries is in the development of their human resources. This is also the area in which there is a potential for them to develop competitive equality with industrialized countries and perhaps, in some cases, comparative advantage. The informatics revolution requires a quantum change in each country's educational and training systems; and, paradoxically, it also helps to facilitate these changes. The changing structure and patterns of employment within the various sectors of the economy produce the need for people with skills that are often very different from the traditional skills required in the industries concerned. The trend will be toward a relatively greater role for people with the kind of skills that require more education and training, with a proportionately diminishing role for unskilled labor. Of course, not all the new skills required will be at a highly sophisticated level; many will require only relatively short periods of specialized vocational-type training, to be supplemented by on-the-job experience.

The difficulties which the developing Fountries will have to -surmount in accommodating to, and benefitting from, these challenges are formidable indeed, but not insurmountable. Nevertheless, it will take exceptional measures on their part if they are to avoid or mitigate the new generation of comparative disadvantage they face and to take advantage of the new opportunities the informatics revolution can make available to them. A *primary need, and* an *urgent one, is to ensure that developing countries have full* access *to knowledge of the rapid changes taking place in information technologies and their applications so that they may develop the capacity to evaluate the implications of these changes,* both positive and negative. Beyond this, they will need access to the best possible support for *their* own efforts to develop the policies, programs and measures which will enable them to realize the benefits and minimize the risks of the informatics revolution.

It is against this background that the North South Roundtable, in cooperation with the Government of The Netherlands and the UNDP Development Study Programme, held a consultative meeting in Scheveningen in September 1955. The meeting was designed to assemble the best available information, analyses and opinions concerning the informatics revolution as it affects the developing countries and their relation to the industrialized nations. The main focus of the meeting was on the problems and opportunities confronting the developing countries, particularly in respect of human resource

development priorities and policies, as a result of the rapid changes in computer and telecommunications technologies and their applications to an increasingly broad range of development and development-related activities.

The participants agreed that the informatics revolution had such profound implications for the future development of the South and for the evolving relationships between the North and the South that a full exploration of all the policy implications will require a continued process of dialogue. In this context, the first meeting could only be regarded as a beginning, where preliminary diagnosis was undertaken and key issues identified for further analysis. The North South Roundtable intends to carry on this process of study and discussion on this issue by organizing a series of meetings.

I would like to record my grateful thanks to the government of The Netherlands for hosting and providing financial support for the first meeting; to the DNDP Development Study Programme for cosponsoring the meeting; and to the participants for contributing to this dialogue, with special thanks to those viho submitted written contributions. A volume like this would not have materialized but for the help of the authors of these excellent papers. I also want to commend our Executive Director, Mrs. Khadija Haq, for her characteristically superb job of editing this report, and the work of the publications staff of the North South Roundtable Secretariat in Islamabad for doing a fine job of putting this volume together.

Finally, on behalf of all participants, I want to express our special gratitude to His Royal Highness Prince Claus of The Netherlands, a member of the Honorary Board of the North South Roundtable, for his important contribution to the success of the meeting through his inaugural address and his participation in the dialogue.

New York Maurice F. Strong
May 1986 Chairman, NSRT

OPENING ADDRESS
By
HRH Prince Claus of The Netherlands

I am delighted to welcome you all here to the SID North South Roundtable Conference, the first to be held in The Netherlands. Our small country is comparatively advanced in at least some areas forming the theme of your conference. We have, of course, what we call "a light bulb factory" in, the south of the country. But there are other institutions, such as the prestigious International Training. Centre for Aerial Surveys and our technical universities, which also play an important part in our technology-oriented relations with developing countries.

Some months ago, at the SID World Conference in Rome, I urged that we move toward a pluralistic but united world and that we thereby abandon the North-South concept, which seems to have outlived its usefulness. This ideal is not about to be realised tomorrow. The old divisions still exist, and indeed in some respects it is no exaggeration to speak of a benign neglect of the South. With the three dominant "northern" blocs - Japan being one - embroiled in major trade conflicts, it sometimes looks as if the South- the developing world-has been forgotten, or its interests neglected. To quote an African proverb, "Where elephants battle, no grass will grow." But there are also more hopeful, positive aspects. New forms of development are cutting across the old dividing lines. South-South cooperation is growing, and its potential is perceived more clearly. Slowly but surely, we are moving in the direction of a greater under standing and appreciation of the cultural differences between nations. The disparity between the need to move away from the North South division and the fact that we still have a long way to go before this can be achieved is also apparent in the wide sphere of new tech nical developments. On the one hand, both North and South are at once developing and developed. There is a development gap in northern countries too, where the gulf between those who develop and control new technologies and those who must come to terms with this, or lust undergo the consequences, is growing *ever* wider. New technologies largely originate in highly industrialized countries, Though this sometimes creates more scope far developing countries, particularly in markets *for* traditionally mass-manufactured products, it may also have the effect of generating new dependencies or strengthening those already in existence, thus eroding the comparative advantage derived by developing countries from

their relatively cheap labour and local supplies of raw materials.
The same is true of new information technologies. Here, too, there is an evident danger of greater dependency. But at the same time, these technologies open up new possibilities for developing countries, such as bringing the benefits of education, health care, agricultural extension, weather and harvest forecasting, and resource development to hitherto inaccessible regions. In the case of information technologies, there is an additional factor: the rapid, efficient transfer of information has become an indispensable condition for the application of other new technologies. New competitive production processes, new products and new markets make constant demands on information technologies, which are thus frequently a prerequisite for the ability to compete in other markets.This dual function of information technologies means that they pose an even greater challenge - and in some cases, a dilemma - for developing countries.
What can we do? It seems to me that we must aim to put an end to the present situation, in which most of the Third World countries play no more than a marginal part in new technological developments. What is required is a policy for both developed and developing countries aimed at the promotion of new technologies which answer to the letter's specific needs. In particular, integrating the social and cultural advantages of traditional technologies with the efficiency and scope of advanced modem technologies could do much to improve production in traditional communities. Small-scale, decentralized industrialization based on the application of appropriate technologies could bring essential on-the-spot employment to rural areas and make a valuable contribution to the solution of present-day development problems. Such a course will make heavy demands on the available (or not yet available) human resources. The basic document for this conference rightly *refers* to the need for a quantum jump in many countries' training and education systems. In addition to cooperation in the development and application of appropriate technologies, the human resource aspects also offer a promising area for extended South-South cooperation.

CHAPTER 1
New Information Technologies and the Developing Countries
Implications for Human Resource Development

Dieter Ernst

The impact of new information technologies on Third World societies, particularly with regard to human resource development, is still a very much under-researched topic. What we do know, however, is that in practically all of these societies, computers are being introduced into an ever-increasing variety of social activities and that so far, this diffusion occurs in a completely anarchic manner, practically unchecked by any type of viable social control.
In addition, as new generations of computer, communication and control technologies are penetrating even remote comers of the world economy, basic transformations are being imposed on global trading patterns, production structures, capital flows and labour markets.' This is bound to affect the scope for industrialization in developing countries and in particular their involvement in the export of manufactured products and services.
But much more is at stake. In fact, due to the worldwide proliferation of new information technologies, the preconditions for economic and social development in the Third World are undergoing fundamental changes Yet we still have a fairly limited knowledge of

The author has benefited from conversations with Rick Gordon, Ben Harrison, linda Kimball, Dave Noble, Dave dconnor, Ashok Parthasarathi, and Ienny Siegel.

what this implies in concrete terms for different groupings of Third World societies, and what kind of policy options should be pursued. In fact, despite a growing body of publications, both diagnosis and therapy are still based on very unsafe ground?
As for the *diagnosis,* most research so far has focused nearly exclusively, and in an often quite mechanistic manner, on the threat imposed by these developments on Third World exports, particularly of manufactured products. Much less attention has been devoted to issues of at least equal, if not greater importance, i.e., the employment, skill and welfare

implications for developing countries, and the radical restructuring of these societies resulting from the rapid *yet* largely uncontrolled penetration of new information technologies into their economic circuits and social regulation mechanisms.

As for the *therapy,* policy reactions in the Third World have lacked a clear strategic concept. Rather, policy formulation and implementation so far have been characterized by ad hoc improvisation, excessive reductionism and hectic vacillation between often quite contradictory positions. There is no need to be hypnotized by the threat of new information technologies, just as there is no reason to be intoxicated by the glamour of "high technology". Neither fear nor euphoria can be reliable guides for policies to subordinate new information technologies to the requirements of developing countries.

Developing countries must overcome this strategic indecisiveness if they want to avoid falling into the trap of new forms of dependence, whether of a technological, an economic or a political nature. While it is true that, for new information technologies, any attempt to acquire systems knowledge is confronted with very high barriers to entry and risks, this does not legitimate political fatalism. There is no reason to doubt that developing countries are capable of coping with new information technologies and their economic, social and political implications. This requires, however, that both individually and collectively, as part of South-South cooperation arrange ments, they start generating pertinent knowledge and ensure that the knowledge thus acquired is translated into viable development

strategies. In other words, there is an urgent need for developing countries to develop, if possible ex ante, countervailing policies and strategies in this field and to identify and mobilize the social carriers who would be willing to back them up.

More specifically, as a result of recent developments in information technology, developing countries more than ever before need explicit and viable policies of human resource development. We are witnessing today a growing gap between the skills required for production and the skills available in the various segments of the global labour market. In other words, there is a gross imbalance between education and the labour market. This applies in particular to Third World societies. On the other hand, knowledge is widely believed to have become a "strategy resource," the linchpin of global industrial competition and military strength. Small wonder, then, that issues of educational reform and human resource development are given high priority on the agenda of public debate. In fact, without the skilled manpower necessary to absorb, assimilate and apply technology to local conditions and national needs, and without people capable of learning from this experience and of designing and implementing new technology (i.e., innovators), no industrial and technology policy, and for that matter, no development strategy, will succeed. Overcoming the "human resource bottleneck" is of crucial importance for implementing industrialization and development strategies. "It is the experience of the older industrial lands that economic development is what education allows.°'

This has important implications for Third World strategies related to new information technologies. Apart from *upgrading the manufacturing capacity* (defined in a broad sense to include complementary services like design, engineering, testing and maintenance) and *controlling information* flows, which are essential prerequisites for any strategy in this area, *developing human resources* should become a third major strategy focus.

Key Technological Developments

The emergence of a new generation of information technologies would have been impossible without recent developments in microelectronic hardware and software and in complementary interface technologies such as sensor and transmission technologies. In fact, as microprocessors, memories and input-output devices have become increasingly powerful, computer, communication and control technologies, which used to be strictly separated, are being increasingly linked together into integrated information systems. For the first time, the most cmcial yet intangible production inputs, information and knowledge, can be generated, linked together, transformad and communicated practically at random. The key development, then, in terns of technology is the *con vengeance of computer, communication and control technologies.* As a result of this convergence, the scope for the automation of industrial manufacturing and related services has increased tremendously, Take, for instance, new approaches to programmable factory automation like computer-

numerical control of machine tools, industrial robots and flexible manufacturing systems. Similar developments can be discerned for the automation of industrial design (computer-aided de sign systems) and of related support services like engineering, testing and maintenance. In fact, strengthening the control capabilities of individual machines and making them mutually compatible is just one aspect involved. Of much greater importance are the vast new possibilities for linking together and integrating different levels of factory and office automation. It is here that new information technologies are likely to have their most lasting effect. While manufacturing was traditionally geared to achieve savings of labour and capital by sacrificing product-line
flexibility to economies of scale, the new generation of computer. based automation systems will allow companies to reconcile these conflicting objectives and thus open new paths to regaining profitability.

Of even greater importance, however, is that previously separate information flows can be integrated irrespective of spatial boundaries. Consequently, worldwide networks of information are being established, leading to a proliferation of data networks and data communication services. It is in this sense that information technologies are becoming an important vehicle for new rounds of internationalizing industrial manufacturing, Today, the strategic area of attack for new information technologies is the computerization of command, control and communication networks required for global industrial manufacturing so that complexity, rigidity and vulnerability can be reduced and overall efficiency increased. Take, for instance, recent developments in traps-border data flows. It is now technically feasible for multinational corporations to install captive worldwide information networks through which headquarters management can link together production facilities around the world as if they were divisions within one factory. Thus, it has become possible today to *synchronize, on a worldwide scale, decentralized production with a strictly centralized control over strategic assets.* This applies in particular to product design and plant layout, global cash management, logistic coordination and on-time operational control of production and complementary support services, particularly marketing and inventory. At the same time, global information networks open up new possibilities for corporate management to control affiliates around the world, to put them under pressure if need be, and even to force them into a ruthless mutual competition. It is possible, for instance, via radio or satellite, over thousands of miles and within a few seconds to transmit work results, feedback information and figures from any affiliate to graphic displays in a company's headquarters or to competing affiliates.

It is important to note that while, in pure technological terms, vast new possibilities have been opened up for searching, storing, processing and communicating information, only a select group of highly privileged actors has been capable of reaping the full benefits of these technologies. To start with, access to important new information technologies, particularly the generic technologies required for worldwide information networks, is still strictly limited to a few powerful companies, predominantly from the United States, Japan and Western Europe. In addition, there has been a growing gap between the development of the technological potential and the capacity of different actors to make use of it and, even more important, to control it. This applies even to the most privileged actors, i.e., the managers of leading U.S., Japanese and European companies, who so far have realized just a tiny fraction of the vast possibilities for rationalizing production structures and labour processes and redesigning products. However, this applies even more to governments and organized labour.

The gap between what could be achieved with new information technologies and the capacity of social carriers is greatest for governments and labour movements in developing countries. With a few exceptions, developing countries have not been actively involved in the development and diffusion of these technologies, and their capacity to monitor, adapt and redesign them has remained quite weak. The lack of trained people capable of accessing and translating relevant information into operational decisions and of learning from such experience has been by far the most important missing link Take, for instance, the case of China. Here, a wave of microcomputer applications started in 1984 as a result of the present modernization policy. Thousands of foreign-made microcomputers were rushed into the country, and more than $300 million worth of components were imported in 1984, enough to make 100,000 sets of microcomputers. Today, however, as many as half of these micros are lying idle because of a shortage of technical skills and software programmers. According to one observer,"it would take China at least five years to train 100,000 qualified people to *work* on these computers.'" Moreover, China is believed to need more than 20 million qualified

professional workers in the short term in order to implement its modernization strategy - a demanding target in a country with just over 1,4 million tertiary workplaces at present'
Similar examples can be quoted from those developing countries which have started to devise explicit policies on how to deal with the impact of information technology. To take just one example, a report on the recently established Regional Network for Microelectronics in the ECLAC Region (REMLAC), jointly sponsored by UNIDO, SELA and ECLAC, states that one of its main goals would be "to increase the number of circuit designers in each participating country at least fivefold in three years."

New Information Technologies and Global Labour Markets

In order to devise a realistic approach to the development of human resources in the developing countries, what is required first and foremost is to understand the impact of new information technologies on the demand for and the supply of labour. Key aspects include:
a) Implications for employment generation/displacement patterns.
b) The restructuring of occupational hierarchies and newly emerging skill requirements.
c) - Changes in the concept of work and in the identity of those performing it.
d) Changes in the organization of labour processes.
e) The search for new patterns of worldwide sourcing for all types of labour, from unskilled to the scientific, technical and managerial elite.
I) Changes in the prevailing systems of labour control/motivation/participation.
For each of these topics, sound policy advice requires much more in-depth analysis. To start with, the worldwide proliferation of new information technologies, in combination with crisis-induced industrial restructuring, has already imposed fundamental changes on the global demand for and the supply of labour. Apart from the impact on quantitative employment levels and skills which has preoccupied research and policymaking, even more significant transformations have occurred in the contents and social carriers of work and in the organization of labour processes. As traditional forms of mobilizing and regulating the supply of labour have become increasingly dysfunctional, i.e., leading to high-cost and low-productivity labour, the search is on for new forms of labour supply. As a result, we are witnessing today a drastic transformation of key segments of the global labour market. This in turn is bound to have important implications for capital formation, innovation and future rounds of Third World industrialization strategies.
Six basic transfornations of the global labour market would seem to deserve particular attention:
a) The trend toward flexible working time and the growing impor tance of part-time employment.
b) The expansion of informal labour markets, particularly the service and "black" economies, including "sweatshops" for the assembly of electronic components onto printed circuit boards. c) New forms of segmenting and decentralizing the labour process (telecommuting, worldwide subcontracting, global networks of satellite design centres).
d) New methods for employing the productive potential of women's labour by means of integrating the homework economy and of "Industrializing" the family.
e) New forms of automating scientific, technical and managenial tasks: for instance, new approaches to design and engi neering automation (CAD and CAE), to computer-aided pro duction planning and scheduling (CAP) and to computer integrated manufacturing systems (CM).
fl New forts of worldwide sourcing for all types of labour, from unskilled to the scientific, technical and managerial elite.
While each of these labour markets has its quite independent history and its specific dynamics, they interact closely and thus should be considered part and parcel of an ongoing process of transforming the social and spatial division of labour of industrial manufacturing. In fact, all these different labour market segments are increasingly connected on a global scale into a single integrated circuit. This does not imply that expectations of a worldwide homogenization of the labour market are likely to come true. On the contrary, heterogeneity, segmentation and

hierarchization are the rules of the game. What it does imply, however, is that wages, working conditions and power relations in any of the existing labour market segments are conditioned by and interact with those prevailing in labour market segments of a seemingly quite different nature.

This has important implications. in particular, it implies that workers permanently employed in the production lines of large companies in the U.&, Western Europe and Japan are confronted today with new and increasingly rough forms of worldwide employment competition. The result has been a worldwide heavy downward pressure on wages and social security for workers within the formal economy both in the industrialized countries and in some growth poles of the Third World. In other words, the internationalization of global labour markets is making it more and more difficult to maintain full employment at a wage level which generates incomes sufficiently high to sustain demand.

On the other hand, however, the aforementioned structural transformations of global labour markets do make a lot of sense from the perspective of corporate management. Quite apart from their advantages in terms of cost reduction, labour market flexibilization and containment of organized labour, they allow employers to select or reject particular pools of labour for specific types of work and to optimize the precise mix of worker qualities for different types of work at different locations. In other words, selective worldwide sourcing for labour has become much more feasible today in key industrial sectors like the automobile or the electronics industries.

Take, as an example, part-time employment in the electronics industry. Increasingly, electronics firms rely on a pool of surplus workers paid only for the work they are required to do as casual stop-gap labour. In the semiconductor industry, for instance, due to its extreme feast-or-famine nature, part-time workers are an essential *buffer* against the vicissitudes of business cycles and structural crisis. In the U.S., it is "Silicon Valley," the heartland of high-tech electronics, which maintains the highest concentration of temporary workers among its labour force (a ratio of 1:60 compared with a national ratio of 1:200). Large U.S. semiconductor firms in the same region typically hire 10 to 15 *per* cent of their production labour force from temporary labour agencies.° And Siemens, a leading European electronics firm, reports that for its new state-of-the-art plant in Augsburg (producing personal computers and terminals), 389 out of a total of 4,750 employees are part-time workers, i.e., 8.2 per cent.' Such developments, however, are not restricted to the OECD region. Similar patterns are appearing in the workforces engaged in electronics manufacturing in the Third World, particularly
in Southeast Asia.

Technical innovation did play an important role in the transformation of global labour markets. With the advent, for instance, of computer-based automation and communication technologes, materials, product design and labour processes present fewer barriers to a readjustment of production methods and to new forms to worldwide sourcing for labour and capital. Important spatial, material and organizational constraints to a worldwide decentralization of industrial manufacturing have been reduced, and management can respond much better to the incessant pressure to rationalize production structures and labour markets. On the other hand, however, technology has *never* been the predominant, let alone the exclusive, cause for the aforementioned structural transformations. Economic, social and political constraints resulting from the present economic crisis condition their scope, and technology can only reinvigorate and facilitate these developments.

Further, it is certainly misleading to expect that as a result of new information technologies, industrial work will invariably be characterized by high skill requirements and high-tech equipment. In fact, attempts to assess the overall outcome of automation for skill requirements have turned out to be quite tricky. For instance, it is important to distinguish the impact of automation upon the skill requirements of jobs *from* its impact upon the skill histories of the workers performing these jobs. Probably the most widespread automation strategy consists of training up less-experienced workers to a deskilled computerized job. This allows firms to "downwage" the work itself without deskilling it. It is important to understand this *strategy,* as it allows management to establish coalitions with at least some important segments of the workforce who are willing to back up the introduction of new automation technologies.

What really matters is the ever-increasing variety of labour market segmentation, with each segment requiring a diverse range of skills. For workers with secure jobs and on good terms and conditions, the so-called "core *workers,"* the stress on training and periodic skill

upgrading has rapidly increased. A completely different logic applies, however, to those who have been squeezed out of the formal labour market or who have never been able to get into it, i.e., the growing number of workers on temporary contracts, working part-time, self-employed or employed by subcontractors. For them, the systematic deskilling of jobs means that training is becoming much less important, and their capacity to upgrade their skills is likely to erode over time.

Take, for instance, recent developments in the semiconductor industry. Here, the extremely short product life cycles and the consequent rush to be early in the market for a new product imply that learning curves (i.e., the time it takes to achieve maximum productivity) cannot be long. Management, therefore, constantly seeks to simplify the remaining manual tasks, particularly in materials handling and assembly, as a way of hastening training and minimizing mistakes and defects. In fact, skill requirements for those operators who have not yet been forced out of the factories by and large seem to decline rather than to increase. For instance, while it normally took about three months for a worker to become competent at manual bonding, today, with automatic bonding equipment, it takes only two weeks to train a machine operator.' °

The Development of Human Resources - A Priority Area

Basic Prerequisites

In order to assess the chances of success of different approaches to human resource development, it is imperative for developing countries to monitor cases of success and failure of major GELD countries' attempts to devise viable policies in this field. Such a comparative analysis would help to improve our understanding of the often quite substantial difficulties involved in terms of costs, organizational inertia and social and political resistance. In fact, available studies, at least for the U.S. and the FRG, show that barriers to the implementation of viable human resource development strategies are formidable indeed.' In the light of these experiences, it might be useful to reconsider carefully the costs involved in the "provision of the necessary educational and. training facilities needed to enable people to acquire new skills."[2] As long as we talk about trah»ng for particular highly specialized skills (e.g., circuit design), costs may be fairly low indeed. Specialist training, however, is only a minor part of the overall educational and training activities required for upgrading the labour force to meet the challenge of the new information technologies.

A second prerequisite would be an assessment of the educational and training systems existing today in the Third World. With a few exceptions, these systems so far have been incapable of preparing people to meet the requirements of their societies. Mass learning has been neglected for the most part, and most resources have gone to third-level education catering to the children of the elite. While some of these institutions have achieved excellence in a number of areas, most of them have become "factories producing more educated unemployed"" or have led to large-scale skill emigration. In the context of such educational systems, an excessive focus on narrow specialization might even further intensify these deformations.

Goals

In most Third World societies, stagnation and the frantic search for survival strategies set the stage for development planning. "To plan is to choose. In our case, we are forced to choose between necessary action, not all at once.."[10] This implies that, before anything else, a first step must be to establish a hierarchy of goals to be achieved by the educational and training systems.

Let us assume that the overriding concern of human resource development would be to improve the capacity both of individuals and social entities to adjust adequately to a changing world. This would imply the following basic goals.

a) Eliminating "outright" or "functional" illiteracy.

b) Augmenting basic skills in reading, writing and mathematics. c) Improving general teaching capabilities.

d) Generating learning capabilities, both individual and collective,
on as many levels of society as possible.

Secondary goals would then be goals for specific areas of great strategic importance - which, however, can be realized only if sufficient progress has been achieved toward the basic

goals. In addition, outlays on secondary goals, however necessary, have to be assessed in terms of their opportunity costs, i.e, the resources foregone which could have been spent toward achieving primary goals.
While the concept of a hierarchy of goals can be useful as a heuristic device, it should by no means be used in a rigid manner. In fact, under specific conditions, it might well become necessary, if not outright unavoidable, to focus on particular secondary rather than on primary goals in order to further the progress of a society. But then, this has to be spelled out clearly, and the social costs, including the hidden ones, have to be made explicit.

Guidelines

No "Quick-Fix" Solutions

"Quick-fix" solutions are out of the question even for privileged actors like South Korea, India, Brazil and Singapore. What is really required is the fundamental transformation of existing educa*tional and training systems, which is bound to be a time-consuming process. Only in this context will looking for immediate "minimumrisk steps" have sufficient chances of success.*

No Reductionist Concepts of Skill Formation

It is absolutely necessary to avoid two varieties of such reductionsim, i.e., the *deskilling stereotype* and the *skill-upgrading stereotype.* The *deskilling stereotype"* postulates that the embodiment of human functions in computer-based technology marginalizes the worker, reduces his/her decision-making and control functions as well as physical effort, changes the distribution of tasks (eliminating some and simplifying others), decreases the knowledge and skill required of the *worker,* and intensifies *worker* dissatisfaction and alienation. Computer-based automation is perceived as Taylorism with a new face. In the long term, workers are expected to be displaced from the production process altogether. The proposed strategy is to prevent or at least to slow down consider ably the introduction of new technology. Experience in the OECD region shows that such a strategic concept, however well-intentioned it may be, is bound to fail, as it simply lacks a sufficiently large social base.'"
The *skill-upgrading stereotype"* asserts that new information technologies *free workers* from machine rhythms, and that the replacement of muscular strength by attentiveness and symbol manipulation necessitates higher levels of skill and responsibility,
increases decision-making abilities and enhances worker satisfaction. It is acknowledged that this will reduce job opportunities, particularly for the young, unskilled labour market entrant, for workers in traditional industries and for women seeking work without the appropriate educational or skill qualifications. The therapy proposed tends to create a new fetish, i.e., retraining, which is expected to enable displaced workers to move into expanding information jobs.
While both stereotypes capture some aspects of reality, they are unable to provide a coherent explanation of the impact of new information technologies upon skill requirements. Thus, they are hardly a reliable guide for policy advice.

No Technological Determinism

Changes in skills, tasks and the qualitative nature of work are cannot be simply read off from the technical attributes and operanditioned of by a onsomic,fsocaliand po tical than by are more same infornlatbon technical constraints requirements can differ nquite es bstantiallY What technology, really matters are the prevailing modes of organizing work and production and how they are reflected in the rateg;es of buts to the man agement and labour. It is these social and es which largely to the introduction of new information technolog computer system does not lion the precise mix of skill requirements..
After all, the me rref mbedded in quite different occur in a vacuum. Computers organizational contexts, and human involvement is still required on a fairly large scale. Various forms of human involvement have in fact been crucial for whether or not computers work, and to what degree they come close to the original expectations of their designers. It would beaimpossible, fuloif designed the diverse skills required forts operation, It has been maintenance and continuous cuter operations depend upon human shown that even routine comp computer into judgements. The need invariably to integration of the comp ng or deficiencies means that the very work involves human acts of considerable ingenuity 1B resources In the final analysis, the distribution of

Computing the patterns and automated equipment depends to a large degree distribution of of conflict and cooperation -nnirntother dwords, "the costs and power within an organi productivity benefits, as well as the broader of computer-based technologies are deity and not only work, I dependent, on the technical change inflows` the which cation of the systems but on the social airanB they operate The Changing Nature of Skill Requirements It can be safely assumed that an expansion of skillss concerned with the manipulation of the physical world is bound to be an

essential element of any strategy of human resource development. Scientific and engineering capabilities will become more widespread and receive more cultural prominence. The need for some level of technical qualification as part of normal employment requirements

will magnify as computer-based automation is applied to a growing number of industrial manufacturing and complementary service activities. Such technical qualifications include minimal standards of computer literacy, which in fact are becoming a basic prerequisite for individual interaction with society .However, the mere provision of specialized technical skills alone is quite insufficient to resolve the problems of computer-based automation and communication technologies. After all, highly specialized forms of skill are becoming more and more outdated, and the ability of existing educational and training institutions to replenish them rapidly has obviously declined.

In addition, as a result of computer-based automation, a worker's mastery of a specific set of tasks within precisely defined job roles is becoming less important than his/her ability to integrate individual activities within the flow of the production process as a whole. In other words, skills are increasingly defined by a worker's ability to apply a constantly changing technology to operations, products and circumstances which themselves are constantly in flux. This is a reflection of the fact that computer-integrated production systems, in contrast to the expectations of their designers, are governed not by cybernetic feedback and regulation but by contingency, not by automatic internal mechanisms but by their uncertain relations with real world occurrences.[30] Consequently, workers do not intervene only in exceptional cases; rather, the normal operation of automated production requires constant worker analysis and judgement regarding specific system characteristics, states and modifications .In order not to impede this adaptability, technical knowledge must be combined with improved learning skills, aptitudes for social interaction and organizational innovation, and an understanding of the social bases of technical systems.

Limits to an Instnunentalization of Education

Educational and training institutions help produce cognitive and vocational skills, as well as behavioural patterns, for the workplace, and educational achievement is a powerful determinant of occupational and social mobility. This inherently instrumental component of education should not, however, be carried too far, because the educational system might lose its capacity to contribute to economic and social development. Prevailing modes of instnrmentalizing educational systems are quite biased. They usually rely on four propositions:

a) Education must serve the requirements of the economy. b) The economy must improve in international competitiveness.

c) International competitiveness can be improved only by means of "high technology:"

d) "High technology" is equated with the introduction of new machinery, which requires changes in the behaviour and knowledge of people.

Nowhere has this instrumentalization of education been carried further than in the United States. However, its results have hardly been convincing. According to recent studies by the National Science Foundation and the American Electronics Association," there has been a significant decline in the capacity for both research and teaching, and this is unlikely to be a transitional phenomenon.

The problems involved are even more fundamental. According

¡ to observers from the Harvard Graduate School of Education, "the dominant American approach [to education] has emphasized logicalmathematical knowledge and skills, and a problem-solving approach to teaching-learning. Is this the best approach for the rest of the world? Is it even the best approach for the United States? "[3]

The Basic Choice

In the final analysis is, the search for viable strategies of human resource development implies a basic choice between the self-defeating technocratizationn of society and the social organization of technology. The goals of commercial and technical success, let alone economic and social development, will best be served by combining cultural learning and technical skill within an education consciously oriented toward the democratic social control of technological change.

Areas for Immediate Action

There is a basic dilemma involved in all policies aiming at upgrading human resources in the context of rapidd technological change: while there is an increasing pressure to proceed fast in order "not to miss the train," the tremendous risks involved require a careful procedure in order to minimize the chances of failure.

Nowhere is this dilemma more pronounced than in developing countries, where stagnation and the frantic search for survival strategies have drastically reduced the resources which can be spent on any type of long-term capacity-building. Still, there are always steps which can be taken immediately, without much risk. The following would seem to deserve particular attention:

a) Build up sufficient technology monitoring and assessment capabilities.

b) Focus on the development of software engineering capabilities. c) Focus on developing design capability on all levels, from system to circuit design.

d) Complement specialized skill training with courses providing basic education on the social, economic and political implications of new information technologies.

Conclusions

There is a need to reassess the policies pursued in a great number of developing countries to promote foreign investment in so-called "high-technology" industries, particularly those related to new information technologies, through a variety of tax incentives and policies to reduce overhead costs (infrastructure, labour and environmental regulations). In fact, driven by the need to service a foreign debt that has become unmanageable, an increasing number of developing countries, particularly the so-called newly industrializing countries (NICs), seem to be ready, very discreetly, to become more pliable in enforcing restrictions on foreign investment.

Such a return to the status quo ante of "open door"policies is unlikely to work, however. First, incentives alone would not be suffident to redirect global investment decisions of leading U.S., Japanese and European companies. Second, the recent rush of countries like the U.S., Belgium and the 0.K. into the most extreme form of foreign investment promotion, i.e., the establishment of "export processing zones" and "science parks," indicates that the global race for industrial investment has reached a new stage where even the most powerful Third World countries might fmd it increasingly difficult to compete.

Rather than relying on defensive and purely reactive approaches to foreign investment, developing countries must proceed to much more $ag_{gr}e_{ss}iv_e$ and forward-looking strategies and tactics. There is ample scope for designing and implementing active policies of technology acquisition if only developing countries would strive to understand much better the strategies and tactics of major U.S., Japanese and European firms and the patterns of conflict and cooperation prevailing between them."

Take, *for* instance, access to technology. Despite recent progress achieved in technology exports from developing countries, private firms based in major OECD countries are still by far the dominant source of technology required for industrial production in developing countries. What matters, however, is that for tech nology-exporting firms, the international transfer of technology has become a double-edged sword. This would apply irrespective of the size and the country origin of the company involved. In fact, these companies are confronted with a basic dilemma.

On the one hand, they are under increasing pressure to expand the worldwide proliferation of their technologies in order to extend the life cycles of these technologies, to penetrate or at least retain increasingly protected markets and to spread the excessive cost burden of research and development. A growing share of these technology exports will have to go to developing countries, as both investment and consumption in practically all major OECD

countries are unlikely to regain their past dynamism and as an increasingly pervasive protectionism surrounds these economies.
On the other hand, however, the process of transferring and disseminating technology, once started, is increasingly eroding the capacity of these very firms, including the most powerful multinational corporations, to control this technology, i.e., to remain in a position of technological dominance. Consequently, these companies are forced to develop ever-new methods to protect and secure their effective control over key technologies and innovative capacities and thus to rely on an increasingly tough technological protectionism. It is important to note that in a period of crisis, the capacity of most firms to handle this dilemma is likely to be considerably weakened.
Viewed from a Third World perspective, this situation has important strategy implications. Both governments and companies from developing countries should strive to understand the new constraints and contradictions inherent in the prevailing concepts of global technology management in order to exploit them *for* their own purposes. In other words, Third World governments, regional organizations and private firms should utilize much more systematically the increasing reliance of U.S., Japanese and European companies on technology exports as a key variable for devising and implementing viable strategies for acquiring new information technologies.
It is in this context that policies of human resource development have a crucial role to play. Any developing country attempt to apply new information technologies to agriculture, industry or the exploration, exploitation and use of natural resources is bound to fail as long as there is insufficient capacity for monitoring, assessing, acquiring, maintaining, adapting and redesigning such technologies. Improved learning and innovative capacities, both for individuals and social groups, are a basic prerequisite *for any* strategy to subordinate informatics to the requirements of Third World societies.

CHAPTER 2

From a Supply-Based informatics to a Needs-Based Informatics

J.F. Soupizet

As one of its activities, the Intergovernmental Bureau for Informatics has been searching for the answer to the following question: how can informatics be a factor in development? From this derive a number of allied questions relating to technological conditions and the physical, economic and social informatics environment.

Work has been undertaken in three directions:

a) Conducting research into national informatics strategies and policies, better known under the acronym SPIN, which was the name of the intergovernmental conference convened jointly by IBI and UNESCO in Torremolinos in 1978.
b) Adopting a regional approach in which informatics is both the subject and the object. It is the object insofar as the minimum conditions for any endogenous informatics activity can be created only through entente and complementarily policies. It is the subject insofar as the many types of changes brought about by informatics may fall within a common framework.
c) Taking a sectoral approach to identify the relevance of informatics solutions to development in terms of application sectors.
One of the cornerstones of this "edifice" is the report which was recently produced by the International Futuribles Association, commissioned and financed by the European Community and IBI following joint consultation. This paper contains some of the findings set out in this report, which is an original research programme having a very definite scope. It took eighteen months of work, with the cooperation of many people, and was completed in three phases: a bibliographic phase, field case studies and a summary of all the data collected.

The Facts: Complex Trends

The situation can be summarized by the following remarks:
a) Informatics in the developing countries is not a recent event. In most of these countries,

the first computer was installed at the beginning of the 1960s. With rare exceptions, it was based on equipment designed and produced by industrialized countries.

b) Informatics in developing countries accounts for less than 6 per cent of the world total, and its distribution varies greatly from one developing country to another.

c) Informatization has been characterized by an approach based on means rather than on needs: this is a market dominated by supply. Thus, its development has been partly financed by manufacturers (leasing procedures), and the very introduction of machines has challenged the preexisting organizations.

d) Informatics systems, which were mainly introduced as an administrative tool, are still essentially dedicated to this type of activity. The development of data collection and processing systems to be used for economic decision-making purposes is a rarity. Local economic data production does not measure up to informatization objectives, while this data on the developing countries is available in the documentation centres of industrialized countries.

Few applications have been designed for other fields considered to be priority areas - agriculture, health, education, etc.

e) The architecture of the informatics systems used has always been and still is highly centralized, involving complex organizational methods in a difficult technological environment (electricity, air conditioning, very highly skilled personnel) that takes a long time to create.

f) The public and semi-public sectors are the largest users of informatics systems organized around large centres, almost all of which are installed in the large metropolises.

g) Rational informatization plans, which did not exist when the first hardware was originally installed, have been drafted by very few countries so far. The political will to appropriate and control informatics technology has been clearly shown only in recent years. On the other hand, most Third World leaders today affirm their desire to implement an informatization policy.

h) Bilateral cooperation occurred mainly with the former colonial powers, which have always played and continue to play a leading role in informatics studies, systems choice, funding, implementation and training through their own research facilities, manufacturers and experts, which they make available to the developing countries. Multinational cooperation and international organizations (mainly IBI and UNESCO) have played a major role through their support for their member governments' informatization efforts, particularly in fostering national and regional informatization policies.

Cooperation between the developing countries on concrete infonnatization projects is still very limited.

Case Studies: The Obstacles

It seems quite logical, a posteriori, that the introduction of data processing technology requiring greater accuracy has often shown up the weaknesses in the organization that existed previously.

While the obstacles in the developed countries were originally due to a reluctance to introduce technologies that threatened the established structures, in the developing countries the main obstacle to informatics seems to be the context into which it has to be inserted. The raw data it is required to process is of questionable quality, and it is not collected on a regular basis; the ramifications the information system ought to have in order to be able to "irrigate" the services and individuals concerned are atrophied. Then, there is the question of democratic access to information: the installation of terminals and accessing procedures might seem more appropriate fot keeping secrets rather than for spreading information.

One has to draw a comparison with the situation in the developed countries. The informatics age, which is drawing to its close, has been dominated by the controversy between end-users and informatics specialists. Part of the trouble has been due to the approach adopted for the implementation of informatics projects. Resources and skills were mobilized to cope with the data processing technology itself, whereas the crux of the problem was to design a realistic and effective information system. The spread of analysis methods, the development of technical possibilities, the didactic character of projects and the improved knowledge of the possibilities offered by informatics have subsequently made it possible to overcome these problems.

There are two original facets to the informatics experience of the developing countries which are worth mentioning: the features of the informatics products market and the context. The market is conditioned by supply, to the extent that market growth has largely been financed by the manufacturers as a result of equipment leasing. Until recently, the selection of hardware available in developing countries was small in comparison to that available in the developed countries. The narrowness of the market, compounded by high prices and the environmental requirements, plus the weight of maintenance constraints, explained this state of affairs and led to two consequences: the attitude was mainly use-oriented, and the equipment was supplied without making an attempt to adapt it to the conditions under which it would be used.

In addition to this, there is another difficulty, typical of development. One of the key factors in modern economies is interdependence and the increasing overlapping of activities. The corollary to this is an increase in the exchange of information. Now, one of the main features in the developing countries is the importance of sectors of activity in which there is very little interdependence, and the chronic coordination and intersectoral exchange difficulties. It is this context which very often hampers the success of informatics in its use for carrying out repetitive tasks in watertight administrative units (e.g., payroll or cash flow accounting applications) and makes informatics ineffective when implementing synthetic information systems.

Encouraging Outlook

The coming years are likely to be encouraging, however, for a number of reasons: the existence of more and better trained manpower in virtually every country; the change in available material as a result of new technological possibilities; and the new attitude to appropriating technologies which is emerging, along with the political awareness of what is at stake in the area of information technologies.

The first point needs to be emphasized. Even though there are not enough technicians to meet the needs, and the educational effort still has to be improved and stepped up, there is now a significant potential pool of skills and expertise in the developing countries.

The second aspect relates to the transformation of the hardware, and particularly to microinformatics and communications, which is a development that augurs very favourably for applications in the developing countries. Ease of implementation, the operating conditions and the level of investment required bring this tool within reach of small communities and individuals. A more broadly accessible, flexible informatics is therefore emerging, which is opening up new prospects in terms of the socio-economic aspects and the development of human potential.

The third aspect has to do with the importance that is attributed to information, and hence the importance of information technologies. The 1980s have been marked by the acknowledgement of the importance of strategies and policies in this field. More recently, a new development has been taking place: whereas the main concern used to be to make the best use of costly technological investments, nowadays, the increasing tendency is to try to set up a dynamic and job-creating national informatics sector. Yesterday, Brazil, Cuba and Algeria were pioneers. Madagascar, the Congo and Morocco have recently signed industrial agreements, and many governments are currently conducting negotiations along these lines.

These developments have largely been decided upon with economic development in mind: the informatics sector (comprising both goods and services) has performed so well that many leaders are already envisaging laying the basis for a national activity. Furthermore, these developments are leading to a regional regrouping of countries, and this is indispensable if economic areas are to be created that will be able to support investments in a field which, despite appearances, is very muck akin to heavy industry.

Regional movements are now being created along these lines: the Club of Cali in Latin America, created under the patronage of President Betancur, and the Group of Yamoussoukro in Africa, under the authority of President Houphouet-Boigny.

At a more technical level, federations for technicians and organizations are increasing in number.

Informatics for Fundamental Problems

What has been done so far has abundantly demonstrated how little informatics is being

used in the developing countries. It is mostly confined to the administrative field in the strict sense of the term, excluding planning or decision making.
Without wishing to criticize this, it would nevertheless seem that the multiplication of technological opportunities calls for a preliminary investigation of the priority areas. A more flexible informatics should be chosen, and this means that its use must be planned taking into account a *hierarchy* of needs.
In this regard, the work conducted so far has provided an original insight compared with the procedures used in the past to design informatics projects, in that the fundamental needs have been spelled out and synthesized.
The study proposes the following basic needs areas for consideration:
a) Health: Epidemiology, medical care, hygiene, health management, pharmacopoeia.
b) Food: Agriculture, farm equipment, food, agricultural research. c) Education: Vocational training, apprenticeship, schooling, literacy.
d) Communications: Transport, press, information distribution, economic data gathering, documentation.
e) Basic *resource use:* Extraction industries, manufacturing industries, water, energy.
f) Control of development: Surveys, processing industries, research and development.
g) Public adminsitration: Public and semi-public services, banking. Proposals have been made for each field. Let us take education,
by *way* of example.

Education

An informatics programmed for education in developing countries would have the following objectives:
a) To help create and manage *centres for the development of teaching aids* (books, manuals, audiovisuals) incorporating both the latest technological developments (voice technologies, word processing, machine translation, CAI) and the socio-cultural features of the country concerned (languages, oral tradition, indigenous knowhow, etc.). In areas with a certain degree of linguistic unity, such as Latin America, these centres could take on a regional character. In areas that do not have this unity, such as Africa, the centres should work directly in the languages proposed by the countries concerned.
b) To promote and provide aid in implementing a sufficient number of *regional centres for the training of informatics specialists* in the categories required, incorporating the latest technological developments into the programmes. The African Institute of Informatics (IAI) in Libreville offers a concrete example of what could be done. These regional centres should also be documentation and research centres, able to direct training to meet the needs and help member countries to organize their own research and actualize these new potentialities. Training requires a comprehensive approach, integrating applied research, the innovative potential (practices and realities of the professional environment) and a system of posttraining assessment to ensure that human resources are put to judicious and efficient use.
At the same time, the curricula for other specialists (agronomists, planners, economists, demographers, statisticians, financiers, administrators, organizers) must be revised by incorporating a section on informatics technologies. These specialists need to be given the "dose" of informatics technologies they need to enable them to up-
grade their knowledge and their innovative potential, as calling on another technician might well slow down their output. It should be possible to link up a certain level of skill with the definition of requirements and the corresponding informatics achievements.
In this framework, one can easily see that the informatics professions and trades will also undergo structural and qualitative changes.
c) To foster the *mechanisms for the social appropriation of informatics* through professional and inter-professional groups, chambers of trade and amateur clubs (informatics professional associations, microinformatics clubs, users associations at both the national and regional levels). These actions will foster the spread of an informatics culture. Today, informatization seems inevitable: the basic problem is not so much whether or not to informatize, but how to organize and master this technology.
d) To provide material and financial *support for other training activities* in the shape of workshops, seminars, mobile regional universities offering high-level informatics courses for professionals and researchers on advanced themes or matters of common interest.

e) To help set up and run *regional research/development centres* to adapt hardware and software to the socio-cultural environment of the developing countries, including the study of keyboards and printers using the developing countries' own alphabets (Arabic, African languages, for example), translating certain informatics languages into the developing countries' own languages, and translating software.

Informatics and Development Cooperation

It is not a question of selecting "sound projects," but of thinking about all development aid strategies, including informatics. The economic crisis has revived national egotism and has helped to bring out a number of relations that were implicit in the past. Traditional cooperation lids partly had its day; its budgets, its structures and, to a certain extent, its principles are all being challenged.

The time has now come to rethink this cooperation, putting it in clearer perspective. Professor Bemasconi, the Director General of the Intergovernmental Bureau for Informatics, opened the CALAI meeting with the following words: The age of cooperation characterized by an exchange between a generous donor and a thankful recipient has ended_ We have to find ways to harmonize the longterm interests in a context within which each partner will truly benefit."'

Informatics offers this possibility precisely because of its development prospects. It would be unthinkable to embark on a process of this kind in areas where the markets are stagnating, or where there are long-standing commercial antagonisms.

The potential informatics market in the developing countries may evolve in different directions. There is no doubt that if informatics is mastered, general interest could lead it toward a strong market growth. That can only be done with technological and comthercial sharing and with regional cooperation.

Technological and Commercial *Sharing*

The chain *from* silicon to end-user is long, and it is certainly impossible to move the fulcrum so that all countries can see-saw in the production sphere, but it is possible to bring pressure to bear on the level of sharing to foster a more active attitude on the part of the developing countries.

The microinformatics and informatics services cost structures are such that a considerable share of the value added of these activities could be transferred to the users' regions. For example, *a survey* carried out in 1980 by IFCI' at the request of 181 estimated, apart from the study costs and the development of the components purchased at market price, the transferable part (assembly, maintenance, marketing and services) of the final cost at 60 to 70 percent.

Even though these transfers do not represent immediately profitable industrial operations, they nevertheless establish the skills and create new knowledge which in turn will be a determinant in the creation and development of the software industry.

Moreover, only an active informatics sector in the developing countries will create the conditions for a solvent demand vis-a-vis activities in the northern countries-

Regional Cooperation

Two important groups have emerged over the past *few* months: the Latin American movement, of which the establishment in Colombia *of* the Club of Cah in May 1984 is an example, and *more* recently, the creation of the Group of Yamoussoukro in the Ivory Coast in March 1985.

Each of these groups sees informatics as a means of strengthening regional cooperation, not to say integration, by setting up common information structures. Both of them aim at creating economic areas where the appropriation of informatics can become a reality.

Notes

I. Opening address to the Conference of Latin American Informatics Authorities, Rio de Janeiro, November 1982.

2. institut de Formation et de Conseil, Grenoble University.

CHAPTER 3'
The Informatics Revolution and Developing Countries

Efrain Friedmann

It boggles the mind to try to sort out the full consequences of the scientific and technological developments which have been taking place with accelerating speed during the last two centuries. If this is a complex undertaking when applied to the analysis of the most advanced societies, the problem becomes even worse when the effort is centered on the less-developed countries. *Here,* events and changes are not occurring in an orderly sequence and extending themselves in broad, encompassing layers *over* most of their social constituents before moving from one stage to the next. In the less-developed world, all processes are telescoped in such a way that their impact assumes the violence of shock waves: one stage arrives before the previous one has been internalized, and society is a tense and explosive mixture of the modem, the primitive and the in-between. Most LIICs are currently trying to deal with the agricultural, the industrial and the information revolutions at a time when the industrialized countries have to deal only with the latter.

While this might appear to make their development task more difficult, it is also possible that if intelligent use is made of the most recent developments in both telecommunications and microelectronics, it may become easier to modernize LDC societies and diminish the distance between them and the most advanced countries, as well as to reduce their enormous domestic disparities in education and wealth.

Recent technological developments have reduced by several orders of magnitude the cost of accessing selectively and, if necessary, instantaneously an increasing proportion of the world's pool of knowledge. Knowledge has always been the main ultimate source of power and wealth. Taking the lead in science and technology initiated the predominance of the West over the rest of the world from the eighteenth century onwards and created the great separation that we *have* today, but which did not exist before between rich and poor nations.

The significance of the information revolution for the developing world, and for all people in the North and the South concerned with the need to accelerate growth in the Third World, is that it can provide the hitherto unavailable economic means to improve the quality and skills of its human resources.

Past Developments and Current Issues

In most Latin American countries the use of computers in government and private companies is nearly as old as in the U.S. The main initial drive was provided by the manufacturers themselves, and this continues to be the main factor behind the computer's growing penetration in all walks of life. The expenditure on computer activities, both hardware and software, represents roughly one per cent of GNP, or half what it is in the U.S. Annual growth, on the other hand, is almost the same as in the U.S. -about 20 per cent.

In LDCs, computer applications are more extensive in (i) government administration activities requiring massive data processing, such as tax administration, budget, customs, social security, personal records (birth, marriage, death), vehicle records, police, mapping, natural resources records, etc.; (ii) administration and accounting in large and, more recently, medium-sized companies, both government and private, especially public utility companies; (iii) the financial sector, particularly banks, which compete in providing faster and better service through the introduction of on-line attention to their customers.

So far, the relative economics of computerization and traditional solutions have not justified the computer's extended application in small companies or offices, but this may change as reductions in the cost of both hardware and software continue to take place and as more computer-trained people become available.

In fact, a significant user of computers is the educational system; the largest computers installed in LDCs are usually found in universities, which benefit from special discounts

and sometimes outright donations from major manufacturers, who realize this is a good promotional investment. The main new development beginning to take place in the educational field is the use of computers at the basic and secondary school levels. In most cases, this is happening only in private schools, under pressure from parents, who sometimes have financed this activity with special contributions. The belief that today's children should know about computers if they are not to be handicapped in the future is widespread. Governmentfunded educational systems are under increasing public pressure to follow the lead of the private schools. Otherwise, it is feared that an unbridgeable gap will develop between the students of private and government schools.

Throughout the last two decades, many questions and issues have come up for discussion and resolution at the government level regarding the need to frame national policies in order to accelerate, contain or direct computer acquisition and use in a manner consistent with the general development objectives of the country. Policy formulation is still evolving and fluid and varies from country to country, in part due to their different characteristics, in part due to different ideological approaches, both of which finally influence their overall economic and social development strategies. In some countries such as Brazil, and to a lesser degree, Mexico, there is a national drive to become in the mid-or longer term at least as capable of self-sufficiency, in both the engineering and the production of information systems, including hardware and software, as WestermEuropean industrial societies. Their policy is to protect the local market from foreign competition. Other countries such as Taiwan and South Korea appear determined to play a role in the world production and trade of microcomputer as an outgrowth of their current role in telivion and other consumer electroincs. Must countries those with smiler domistic markets and comparative adveantages in other areas of world trade , such as export of natural resource are conecntrating on developing local capabilities for customized softwhere applicition and the traning of people nedeed to purchese the most approprate heardwhere and softwhere product elswhere.

The above there taypical choice my be clear in same case but not always. There are case where the option are more doubtful in both national and regional terms. For example the andean pact, or a group of spinish speaking south amrican countries could prvide the base for a burzilian style approch. Or maxico taking advantage of its proximity to the U.S could serve as a base for an exportorinted computer manufacturing industry.

But there is another aspect of the information revelition tthat LDCs need to address independntly of there purely industrial policies in the filed heardwhere and softwhere developiment. This is the education and trining of their populations at all level of formal and adult education and trining of their inculding the provision of the physical infrastructure needed for the full utilizition of there human resources. The main challinges is the quantitative extension and the qualitative improvement of national and international telecommunications system.

Yesterday,s Problemes and solutions: A Relevant National Model

how is the informatic revelition being dealt with today in latin amrican countreis? It my be useful to refer to chile,s early experiences as they provide some insights which are stillrelevant to other third world countries in the low incom rether then the midle income bracjket where the informatization of society is in stage similar ti that which chile experiencd some fifteen year ago when the third generation of computer (i…e., IBM 360s) made their appearance. They represented a quantum jump in date processing capacity and raised crucial questions regarding the optimal and efficientdesing of information system in government administration and company management. Until then, most computers had been looked at as little more than faster and more efficient machines for the accounting departments, of little or no interest to the rest of the organization, especially to top management.

The way Chilean policy-makers analyzed and then dealt with this situation is worth recalling. We took three main steps. First, we realized the urgent need to upgrade the skills of professionals involved in informatics. As waiting for trained personnel to emerge from the formal educational system involved excessive time delays, the government acted simultaneously at the adult and university education levels. A government-funded training institute was set up, and up-to-date educational materials (developed mainly in the U.K. and

the U.S.) were acquired to produce applications programmers and systems analysts in intensive two-to-four-semester courses. At the same time, the universities were equipped with third-generation computers, encouraged to send graduates to study in the best North American and European computer-oriented universities, and directed to establish formal computer education curricula in programming, applications to various professional fields (initially, the exact sciences, engineering and business administration) and computer science (hardware and operating systems/compiler software).

Second, a government computer committee was set up to review and approve the procurement of computers by government administration. Any government department wishing to acquire computers was requested to present an adequate technical and economic justification of the project and to show that it had taken all accessory measures to efficiently utilize the equipment (especially through training and organization). Experience had shown that many departments had acquired computers which lay idle or underutilized for years because applications had not been programmed and the personnel needed to operate them had not been trained in advance. In fact, many of their managers fell victim to the high-pressure sales tactics of equipment vendors, who in those early years tended to oversell the benefits and minimize the problems related to the efficient use of computers. This government intervention was resented by the vendors and by many department heads, but it provde extremely valuable. It forced them to attend to all the problems connected with the introduction of computers in a comprehensive way. In the end, it brought about a much broader and faster computerization of government systems.

This committee also took steps to facilitate the common use of data stored in different divisions of government by creating a national personal identification system (natural and juridical), by specifying preferred programming languages, and the like.

Third, the government set up the National Data Processing Service Company. This was organized and ran as a private, competitive service and was set up to fulfil several roles which were important at that time, such as: (i) to compete with data processing companies owned by foreign multinationals and bring down their extremely high prices; (ii) to encourage the establishment of more foreign suppliers by purchasing from several of them, rather than from one or two, forcing a lowering of prices and an improvement of services; (iii) to require government departments and government-owned companies to show, before acquiring any equipment, that in-house processing was cheaper than purchasing the services provided by the government company, which provided a benchmark for measuring. the effi$_{c}$i$_{ency}$ of foreign or local data processing services; (iv) to develop general plans for the efficient and integrated operation of all public sector information systems.

As this model for the rapid and efficient introduction of the information revolution in our country was being developed, great attention was being paid to international experience. Leading experts in charge of the computerization of universities and government services *were* invited to Chile and gave seminars. The experiences of Denmark and Israel in government data processing, the U.K. in adult training and the U.S. in university education were of great value.

After a few years, this approach had fulfilled its objectives. The country had trained an adequate number of skilled people. Data processing was used widely and efficiently in ever-increasing new areas. Eventually, the need for governmentt committee review of projects became unnecessary, as each department had a management fully capable of taking proper decisions. The National Data Processing Service also became less important, as many private, national and foreign-owned centers were established offering good services at reasonable cost due to market competition.

For a developing country starting now from a weak base, as did Chile fifteen or twenty years ago, the above model is worth keeping in mind.

Current Issues and Projects

Three current issues seem particularly important. First, there is no particular strategic need for an LDC to be industrially independent in this field. In fact, goods and services related to information technology are likely to be available from increasingly diversified international competitive sources. For most LDCs, the best road to acquiring the benefits of the new technologies is often not that of establishing their own local R & D and industrial capabilities, but to concentrate on those few area in which, because of specific reasons, each country has a natural advantage or a priority interest. In the case of Chile, there is a need and justification

for developing a national engineering, industrial and informational capability in areas such as copper mining and refining, or forestry and cellulose. In these areas, where we are important world suppliers, we can support a technological and informatics industry based on our own needs and eventually direct them to the export markets. But we cannot do the same in general. For the rest, in informatics, as well as in other fields, what we need is to have skilled professionals who can search for, evaluate, negotiate and adapt the best equipment and technology available in the world for the specific needs of our country.

A possible exception relates to microcomputers. As these become accessible to the masses in the form of home computers, it may be justified to study the feasibility of their local production. This could make sense, but in the end it will not be too different from similar decisions regarding the local manufacturing of TVs, radios or telephones. The main value to LDCs of the informatics revolution is not the eventual role of computer manufacturing but that of computer utilization, which in turn is valuable because it is a tool for the best use of information.

Second, the commercial use of computers in the industrial countries has moved beyond administrative data processing; its application to industrial processes, machine control and robotics is changing the traditional economics of labour and capital in a way which may prove extremely threatening to LDCs. The conventional thinking, which encourages LDCs to develop through export-oriented manufacturing in order to utilize their comparative advantage in terms of labour costs, may eventually prove unworkable if developed countries regain their competitiveness through the advanced informatization of manufacturing. In Europe, modern factories can produce men's suits at costs competitive with those of suits made with cheaper labour in Eastern countries. In a recent discussion panel, Brazil and Mexico acknowledged that in spite of their severe unemployment problems, their export-oriented industries *were* being compelled to use the latest computerized methods of production to stay competitive in price and quality. More and more, it appears that LDCs will be forced by employment considerations to distinguish between two economic sectors: a highly modern capital-intensive and competitive sector devoted to export and a carefully protected, labour-intensive, deliberately traditional sector devoted to domestic consumption needs. This situation, at least in Latin America, is intensified by pressures brought about by the need to service a very heavy foreign debt.

Finally, if cheap labour is not going to be the main comparative advantage of LDCs, it is clear that they, like the industrial countries, will have to rely more and more on properly trained and skilled human resources to develop their countries. Only through education can they defeat the symptoms of underdevelopment: infectious disease, infant mortality, poor agricultural productivity and a lack of entrepreneurial spirit and skills.

It has become essential to utilize the full potential of the information revolution in the solution of this critical problem. The combined use of computers, television and telecommunications in education in such *a way* as to extend coverage to rural and urban poor areas and to all levels of education can make the difference. Little has been done so far in this direction. Latin American governments, and even most of our educational authorities, are reluctant either to spend what is needed or to change traditional appioaches. International institutions like the North South Roundtable should encourage efforts to design new educational systems which make full use of these new technologies.

In Chile, a few small pilot projects are under way. At present, a proposal is under preparation for the massive and rapid introduction of computers in basic and secondary education. The program would consist of three stages. Over a period of five to seven years, computer workshops would be established in the 10,500 schools of the country, enabling teachers and students to use information technology to achieve a more creative, individual and rewarding education. The three stages are (i) to train 75 university graduates in the first year as teachers of basic and secondary level teachers; (u) to train some 7,000 basic and secondary school teachers at the rate of 1,400 per year for five years; and (iii) to maintain a permanent staff to design, adapt and develop educational software in all subjects.

CHAPTER 4
Information Technology : A Brief Assessment in a North-South Perspective

Gerard K. Boon

This paper will briefly highlight a few points on information technology or "IT," assess this technology, summarize its essential features in a North-South perspective and put forward some policy recommendations. -

Information technology is defined herein as the capacity, in embodied or disembodied form, to collect, process, transmit, receive, store, retrieve and apply information for production or consumption purposes at various institutional, individual, private or public levels in order to satisfy certain human desires and needs.

This definition is clear and operational and refers to all production and consumption activities in which IT may be involved. Indeed, information technology is spreading rapidly and affecting all the production and consumption functions of society. Its potential diffusion may be compared to that of electrical energy, which also plays a predominant role in the economic life of modern man.

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IT: Some Aspects

IT originates from the technologically developed North,particularly from a number of transnational companies in that area. Rapid developments in microelectronics and communication technology in the last fifteen years have contributed to the fast diffusion of cost-saving technologies. The leading countries and furs have experienced an increase in economic (market) power, which translates itself into increased technological dependencies with inevitable economic and political consequences for the countries and firms which lag behind in these developments. It should be stressed that this phenomenon occurs equally among countries of the North,which are at different stages in the development of this technology, as well as among the developing countries of the South. There is no principal difference. However, the differences in the pace of development of information technology, as well as in overall economic development, are more extreme in the North-South context than within the North itself. Nevertheless, there is no escape, and all countries have a certain need to try to reduce their technological dependence both in the domestic production of hardware and in the application of imported hardware and software.

Few countries can justify the development of an independent information hardware industry. But to increase a country's technological capability also means spreading the diffusion of the embodied information technology and software. While closing the technology gap with the developed countries may favourably affect exports and the terms of trade, there are nevertheless certain limits to any leapfrogging development strategy concerning informatics. Social costs and benefits have to be carefully considered for the country as a whole. Such an analysis necessarily has a qualitative character. Preferably, such an evaluation should be based on a systematic technological assessment, to be carried out at the country level as well as at the sector and enterprise levels. Some of these qualitative aspects are discussed below.

Scope

In IT, a number of technologies integrate, principally computer and telecommunication technology (telematics). Since computer technology is influencing virtually all existing production technologies - industrial, agricultural and service - the scope of the technological change under way is tremendous. This is more so as information technology affects not only the production but also the consumption sphere. Television, with access to data banks and

- home computers linked to telephones, will provide new, opportunities for integrating the consumer more and more with an information network, affecting consumption patterns. Further, IT may enhance the individual, social and political involvement in direct decision making. Access to television programmes beamed in by satellites from remote countries and cultures may give rise to a situation where modem man is overloaded with information and influences which he finds difficult to control.

Diffusion Speed

Past experience *shows* that although the process of technological change is very fast, the diffusion of informatics based on widespread adoption of the technology is so rapid that the diffusion process and its effects become uncontrollable. The technology is not a free good, although rapid reductions in costs for certain items have already occurred. Nevertheless, in the production as well as in the consumption sphere, investment requirements are significant. Besides, in a technology which changes rapidly as to both content and price, many potential investors are waiting for the next round of change before jumping on the bandwagon.

Developing Countries

To developing countries, any new technology, and particularly such an important, all-embracing one as information technology, poses a direct threat to their relative position on the international scene. This is particularly so where such a technology has a direct influence on strategic issues-ideological, military or economic. Such technologies usually affect the country's developmentall policy and strategy objectives in the short, medium and long term.

Clearly, the threats and challenges posed by information technology are not equal for all developing countries. We differentiate among developing countries by identifying the Leading Third World Countries (LTWCs), which are regionally very important and which have considerable weight internationally; the Newly Industrializing Countries (NICs), countries with rapid industrial growth and development; and Middle-Income and Low-Income Developing Countries (MIDCs and LDCs). The immediate strategic and policy urgency of IT is not identical for these groups and declines correspondingly as they are listed here. Nevertheless, *from* the point of view of international competitiveness, IT is of importance to all developing countries to the extent that it affects their principal exports.

For countries experiencing a technology gap in the sense of shortcomings in technology production and/or technology adoption capability, a policy to reduce this gap is desirable. This is *more so for* those countries where the technology gap is felt as a serious drawback affecting the country's relative economic and political power. By means *of* an effective *policy,* the implied technological economic and political *dependency* on other countries may be reduced.

Still, all countries are tied in various degrees by means of their imports and exports to the international market system. The international division of labour implies the diffusion of technological, processes and capabilities and places countries hierarchically according to their production capability, which influences the product mix of their exports. Particularly for those technologies which are considered to be strategic in a security and/or economic sense, as they are seen as important agents and instruments for future growth and development, the diffusion as *implied by* the prevailing international economic order is usually judged to be too slow.

As soon as this judgement is reached, the need arises to design strategies and policies to accelerate domestic technology adoption to *reach* domestic diffusion levels greater than those implied by the international division of labour.

Technology Market

Prior to designing strategies and policies, careful research
should be conducted into the technology as to its principal components, producers, suppliers and potential markets. In short, a survey of the structure of the world technology market for each principal technology component has to be conducted.' Such a survey is

relevant to all technology-demanding parties, wherever located. It should preferably be conducted or initiated by an international public organization such as UNIDO. The technology market for mainframe, micro, mini and super mini computerss differs. There are few mainframe producers, but many producers and suppliers of mini computers. This is already indicative of the barriers to entry into the production of these various types of computers. The production of large mainframe computers is highly concentrated, and the barriers to entry are enormous. Even the technologically highly developed countries and transnational companies in Europe have experienced great difficulty in entering a market which is dominated by a single American company and some other American and Japanese firms. This illustrates that LTWCs will experience almost insurmountable difficulties in establishing a domestic technological capability in mainframe computer technology.

Interestingly enough, the USSR, by strategic necessity further emphasized by the export embargo on sophisticated mainframes, hardware and software to their country, has developed a domestic capability in mainframe computer technology. However, the USSR lags behind in computers designed for the civilian, production and consumption sectors. To accelerate domestic diffusion, the USSR is contemplating vast imports and possibly even joint venture production of leading western micro and mini computers.'

Generally, however, the chances are much better for software technology. The production of mini computers and personal com

puters is another possibility for those LTWCs and NICs with some experience in microelectronics. Taiwan, South Korea and Hong Kong

already produce rather sophisticated microelectronic devices. Brazil is establishing a technological capability in micro and mini computers,

communication technology and computer-controlled machine tools, robots and related techniques. India and China are also making

significant advances in microelectronics technology and informatics.

Western Europe- LTWC informatics Link

Unfortunately, to explore the strategies and technology policies pursued by the various types of LTWCs and NICs is outside the scope of this paper. However, as a more general policy consideration, it is noteworthy that the European Economic Community is trying hard to catch up with current developments in information technology. Virtually all member countries have advanced telecommunications and microelectronics industries. European-based transnational companies (TNCs) exist in the area. Yet the necessity is increasingly felt to operate from one big market, the EEC. As far as informatics technology is concerned, the EEC is less a community, or even a common market, than the official name suggests. Certain LTWCs and NICs which want a swift reduction in their information technology gap should perhaps explore the possibilities of closer collaboration

with the EEC. Such collaboration could be beneficial to both parties in reducing their technological dependence on the USA and Japan. The problem for the EEC is that it is not a sufficiently integrated market. Nevertheless, programmes like 'Esprit' and others could possibly be conceived with a wider scope in order that LTWCs could be linked to the research effort and its results, even if only indirectly. A complication, of course, is that due to the strategic nature of the technology and geopolitical differences, LTWCs and EEC member countries may have different objectives. Also, Esprit participants and beneficiaries are companies, many of a transnational nature, and not countries.

Lea p-Frogging Strategies

European transnational companies like Philips NV and Siemens AG are engaged in an effort to catch up with fifth-generation computer technology after having missed some previous opportunities. Apparently, their strategy is to jump back into the race, working to obtain the technological capability themselves instead of buying equipment from firms already more advanced in their production. This could be an important step in building up future technological advancement. Such a leap-frogging policy makes great demands on

intellectual and financial resources. Nevertheless, LTWCs have, equal if different, possibilities for leap-frogging to reduce their technological dependence. A major element in the success of a leap-frogging strategy is the human resource element with regard to

specialized skills and dedication. Skills are partly acquired through learning by doing (or lost by not doing); therefore , initiating something in an area where the country's know-how is less developed may be Justified from an experience-gaining point of view. Learning is usually enhanced by collaboration with persons and institutions which know more. Therefore, if transnational companies are allowed to operate in the production of information technology, the conditions under which the company is allowed to operate are possibly more important than the question of who has the majority in ownership. Conditions may refer to the extent that research will be done locally, local staffing of research positions, local content of products, domestic market share, training of nationals in foreign-located schooling facilities, and so on. IBM was apparently allowed majority ownership of its productiog facility in Mexico because these secondary conditions were particularly favourable for developing a domestic capability in that country.

LTWCs such as India and Brazil are demonstrating excellent capabilities in software production, thus reducing their technological dependence in that area. Interestingly enough, software production seems to have encountered a bottleneck in Japan .[3]

Diffusion

In addition to the desire to produce hardware and software locally, the diffusion speed of imported technology is another important aspect of national technological capability. The latter is not restricted to the local production of a technology, but also concerns its application. The actual use and adoption of a technology determines its diffusion.

Research into the diffusion and effects of computer-based techniques in the North and in the South shows that the diffusion of new techniques is linked to the level of economic development of individual pountries. The diffusion process at the global level can be envisioned graphically as an Scurve. This implies that when the economic growth of a country starts to accelerate, the diffusion of new technique applications also accelerates. The economic growth rates of countries are indeed influenced by their phase of development in such a way that NICs experience higher overall growth rates than LDCs and DCs. The degree of complexity and sophistication of IT systems is also a function of the country's phase of development. By means of specific policies, the domestic adoption of new techniques can be further accelerated. One of the crucial elements in the adoption of the new techniques is the *domestic absorptive* capacity, which is strongly influenced by the quality and skill of the domestic human resource endowment. Therefore, creation of training facilities becomes imperative, as it directly and indirectly influences the diffusion of technology. In this respect, it is interesting to compare the training programmes for primary, secondary and university students in various countries, including the USSR. In the USSR, IT education and training is being undertaken on a large scale, presumably according to a well-defined plan. Nevertheless, the training facilities which can be created depend on the educational Infrastructure already in place. The investment resources which can be mobilized for educational programmes depend to some degree on the phase of development of the country concerned. The latter also influences the demand for IT technology and the complementary human skill requirements.

Thus there will remain a more or less proportional relationship between the phase of economic development, IT absorptive capacity and diffusion, and the actual need for IT. IT is unlikely to severely unsettle the present economic and political North-South power balance, since technological change in this field will probably be more gradual than many observers now believe. This view is based on the differences among countries in absorptive capacity for this technology. Although the absorptive capacity is a policy variable, this is so only within certain limits. Only if revolutionary technological change would make essential parts of IT so cheap as to be almost free could a quantum jump in IT diffusion occur.

The diffusion of IT will also accelerate if the new IT vintage is far superior in speed and reliability to, or less costly than, the technology vintage presently in use. The technological dominance which some firms and countries currently enjoy will in time be counterbalanced, leading to more competition and lower prices, even in the mainframe computer market. Meanwhile, the development gap between Third World countries which are able to absorb the new technology and those which are not will increase.

The issue of information technology is a critical one for all countries. What is

particularly needed is more information on information technology, which can only be obtained by doing more research. Further research and the effective dissemination of research results on the nature of the diffusion of IT, on the assessment of the technology and on the formulation of policy issues and recommendations is an imperative.° Such an assessment should '.include the economic, social, international trade, employment and political effects of the technology.

Information Content

For all but a few of the developing countries, the rapid development of this northern geotechnology' implies increased technological dependence. More important than that is the increased hidden dependence caused by the nature of the information which is transmitted, received and applied. Concentrating now on the *information content* which is put through the information technological system, we mention a number of aspects or characteristics which will now be assessed. Basically, the point is that information is clearly not neutral; neither is it a free good. On the contrary, it may be quite expensive in both direct and implied costs. These factors may influence the choice of an information supplier. Major factors include:

a) Ownership.
b) Source/origin (public or private, confidentiality).
c) Reliability (of both the service and the content), accuracy, depth.
d) Value neutrality:
I) Economically (consumption or production, demonstration effect, choice of product or technique).
2) Socially.
3) Culturally.
4) Politically.
e) Final use/skill requirements:
1) Production (industrial, agricultural, service, communication).
2) Consumption (leisure).
f) Characteristic of transmitting/receiving agent (public or private).
g) Accessibility (economic/financial, education, cultural, legal) obstacles to accessibility.
h) Costs/production factor usage (installation, capital, tech nology intensity, flow per time unit).
i) Potential infringement of sacred rights (private individual, national/international public, copyright/authorship).
j) Existence of alternative sources of information.

The ten essential aspects *which* we identified will now be dis cussed and summarily assessed.

Ownership

Information has a price: it can be sold, and thus it changes hands. Ownership is important, and the terns of transfer of ownership are important too. The information may be contained in the form of programmes (software), and the transfer may be by means of a licence agreement. Licence agreements have to be assessed as to their terms, that is, their substance. They may contain restricting clauses but still imply clear advantages to the licensee. The direct sale of information (know-how) also occurs. Clearly, one has to know if the information justifies the price paid for it, and whether alternative suppliers of the information exist who may quote different prices and different transfer terns.

Origin and Source

An important aspect of information which often depends on the origin and the source is the compatibility of the programmed containing the information with the various makes of hardware. The greater the compatibility of the information in that sense, the greater its potential application and usage.

Information may also have a private or public origin, with varying degrees of confidentiality, scarcity or uniqueness, implying

varying degrees of protection, accessibility and cost. The source and origin of the information, may greatly affect its value neu
trality.

Quality/Reliability

Information is not always clearly recognizable as information; for example, a movie from the North contains a lot of information, not in digital form, but concealed in the story, dress and behaviour of the actors, the houses they, live in, their cars, etc. This hidden information has also a quality aspect in it; not only may the story reflect a culturally conditioned problem, but also, all the factors just mentioned are equally culturally conditioned, and in that sense are also translatable in terms of quality according to certain social, ideological, esthetic, moral or religious criteria.
Obviously, information explicitly recognizable as such has quality, reliability and other dimensions directly related to these aspects, such as, for example, the detail, variety and depth of the information. Since decisions are based on information, the quality, and particularly the reliability, are of prime importance. Quality and reliability are partly determined by the source or origin and partly by the ownership of the information. However, in order to balance the information content, it may be necessary to have access to various alternative sources of information covering identical subjects. Where objectivity in information is desired, information covering the same subject coming from alternative sources should be analyzed or presented to allow for individual opinion-forming.

Value Neutrality

Information is seldom neutral. Information on weather, atmospheric conditions or market prices is probably the most neutral; but
generally, information is economically, socially, culturally and/or politically conditioned, and therefore should be judged with care by users. Decisions on information contained in production programmes for computer-controlled machines involve not only a decision on the information, but also on the product and the technique of production. Both products and techniques are economically, socially and culturally determined. As a generalization, one may state that for the domestic market of developing countries, the product's physical characteristics, degree of maturity and standardization are determined by the phase of development of the firm, the sector and the economy at large. The phase of development also influences the average income and demand of the consumer. Since technology mix is directly linked to product mix, which both influence labour productivity, employment, income and demand, the choice of product and technique is a vital element in the overall productionconsumption system of a country. The product and technique choice are simultaneously made in the choice of the information programme, which clearly indicates its importance. The choice of product as regards its characteristics, particularly for the domestic market, is economically and culturally determined by the phase of development of a country and therefore should not be fixed by a piece of information technology originating from a very different economic and cultural development level.°
In the case of TNCs, it is already possible to transmit coded production programmes by means of telephone lines or space satellites from headquarters to affiliated companies anywhere on earth. Computer-controlled machinery in the affiliated company can start production within seconds on the basis of such transmitted instructions. These transborder data flows are difficult to control and may erode national sovereignty over economic development objectives. Governments may lose their grasp on key economic, social and, ultimately, political events.
All this may sound a little dramatic. However, certain measures are possible to monitor transborder data flows and resolve the issue by means of bilateral or multilateral treaties.

Final Use and Skill Requirements

The final use of the information may be broadly distinguished between production or consumption destinations. In both cases the quality, reliability and value neutrality of the information are important. Both destinations require the know-how to use the information. In

the production sphere, certain computer programming skills are needed which can be fairly easily acquired. In any contract concerning IT hardware transfer, adequate attention should be given to the complementary software. Attention must be paid where appropriate to the training of operating and maintenance personnel and to maintenance and repair facilities to be provided by the supplier, at least for an initial period. A scarcity of maintenance and repair facilities limits the diffusion of the devices through which the information flows.

In the production sphere, the information should also be judged by its potential to contribute to the development objectives of a country. Usual among these objectives are economic growth, employment, increases in the net income of the populace, more equitable income distribution, economic and political integration of the country, reduction of class or racial antagonisms, and others. IT may contribute to these various objectives, and it is important to try to identify these contributions and to assess their value. In larger countries like India, China, Brazil, Argentina and Mexico and in island countries such as Indonesia and the Philippines, improved telecommunication, or rather, telematics by means of satellites, may indeed enhance the integration of a country,, which in turn may lead to an improved use of human and natural resources, contributing to the country's development objectives. It is clearly important for each country to have its information flow fully under control. If not, the opposite may occur - national disintegration through economic and cultural confusion caused by information and signals alien to the aenntry's own objectives.

Hence, information originating from abroad may also jeopardize development objectives. Moreover, information has a cost, both in a direct and indirect economic sense and also in an implicit sense. The total costs and benefits have to be weighed with care, particularly since physical and human capital resources are very scarce in developing countries, and there may be alternative uses *which* give yields superior to those of IT investments. IT use in the consumption sphere, by means of the demonstration effect, may influence the demand pattern and stimulate serious feelings of discontent if the domestic industry cannot supply the goods desired. Also, not all societies wish to duplicate the very materialistic western consumption patterns. Even if a country's development objectives do not ultimately exclude a western-style consumption society, it is still important to remember that development is *a gradual* process. This is implied not only by the limits of the resource capacity, which, in the short term show little elasticity, but also by the capacity to mentally, intellectually and culturally absorb new products and a new lifestyle.

National and international codes of conduct on information and its technology may be needed. Laws and regulations are already in force in many countries.

Private or Public Transmission

The legal status of the information transmitting agent may be a factor, although the legal status of the origin of the information is probably of greater weight. Obviously, publicly owned transmitting agents may be more easily controlled, but this fact has its advantages and disadvantages.

Accessibility of the Information

Accessibility has various aspects, some of which were already mentioned and discussed in connection with other aspects. Obstacles impeding the access to information may include cost, ignorance about sources, lack of required skills, or limited uses for the information. Tostartwiththelast point, it is obvious that the nature and the extent of the information needed for making decisions is a function of the role played by the recipient in the world political scene, in the world market, in the production of a certain commodity, etc. The government of the USA needs vastly more and diverse information than the government of Monaco, for example. Too much information leads to confusion and immobility, as it makes decision making impossible. This demonstrates clearly how important *infornation on information* is. The solution to the problem of accessibility starts with the decision on which information one wants. Next comes the decision on the source, when alternative sources exist. Such a decision should be based on a number of considerations, most of which we are discussing here. While the decision on which information one wants, and from whom, requires judgement and skill, the actual use of the information may require even more skill. If the latter is not available, the information has de facto become inaccessible, which demonstrates the role the human resource factor plays. Again, we want to stress the importance of the supplier as a source of

training. The training facilities which different suppliers may provide are a very important consideration in the choice of a supplier.
Lack of skill in processing information may lead to decisions by developing countries to use the services of specialized data processing firms from abroad. Domestic unprocessed information may be transferred to a foreign country, processed and then transmitted back. Or, the services of such firms may be hired to do the processing job in the country itself. This raises questions of confidentiality. Foreign countries and companies may possess more specific information on a particular country than the national government or any domestic private party. These points show that the accessibility question does not refer only to "foreign" information, but also to "domestic" information. Foreign processing of domestic information clearly increases the dependency of a developing country.'

Costs

Although in this part of the paper we are primarily referring to the content of the information, it is not possible to limit the discussion to that aspect alone. There may be tradeoffs between the investment requirements needed for the technology in a hardware, software and skill dense and the cost of the information flow itself. The more capital- and technology-intensive the hardware, the less need for software there may be. The price of the information flow lied. To build and to linkages to international data networks related to civil aviation, weather, atmospheric or earthquake conditions and the like may be most helpful. Linkages to international news services clearly show the importance of the neutrality aspect, as does subscribing to foreign television programmes, even those merely aimed at mass entertainment. Each country has to make up its mind *which* influences it will allow or not allow. To control the inttlow of foreign
information *which* is openly offered for sale is not difficult. Controlling hidden information flows originating *from* foreign sources is more difficult, but usually, the potential transmitters and receivers can be fairly easily identified. International regulations on the question of transborder data flows are possible, but national regulations
certainly make for more effective control.

Existence ofAlternative Sources

Each economist is trained to think of alternatives, and this note
emphasizes this point. The existence of alternative sources of information is one thing, but knowing about them and gaining access to them is another. However, one begins by being aware of alternative sources and by having relevant information on them. Access may be determined by cost, skill, geopolitical or other considerations *which* may ultimately determine the choice of source. The choice of an information source and the concomitant choice of an information system clearly is a crucial one *which* should be conditioned by most
of the considerations discussed above.

Global Development: IT's Potential.

IT tends to make the world smaller and more integrated and to widen the development gap between those countries and firms *which* have IT production and application capability and those which do not. This implies more inequality, hence, more domination and exploitation. This always occurs when, in an already unequal world, the strong strengthen their capabilities further. However, what may be different this time is that within the group of the strong, the traditional innovators may have lost leadership to the younger members, or even to potential members, of the club. Thus there is hope for all developing countries.
Nevertheless, the essential question is: Can we formulate policies minimizing the forces working toward greater inequality? Can we maximize the global social benefits of this technology for all countries and all peoples? This objective may be attainable. within a number of limiting or constraining conditions; one should be very realistic. At the beginning of this paper we briefly compared information with electrical energy. Even the latter is still beyond the reach of hundreds of millions of humans. Moreover, electrical *energy* is neutral, while information often is not. This may mean, however, that the diffusion chances of IT *are* better, as governments may see clear advantages in

such diffusion. To bring information under the national control of existing governments clearly does not guarantee a better world. Unfortunately, the reverse may be more likely. Nevertheless, in time, governments and the objectives *they* pursue may mature; and there are nowadays few governments which are not interested in better educating their people. Education may contribute to objectivity in thinking, and the latter in the long run erodes narrow feelings of nationalism.

More concretely, how can IT contribute to strengthening the global social benefits of the technology? Particularly, how may IT affect comparative advantage and international trade, employment in the South and North, the international economic and political power structure, global prosperity and peace?

Comparative Advantage and International Trade

IT has already had an impact on comparative advantage and international trade, affecting the mix of goods traded between countries and areas. We distinguish between IT products (both producer and consumer goods) and the products produced (whether or not they contain microelectronics). The major innovators and producers of this technology have a comparative advantage in both categories of goods.

Initially, this situation creates a dangerous dominance of the IT "haves" over the "have-nots." But IT is diffusing, because producers

of this technology want to sell technological capability, and buyers want to obtain it. In technology trade, an important distinction has to be made between trade in *the producing technology* (know-how) and the *embodied technology* produced with this know-how. The latter are the process applications of the users. The trade in embodied technology in both hardware and software is competitive, and therefore, this technology is easily obtainable, which aids in its diffusion. But the demand is influenced by a number of micro, meso and macro economic, educational and social conditions. The barriers to change are strong, and the best policies to remove obstacles are not always clear. It is difficult to absorb new technology into a produc

tion, educational and social system based on conventional technology.° This problem exerts an influence on all aggregation levels. As we pointed out elsewhere,' the demand for and diffusion of new techniques, including IT, can be viewed as a gradual but non-linear process corresponding to various phases of development. This implies various degrees in absorptive capacity, awareness and understanding which are all related. In the micro adoption process, a number of explanatory variables play a role. Their importance varies according to the phase of development. They can be ordered by the following sequence:

a) Product characteristics of a physical nature. b) Production process characteristics.

c) Labour(saving) and skill.

d) Capital investment (savings).

e) Market structure (internal, external).

f) Macro.[10]

At any given moment, firms, branches, sectors and countries are in different phases of development and, therefore, in the diffusion of IT. This basic fact will not destroy trade but intensify it. This is because IT can be viewed as a specific type of capital which differs among countries relative to scarcity. Since not all tradeable goods are in the same degree affected by IT, international trade will be increasingly determined by the difference in IT diffusion among countries.

on the production and trade of their products in exchange for goods whose cost of production is unaffected or less affected by IT.

By considering IT as a type of capital, capital becomes more differentiated, and this $i_m pli_{es}$ an increase in the number of combinations of the production factors, which in turn implies an increase in the potential for more international trade as more and more market niches are created..

Employment in the South and North

If world trade on the basis of informatics is bound to increase, so will world production. If telematics attains full development and diffusion, but in a differentiated way, it is almost certain to increase labour productivity, personal disposable income and the demand

for new products and services. In the long run, the socioeconomic advantage of the new technology will become ever clearer, and IT in most of its applications will be capital-saving. Either it will produce existing products of a superior quality at the same or lower prices, or it will produce new products which in time will rapidly drop in price.
Hence, although telematics is laboursaving, it has the potential to lift the production-consumption system to a higher level, implying more or less full employment at reduced working times. This effect is further stimulated by the capital-saving nature of the technology. Ultimately, this is of great importance to all countries where capital is scarce, and in partjcular to the developing countries. Nevertheless, a word of caution: It does not follow that due to the capital-saving potential of certain types of IT, its diffusion should be uncritically pursued by developing countries. Diffusion depends on absorptive capacity, and there are inherent limits to increasing that capacity quickly. It is not only a question of skills, the formation of which takes time, but also of product mix and demand mix. These variables *are* ultimately linked to the phase of development of a country. This is not a deterministic view; catching-up and leapfrogging strategies are possible, but one cannot lift up an entire economy in a brief time span by grafting a new technology onto it. If this is attempted, the result will only be a tremendous waste of scarce resources, social confusion and possibly disorder.

The International Economic and Political Power Structure

IT strengthens the position of those countries which are most advanced in IT production and use; but for certain NICs, IT may prove to be a boon, particularly for the Asian islands and peninsula nations. IT may give India, China and Brazil an opportunity to catch up in development, as they might have jumped on the bandwagon in time. By the year 2000, the effect of the reshuffling of the development deck will be clear. There is already a widespread belief in Western Europe that the twenty-fast century will witness a development boom in the Pacific Basin, to some extent to the cost of the Atlantic Basin. If so, let us hope that the new leaders are as generous as the old world has been in the last thirty years, rather than taking their lead from the old world policies of some 100 to 150 years ago.

IT for Global Development and Peace

The contribution of IT to global development and peace has already been sufficiently discussed. There may certainly be a contribution to global prosperity, but to achieve it, feelings of human solidarity may have to be developed further. IT may in the long run contribute to peace by encouraging a habit of objective thinking.

Policy Recommendations

We are making a distinction between policies aimed at the faster diffusion of IT and policies aimed at increasing the domestic productive capability of IT items.
The diffusion implied by the international division of labour, which we *term* natural diffusion, is best served if the rules of free trade are adhered to. Legal or structural protectionism may hamper diffusion in the long run. The well-known infant industry argument certainly remains valid. A specific technology policy to accelerate diffusion in order to catch up or leap-frog is another valid option. However, leapfrogging is dangerous if it is based on a misunderstanding of the basic structural barriers to diffusion.
The diffusion of IT may be increased at the government level by:
a) Having insight into the structure of the international IT market according to its principal technological components: Who are the principal producers/suppliers? What are the alternative supply sources? What are the terms for IT transfer?
b) Initiating and stimulating programmes for training in the relevant skills.
c) Increasing the total supply of IT goods by lowering import duties, or by stimulating the domestic production and supply of IT items by temporarily increasing import duties.
Further, governments may stimulate the diffusion of IT by:
a) Providing financial and fiscal incentives to firms to invest in IT.

b) Making eligibility for government contracts conditional on the degree to which firms have invested in IT.
c) Reducing the risk involved for private firms investing in IT.
d) Stimulating the general demand, and particularly the government demand, for products and services in which IT is used, e.g., by an adequate procurement policy.
e) Providing public support in the negotiation of IT technology transfer by TNCS too domestic firms in order to improve the transfer conditions as to price, operating, maintenance, repair and training facilities.
f) Giving guidance on technology and product standards.
g) Giving support by government R & D facilities to private R & D related to IT.
h) Stimulating and supporting private enterprise apprenticeship training programmes.
i) Formulating formal IT training programmes in schools as part of the curriculum.
j) Improving the quality and reliability of public IT products and services such as telephone and telex facilities, which in many countries are operated by government enterprises.
k) Improving the infrastructure relevant to IT for which the government holds responsibility, as well as enhancing the busi ness climate, which is strongly influenced by the economic, financial, social and political stability of the country.
I) Designing a total development policy for the country in eco nomic, fiscal, trade" and technology matters *which* shows consistency and realism. Over-ambitious plans to increase the technological capability in IT may prove dangerous and _destabilize the entire economy.

Many of these points also have a bearing on stimulating the domestic production of IT. As several IT components are difficult to produce due to skill, capital and technology requirements, developing countries should try to collaborate on a regional basis by initiating joint programme activities. Nott all phases of the production process and not all products are strategic; and even if they are, groups of countries may have common strategic interests.

We spoke earlier of the EEC's IT efforts and programmes and suggested exploring the possibilities of EEC collaboration with developing countries. Clearly, the size of the market is an importantt stimulant for the creation of technological independence and excel lence.

Notes

1. For example, see G. K. Boon, *Technology Transfer in Fibres,* Textile *and Apparel* (Dordrecht: M. Nphoff, 1981), end D. Ernst, The Global Role *In Micro* Electronics (Cam pus, 1983)
2. See C. Antlers, "De Slag am de RussucheComputercontracten, NRC/HANDELSBLAD," Financial rYmes (14 August 1985).
3. See "Software: Japan's Soft Point," *Economist* no.7406 (10 August 1985).
4. See 'Computer-Based Techniques: A Technoog Policy Assessment in a North South Perspective" (TSF 85-1), paper published by the Technology Scientific Foundation, Noordwsk, Holland, May 1985.
5. A geotechoology is defined as a technology which is fully conditioned as to its production and application by a specific technological, economic and cultural development level in an area and therefore is fully appropriate as a product or process in similar areas or environments. See Boon, *Technology ruins/er M Fibres.*
6. See "North-South Interdependence: An Economic Interpretation" (TSF 84-I), "The Diffusion of New Techniques" (TSF 843) and "Computer-Based Techniques: A Tehnology Policy Assessment in a North-South Perspective" (TSF 85.1), papers published by the Technology Ssientffic *Foundation,* Noordiva Holland
7. In this context, J. Rada uses the tern'lkctronic intelligence emigration" in 1. Km®nann-Randolf, °HiRJt Technology and the Third World," *Development and Cooperadon no.3* (June/July 1985).
8. For an exeelent paper from the economic/production side, see C. Freeman and L Soete, "Information Technology and Employment: An Assessment," executive summary, SP0.U, Sussex University, May 1985.

9. See note 6 above.
10. See note 4 above.
11. Often the trade policies of NICs and DCs are too protectionistic, cushioning the domestic market from foreign competition, which is an important diffusion-stimulating factor both economically and politically.

AddideaW References
"The Diffusion and Effect in North-South Perspective of Computer-Based Techrrq. eC (TSF 84.10), *paper* published by the Technology SdentJc Foundation, Noord w4k, Holland
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CHAPTER 5
Computer-Industry Support for Relief and Development

Paul Stern

How can the U.S. computer industry assist relief and development efforts in less-developed countries (LDCs)? In addressing this question, we shall consider what LDCs need, what computer industry corporations are able to contribute, and how the corporations' contributions can be delivered most effectively.

Taking the second question first, what can computer industry firms contribute? To begin with, they can offer the same kinds of assistance to established relief and development agencies as any other firm. Some examples of such "generic" assistance are the following:

a) Funds. These include both corporate contributions, in the form of outright grants and blocked-currency grants, and corporate matching grants augmenting employees' contributions.

b) Influence. Corporations can contribute by sponsoring employee fund-raising compaigns, by undertaking special advertising (e.g., the recent Computerland campaign), by using informal execu tive networks to encourage other firms to contribute similarly,

The author is grateful for the assistance of Hamilton Richards, of the Burroughs Austin Research Center in Austin, Texas, and of Robert Beard, Jack Fritz, Dileep Gajendragadkar, Gary Garriott, John Gordon, Carl Gotsch, Charles Mann, Henry Norman and Rob Schware in the preparation of this paper. and by lobbying for government policies (both U.S, and LOC) favoring development.

Computer industry firms in particular, however, are uniquely situated to make contributions of unrivalled *significance.* Their stock in trade, information technology, is an *enabling* technology: as Amadow Mahtar M'bow of UNESCO has put it, it is "not just one form of technology among others, but an ability to make use of other *techniques,* to give or to refuse access to a whole range of scientific data 'and knowledge and thus to new models of development;" Its role as a facilitator, *advancing* the development, diffusion and application of many other technologies, makes its rapid dissemination throughout the less-developed world an objective of the highest priority.

Particularly important in the less-developed countries is microelectronics, which has brought information technology within reach of millions,

"The Information Revolution will some day be seen by historians as having been as fundamental in its human impact as the two sreat convulsions that preceded it, namely, the Agricultural and Industrial Revolutions," said Stanford anthropologist Robert Textor in initiating discussions at the [International Symposium on Microcomputer Applications held in November 1984 in Sri Lanka). Tenor went on to predict that because of very high data storage, low cost, low energy requirements and portability, microcomputers will become the most common pieces of technology in the world, useful to all sectors of the economy.'

These attributes of microcomputer hardware have in turn inspired the development of thousands of convenient and inexpensive software packages designed for relatively untrained users. Microbased systems can therefore be employed in countless applications closed to all previous generations of computer systems.

A microelectronics revolution is in fact under way in the lessdeveloped world, and its potential to catalyze development there is clearly at least as great as it has been in the industrial nations. Experience has also shown that most of the difficulties that attend the adoption of information technology in the industrialized world
reappear on schedule in the less-developed countries, along with several new ones. Although the diffusion of microelectronics would presumably proceed even in the absence of deliberate contributions by the computer industry, there are actions we can take that can significantly reduce the cost of the process, eliminate some of the difficulties and ameliorate others, and hasten and increase the beneficial effects. Specific examples of corporate assistance include the following:

a) Providing information processing systems (hardware and software) as in-kind contributions.

b) Developing rugged microcomputers (such as the military version of the Burroughs B25) that can withstand extremes of temperature, humidity, dust, smoke and power fluctuations; also tow-powered systems that can operate entirely independent of mains supplies.

c) Providing expertise (through loans of trained and experienced personnel) for applications analysis and development and for installation and training.

d) Providing technical support (service and maintenance) for installed systems.

It should not be overlooked that the industry makes a substantial contribution whenever it extends its marketing, distribution and field service organizations into less-developed regions, where the lack of the kind of support that is taken for granted in the industrialized nations can be crippling.

How, then, are microcomputer systems actually beginning to be
used in l_{ess}-$d_{eve}l_{o}p_{e}$d countries? What are the most promising appli
cations and the most pressing unfulfilled needs? How can the computer industry's potential contributions be brought to bear on these needs? The next sections address these questions in relation to LDCs' needs in the short, medium and long term.

Short-Term Needs: Disaster Relief

The problem of disaster relief is to supply enough basic resources - food, water, medical supplies, clothing and shelter - to sustain life until the immediate emergency (drought, famine, etc.) has subsided. The importance of information processing and communications in getting resources to the people who need them is only now receiving the attention it deserves. "The logistics involved in allocating commodities, warehousing, coordinating shipments . and tracking persons assisted is. .. beyond the management capability of manual systems." The multiplicity of donors, each with its "unique reporting requirements," requires "the ability to provide documentation in a flexible manner." The difficulty of collecting data for processing "suggests the use of more efficient communications systems, including inexpensive digital means." Just now appearing are "early warning systems which attempt to predict. . catastrophes [and] seem particularly amenable to a new generation of hardware/ software that combines a high degree of visual impact with typical database management features.

A promising example of an early warning system is "a set of software designed to be run on standard microcomputers that can predict the likely effects of drought" on food supplies:

The technology, called *agroch'madc assessment,* is now being introduced in Bangladesh, India, Indonesia, Malaysia, Nepal, Pakistan, Philippines, Sri Lanka and Thailand .... Based on rainfall and other data, the technology gauges the moisture available to crops at critical periods of the plant growth cycle. If moisture deficits occur during these periods, agronomic and economic techniques permit forecasts of actual harvest shortfalls to be made. This information should permit governments to act before a crisis develops!

The promise of early warning systems should not be overrated, however. According to one observer, "the irony of the vast international [Ethiopian relief] effort is that the famine was predictable and indeed was predicted both by the Ethiopian authorities and by those studying the effects of the land reform program"s - presumably without benefit of software assistance.

In the short term, computer manufacturers can probably contribute most effectively through established relief organizations (e.g., CARE, UNICEF and Oxfam) with funds, in-kind contributions and technical resource assistance (e.g, loans of company personnel). These agencies, and others, are already using microcomputer systems in relief operations as well as in there central offices. The problems they have been encountering include insufficient number of system poor communications with and between field operations in remote regions difficulties in catering to microcomputer system environmental and power requirement and unavailability of maintenance and service . some specific areas in which contributions are needed are the following :

a) the planned PACSAT packet communicatation satellite which would provide an inexpensive digital means of tow ways communication between headquarters and filed stations as well as between field stations.

b) CARs proposed new headquarter information system

c) Microcomputers and epically extra rugged visions of widely distdistributed models (for the shack of soft where availability)for filed use in relief operations.

d) Provision of reliable rapid and inexpensive maintenance and service in remote regions.

e) Loan of training facilities and personal.

A significant event in prospect is a regional African conference scheduled for nairobe in march 1986 on the strengthening of relief operations through of microcomputer technology sponsored jointly by tow nonprofit development organization VITA and CARE the conference will address the issue noted above and preparatory work is already in progress to identify useful case studies. The conference will generate an action plan to include activates that VITA could conduct on behalf of relief organization such as CARE that will provide for sustained follow through on those issue identified by conference and other like it(e.g., the forthcoming BOSTID conference in Mexico) could benefit from the attendees and the support of the computer industry.

Medium Term Gole: Self-Sufficiency in Basic needs.

once the immediate crises have been dealt with attention turns to preventning their recurrence to ensuring the affected populations continuing ability to secure the minimum resources needed to sustain a tolerable standard of living. Indeed, "the devastating droughts in Ethiopia, the Sahel, and parts of southern Africa ... *are* ..- only the most visible manifestation of the much broader economic crisis currently facing the continent."'

A vital weapon in the struggle against the "much broader economic crisis" is information technology, which can improve the efficiency with which scarce resources are employed through better planning, budgeting and control. It can provide access to information and knowledge through communication systems and database maintenance and search services; such knowledge includes not only technical know-how required for improved agriculture and new enterprises, but also marketing information, such as current commodity prices. Furthermore, microprocessor-based applications systems themselves constitute "knowledge in tangible form."[10]

Although expatriate organizations play a vital role in development assistance and require the same kinds of assistance (noted above) as in relief operations, LDC nationals play more active roles in development programs than in short-term relief operations, where they act mainly as recipients. LDCs' own development-related organizations and agencies are highly significant potential users of microcomputer systems, and they can benefit from the same kinds of assistance as the relief organizations described above - information systems (especially extra-rugged versions of widely distributed microcomputers), digital communications systems, training in the use of these systems, and maintenance and service support that is rapid, reliable and inexpensive,

At least as important in these application areas as the information processing systems themselves, however, is "thorough analysis of the [prospective user] organization's existing systems for manually organizing and managing all of the data that will be processed by computer."" Because experience with computer applications is so much less common in LDCs, outside assistance in preparing for the transition to computers is probably more important for them than for expatriate organizations. Furthermore, if the enormous potential of microelectronics technology for catalyzing development is to be realized, it is necessary not merely to focus on automating what is already being done; it is the `power to

go beyond what they are already doing which has captured the imaginations of manger in the developing countries.
Four specific economic sector vital to basic self sufficiency are agriculture public health education and energy. Microcomputer technology has much to contribute in each of these sectors.
Agriculture land reclamation reforestation and new agriculture policies and farming practices. This sector which made possible civilization itself requires the most urgent attention:

There is gernal consensus among Africans and forgoing development specialists that agriculture production must expand more rapidly if growth is to be sustained if the standard of living for the majority of African is to improve and if the cost of food import is to stabilize…
A long run challenges facing African agriculture is to find way of makining land and labor more productive. Facilities for agriculture education research and extension which are rudimentary in most countries most be expand …… agriculture recrach on farming techniques and on improve crops my hold the key to the long run expansion in African agriculture.

Saunders and Hudson describe the use of tow way communications between lower level and upper level health workers to increase the effectiveness of both. Also mentioned is the use of remote access to computerized patient records for such purposes as:
a) Serving members of migratory populations, who may be served by several different clinics simultaneously.
b) Tracking patients as they are moved through the health care system.
c) Providing patient data and up-to-date listings of vaccination and check-up schedules to itinerant health workers going from village to village.
Much of this message traffic could be well served by electronic mail, using portable PACSAT terminals to communicate with district and provincial health centers.
Other applications" include database management, statistical analysis and modelling applications in such activities as field record management, health information systems, hospital management, demographics, population analysis and planning, and fertility and mortality research. Especially worth noting is the use of micros for interactive graphic displays of the implications of alternative population policies and growth assumptions; micros' portability is an important element in communicating policy conclusions directly and forcefully to senior government officials.
Education: primary through university, as well as vocational, literacy and health care training. Computing technology is an important tool for the educator. Although some of the currently available educational software leaves much to be desired, the best products demonstrate considerable potential.
In most countries, it is the scientific or economic communities where microcomputers will be used first. Often one fords the education sector far behind because of limited resources and lack of knowledge *of new* technologies. Yet this is the sectoy that must be cultivated early so that young people will have the practical skills to use this technology efficiently for the benefit of economic development within their own country.

It is to the educational sector, therefore, that corporate contributions may well have the greatest and most lasting value.
Among the symposia and workshops to be sponsored by the Board on Science and Technology for International Development (BOSTID) of the U.S. National Academy of Sciences is one to be held in Mexico in November 1985. It is intended to consider the "application of microcomputers and associated graphic systems .. . as a training tool throughout the educational chain."" Computer industry support for these symposia is welcome in the form of attendance or presentations by company representatives, sponsorship of attendees from LDCs, or both.
Energy: Because of the importance of energy in many developmental sectors and the need of many LDCs to import petroleum (at ruinous cost in hard currency), effective planning and control in the energy sector yields great benefits. Useful software for such purposes includes the usual database management software, word processors, spreadsheets, and packages for

math and statistics, graphics, economic and financial analysis, work scheduling and monitoring, and modeling and simulation. Applications range from energy assessments and renewable resource studies (sponsored by such agencies as the U.S. Department of Energy, the Swedish Government, the Canadian International Development Agency, the EEC and the World Bank) to engineering design and analysis of energy systems.

The microcomputer in particular helps in two ways: it makes it possible "to attempt the more challenging problem, to come closer to the ideal in decision analysis and probe a large number of alternatives... [and] forces [users] to become more organized in [their] work and develop more extensive and better sources of data."°

Crucial to the success of many kinds of relief and development projects are censuses and surveys. In the planning stages, they are needed for project design and resource allocation. While a project is in operation, they are essential for monitoring its progress and making midcourse corrections. At a project's conclusion, they are used to gauge its effectiveness as a guide to the design of subsequent projects. The main conclusions of a recently convened expert panel on survey and census processing needs were as follows:

a) There should be considerable scope for using micros to process and analyze surveys and censuses *over* the next five to ten years.

b)a good deal of soucess has already been experienced in LDCs using micro for work of this type.

D) the availability of souit able software is likely to be a much greater problem than the availability of suitable hardware.

A recent survey project in Zimbabwe used microcomputer very succefully to prosses data from 3000 household .one of the following:

One important advantages of decentralized data processing is that the work is not handed ogg from one departing to another as is typically the case when central data processing is used. With decentralized processing those involved with the actual data coultation see the prosining work through to completion and are generally much more highly motivated to preserve the quality of the data.

When result of says are used in designing relif and development project the faster turnaround of decentralized processing is as important as the result superior quality in makining the difference between faliour and success.

In the other case the Tunisian ministry of agriculture adopeted micricoumpter based spreadsheet softwwhere intending simply to speed up exciting pencil and paper work the micro were soon put to new uses however which quickely came to be more important than tha use original identified. The spreadsheet softwhere allowed Tunisians to creat there own view of the feture {a} model whose structure and and assumptions {were} controlled and manipulated by the Tunisians themselves. Any shortcomings their model relative to more elaborate foreign models implemented on distant mainframes were more than offset by the speed with which the micros could produce answers to questions, and by the fact that their predictions, being the Tunisians' own, were far more persuasive and effective in galvanizing action. Indirect impacts included giving people more time to analyze the figures, letting them undertake more tasks than before, enabling more people to undertake such tasks and decentralizing analyses. It was also noted that the micros improved working relationships in the departments using them and that they served as a bridge to other departments.

The computer industry can assist projects such as these by direct involvement, perhaps most effectively in partnership with agencies such as VITA, CARE, or Family Health International (FHI), which have considerable experience in developmental programs in LDCs. Assistance can take several forms, including donations of equipment and loans of technical personnel to analyze the prospective application, to configure and install the systems and to provide instruction in their use. Because the success of individual projects is still somewhat unpredictable (despite the recent emergence of guidelines born of experience"), it would be risky for a corporation to concentrate its assistance on too small a number of such projects.

The computer industry can also assist such projects indirectly by removing some of the common barriers to more widespread employment of microcomputers. Among these are the unavailability in most LDCs of equipment and software, of training and of quick

and reliable maintenance and service. Initially, these services would have to be provided from abroad and would no doubt incur losses for a time; provision should be made from the start, however, for training LDC nationals to take them *over* in the long term. Another form of indirect contribution would be to encourage employees to volunteer their services to Volunteers in Technical Assistance (VITA), a private nonprofit organization which has been providing technical information and consulting services to LDCs for 25 years and is a leader in the use of microcomputers for information management in LDCs. An advantage of such "infrastructural" assistance is that it benefits all users of microcomputers, both governmerit and private. And *even* in the medium term, the private sector must not be neglected, for in Africa, at any rate,
foreign aid donors and, increasingly, some African leaders believe that African governments must reduce their role in *their* economies if resource use is to be more efficient and that private entrepreneurs will duo a better job in providing *goods* and services in areas like transport, food procurement and distribution, and banking,°

Long-Term Goal: Development of Indigenous Enterprises

When we consider long-term objectives, the emphasis shifts once again from the *application* of information technologies to participation in their *development.* The focus of outside assistance broadens to include assisting LDCs in acquiring their own capabilities to develop information technology. *Motivations* are threefold: to reduce LDCs' dependence on foreign suppliers, to ensure that equipment and application software available to them are well suited to their true needs, and to secure for them a share of the proceeds. As one economist has expressed it,

Any strategy of applying microelectronics in developing countries to agriculture, industry or the exploration, exploitation and use of natural resources requires strong capacities to develop, operate and maintain software, particularly applications software. Strong capacities in applications software *are,* in fact, a prerequisite not only for selective delinking from application patterns a Ia OECD, but also for effectively integrating the application of microelectronics to the overall concept of development. What matters is that there is secured access to knowledge needed to run, adapt and maintain information processing and communication systems [and] industrial electronic equipment and to subordinate their use to the requirements of development strategies.'[6]
Complete independence, however, is not to be hoped for. Capital requirements are so large and markets so, small that, as David *O'Connor* has expressed it,
.. the opportunities for local computer production are limited for most developing countries.. . For most countries, a niche-oriented approach concentrating on the development of software and the configuration of systems for local and possibly regional vertical markets is apt to be the most viable entry strategy".

Nor should an LDC; necessarily regret its inability to develop an indigenous computer industry:
When the contribution of computer applications to other industries' export potential u considered, the new effect of the computer sector on a country's overall balance of trade may be positive, even though it runs a chronic deficit on computer trades'

How can the U.S, computer industry promote and encourage such developments? O'Connor suggests that "partnerships or subcontracting arrangements with local software institutes. .. are apt to be the most common form of software-related activity undertaken by developed country-based computer firms in developing country markets." As an example, O'Connor notes, "the U.S: based Burroughs Corporation ... has an export-oriented software joint venture with the Tata Group in India."[3°]
The Tata Group, India's largest private concern (with annual revenues of about $3 billion), has been distributing Burroughs products since 1974. The software joint venture referred to by O'Connor is an outgrowth of the distributorship's service bureau, which had purchased a Burroughs B6700 computer system and had undertaken some overseas software assignments for Burroughs as a way of meeting the Indian government's requirements that such imports be offset by exports.
The software projects' success demonstrated Tata's suitability as a partner for Burroughs in expanding the tatter's share of the growing Indian computer systems market. Accordingly,

Tata Burroughs Limited, a formal joint venture, was set up in 1978 to engage in three distinct activities: sales of Burroughs systems, manufacture of certain Burroughs hardware and international software consultancy. Of these, the last has been the most successful - more so, in fact, than either partner had anticipated. This success has been attributed to the parent companies' flexibility in recognizing the venture's early potential and in quickly adapting their goals and plans to make the most of it."

Tata Burroughs currently maintains a pool of some 400 programmers based in Bombay whose services are exported worldwide for software consulting - converting and adapting existing software, developing new applications and providing training for users of Burroughs systems. The consultants themselves receive continual training both in India and in the U.S. and gain further experience in their on-the-job exposure to state-of-the-art systems both at Burroughs installations and at customers' sites in the U.S. and Europe. Equipped with this expertise, they are particularly well suited by their Indian nationality to apply it in Third World countries and have worked successfully in such places as Sri Lanka, Singapore, Hong Kong, China, the Mideast and Jamaica. Consulting assignments are fairly brief (typically a few months each), and consecutive assignments often take a consultant from the U.S. or Europe to an LDC. As an avenue for technology transfer to LDCs, therefore, the program's impact appears to be substantial.

By encouraging and assisting local entrepreneurs in setting up software development, *service* and maintenance enterprises, expatriate computer firms can contribute to Third World development efforts while building future markets for their own products. The companies' overt contribution could take such forms as relaxed expectations for immediate returns on its investment, better support (training, translation, etc.) and more liberal credit terms.

Computer industry firms can provide further assistance by supporting the national "centers of excellence." Such centers

could serve a number of purposes. *They* could offer advice and assistance for the selection and installation of both hardware and software and be available for consultation on issues of standardization and compatibility without playing a decisionmaking role. They could provide an opportunity for potential microcomputer users to test hardware and software to ensure that the equipment package they decide to acquire is appropriate for their use. The center should also serve as a clearinghouse for microcomputer applications developed in other countries with similar needs. Information and software available at the center would limit the amount of investment the individual microcomputer user would have to make. They could serve as meeting places where groups of users could exchange information; if the centers also had access to telecommunications equipment, these groups could include members from developed as well as developing countries. Finally, they should contaid libraries of manuals, both for hardware and software, providing access to information that the
individual user might find it uneconomical to acquire."

Computer industry support could include equipment, documentation and other literature, provision of visiting experts and guest speakers, and subsidization of packet communications and electronic mail facilities to link centers with one another and with the global technical community.

The greatest contribution the industry can make, however, is probably in the field of education- Whereas assistance appropriate to medium-term gdals includes support for the application of information technology to education in general, long-term educational assistance *should* expand to include education and training in information technology as a subject in itself, for a significant informatics sector can only be constructed atop a strong and broad foundation of knowledge.

Corporate contributions to higher education are a familiar idea, of course- Many of the forms of assistance practiced in the U.S, are equally appropriate for LDC universities: grants of equipment, research and development contracts, endowment of professorial chairs, faculty and student fellowships, subsidization of conferences, provision of visiting lecturers, and temporary employment of faculty and students during holidays and of faculty members during their sabbaticals.

In LDCs, *however,* it is not only the pinnacle of the educational system that needs support, but also the much broader supporting layers- This is partly because the fraction of the working population

that attends universities - or even finishes secondary school - is far smaller in LDCs than in the U.S., so that assistance to universities reaches a far smaller group. Another reason is that LDC's' vocational training systems - public, private and intracorporate-are far less developed than in the U.S. Accordingly, means devised whereby sub-university training programs can be made accessible to far larger audiences than the universities can serve so that as many people as are needed can find employment in the information technology sector as paraprofessionals - technicians, operators, software customizers, and so on - for whom university-level training is not necessary.

As developed countries' computer firms extend their influence into the LDCs both in their development assistance' programs and in their business activities, they need to recognize that various LDC governments (a notable example is Sri Lanka) are beginning to formulate policies intended to enable them to come to terms with the information revolution. The need for such policies arises from the recognition that

computer technology is changing the world within which developing countries struggle for economic survival and growth. This change is a matter of great significance because computers can profoundly affect the central social and economic functions of an interdependent world economy. This technology will change every country's development opportunities. How developing countries manage the computer technology change process will influence whether their development goals will be achieved. Structuring that process will determine who will benefit and in what ways. Therefore these change processes require systematic consideration In the formulation and implementation of national policy 3[1]

The computer industry should strive to support such national policies where they have been established and should encourage LDC governments to develop them where *they* have not.

A model policy worthy of consideration by any LDC government has been formulated in Sri Lanka "under general national guidelines encouraging application of information technology through detailed planning by government ministries, and by allowing considerable initiative on the part of the private sector and individual professionals."" The Sri Lankan policy's objectives and guidelines reflect "the conviction that given the support and guidance of the government, and a commitment of resources that will be very modest in terms of an overall national investment program, the resulting developments in computers and information technology will bring about incremental improvements in all other sectors of the economy."" Such an enlightened policy deserves the support of the computer and information technology industry worldwide.

Summary

We have discussed numerous ways in which firms of the computer and information technology industry can contribute to relief and development efforts designed to improve standards of living in the world's less-developed countries. Although firms belonging to this industry can, like any other firms, donate funds and other "generic" forms of assistance, the paramount importance to relief and development efforts of information technology - and in particular of microcomputers - puts them in unique position to contribute.

Possible contributions are classified according to the time scale of the goals to which they are addressed. In the short term, the goal is relief from disasters, particularly famine. The most appropriate forms of assistance appear to be contributions of equipment and loans of technical personnel to established international relief agencies.

The primary medium-term objective is to prevent recurrence of famines, epidemics and other disasters by improving the abilities of the populations at risk to secure adequate supplies of basic resources such as food, water, medical supplies, clothing and shelter. Assistance toward this goal is designed mainly to help LDCs' own development agencies and private enterprises make effective use of microcomputerbased systems.

The long-term objective of every development assistance program must be to render further assistance unnecessary. In the present context, this means the LDCs must develop their own capabilities in microcomputer systems and information technology. Although it would be unreasonable to expect each LDC to develop its own complete computer industry,

there appear to be substantial opportunities for them in system integration and applications development for national, regional and even global markets. Expatriate firms can contribute to the development of such capabilities by entering into joint ventures with local enterprises, by supporting centers of excellence set up to assist LDC microcomputer users and by supporting educational programs and institutions at all levels in their efforts to broaden the base of technical know-how in information technology.

Finally, it should be noted that merely by extending their marketing and service organizations into remote regions, where the lack of services taken so much for granted in the West is crippling, computer industry firms make a valuable contribution to the adoption of information technology that is independent of time scale.

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CHAPTER 6
Technology and The Human Factor The Uses of Microcomputers

Dan Resnick

Just as the vast inequality among nations is reflected in indicators of wealth per capita, education and human services, so is it also seen in access to new technology. But because the developing world remains overwhelmingly rural and agricultural advanced technology may appear as a trap to avoid rather than a gap to narrow; for with new technology, there is the fear of unemployment, conflict between generations, foreign dependence and the devaluing of traditional village life. Can computer technology be any different?

All nations now have access to the technology of hand tools for human pursuits that range from agriculture and construction to music and pictorial art. In some areas, the hand tool, the symbol of artisanal production, enjoys a merited reverence. In other areas, it is correctly seen as an instrument of crippling labor. The short hoe has bent and twisted enough farm workers for it never to be the subject of an elegy.

Almost all nations in some sectors of their economic activity have access to the technology of power tools. Motors come in all sizes, shapes and applications, suitable for particular agricultural, industrial and domestic purposes. There are lathes for production, generators for power and tractors for a variety of farm and construction work. From *aircraft* engines to tiny fans, the motor in various shapes and sizes has gained wide acceptance. A few people reject motors on principle, a few more on their days of rest; for most, however, the question is not whether motors in general are an appropriate technology, but whether a particular tractor, processor, or generator is right for a particular project.

Only a few nations are rich in computers, which are still expensive acquisitions. These tools have in the past forty years undergone a remarkable transformation. The replacement of vacuum tubes first by transistors and then by integrated circuits has reduced size and price while increasing speed and memory. The maxi mainframe that once required an air-conditioned presidential suite is ceding its market to powerful minis that can fit on desktops; and the micros, some nearly as powerful as the minis, have found a place in the household. But computers have not yet had the opportunity to evolve into the varied pieces of relatively low-priced equipment that now characterize motor-driven tools. The consumer does not expect to use the same motor both to drill a hole through metal and to whip up a chocolate mousse; but with computers, the buyer still risks having to purchase expensive all-purpose equipment for which, as an add-on, special applications software must be purchased.

The microcomputer has become an appropriate tool for human resource development projects. Small units with eight, sixteen or thirty-two bit microprocessors, in modest configurations of less than a megabyte of memory, with monochrome screens, can be

purchased for prices that range from $300 to $3,000. A few are available as battery-powered instruments that also resist dust and high tempera tures. They ale powerful enough to handle a variety of functions, from data collection and analysis to instruction. Because they allow data to be collected, stored and analysed without reference to centrally controlled data banks, they are an excellent development tool for rural areas.

Nonetheless, there are very few micros in the developing world. There are mainframes in the capital cities of even the poorest countries in sub-Saharan Africa, serving the interests of large state agencies, but very few smaller machines to serve the interests of cooperatives, small universities, schools, health centers and isolated branches of public administration. Because the number of micros available to developing world users has been very limited, the range of possible uses has not been well explored.

The question of how microcomputer technology can be priate for development purposes needs to be examined in the light of all current knowledge. Given the small amount of experimen tation that has taken place to date, what has been learned in the trial programs of the World Center for Informatics in Paris is of special interest.

The World Center for Informatics president re mo n Mitre and to tique) was created four years ago by p address the development and diffusion of computer technology interest France and the developing world. From the beginning, to deal with has been in the human factor - the training of people Both our first

the possibilities presented by this new technology. president, Jean-Jacques Servan-Schreiber, and our current president, lean-Louis Funck-Brentano, have called the improvement of human

skills and talents an economic and moral imperative. What have we done, and what have we learned? Software and some hardware development was undertaken for pr agr Mural three human services areas aneducation medical diagnosis tand treatment. management and planning, The material developed was used in various trial programs within France and in parts of the Third World. In the course of our experimentation, we have learned a great deal about how users relate to computers, and also about ways in which the technology needs to microcomputers in heoareas r of education and medi ine will be described evolve. S below.

Informatics and Education

The notion of what should be learned as a part of general education continues to broaden and deepen in modern societies, at the same time that methods for making that learning and efficient ect receive more attention. Some of the work by pedagogues writing and

area specialists in teaching basic literacy skills - reading, writing - has been done with computers. At the Center, we have been especially interested in computer-aided basic literacy programs for very young children.

Computers for the classroom, starting with the earliest grades, are a priority public school investmentt in the developed market economies and are becoming so elsewhere. The school landscape is now dotted everywhere with experiments of various kinds to see how the technology can be best adapted, and with what software, for children of different ages, studying different kinds of subject matter in different cultural settings. The Center has participated in this experimentation, encouraging a national plan for computer workshops in France (Plan Fabius) based in the schools.

The printing press, generating inexpensive and standardized text, made possible Martin Luther's mass literacy movement, the first in the modem period. What, then, can computers be expected to contribute to the growth of literacy skills in our own century? Most computer programs are designed for the already literate. Interaction with the computer takes place almost everywhere in the West through the medium of alphabetic text. The means of access to the screen is most frequently a keyboard, with the same letter-face that was introduced on typewriters a century ago. The ability to read at some level is a prerequisite for all but the most routine of instructional programs. Progress on many programs demands the skills of a touch typist.

We have found, however, in trial programs with children aged 4-7 that it was possible to design programs that used the keyboard and screen graphics to make learning and manipulating words easier. Learning goals could now be extended from the reading of unfamiliar text to writipg stories. Access to interesting teachers and good written materials helped make this growth possible, but the computer played an essential role. Children enjoyed working with

attractive graphics and screen text. Especially appealing was a nearby printer attached to the computer which gave the child the experience and satisfactions of an author

Those who have had experience with children from poor and immigrant neighborhoods in these trial programs are enthusiastic about the human possibilities opened up by this technology. Of course, this computer software is an aid to teachers, not a replacement for them; it is also an additional expense, above and beyond textbooks. But it does permit skill development that was not possible under other conditions. Developing countries can allow their interest in this kind of program to grow as the price of hardware drops. We are currently discussing with educators from countries in the South the codevelopment of software in other languages to teach reading and composition in ways appropriate to other cultural traditions.

Adult Technical Programs: Training Computer Educators

Computers, unlike humans, *are* capable of working day and night and beneft from installations where they can receive round-the clock use. The Center has been an advocate of computer practice centers in public buildings, where *heavy* investments in equipment can be justified by equally heavy use. This formula for grouping machines, software and printers was adopted for France on a national scale in the Prime Minister's programs, Informatique Pour Tous. With our encouragement, a program of public computer centers has also been launched by Colombia, which now has at least eight centers in operation.

Computer literacy centers require trained personnel to run them. At the handsome Bourguiba Center in Tunis, inaugurated in 1985, we ran our first technical training program outside France for prospective computer center directors. Our staff, in cooperation with computer scientist-educators from Tunisia, ran a six-week pro gram for trainees from Tunisia, Senegal and the Ivory Coast.

we agreed with our host in tunids that such entries to assures their viability would have improved de instruction for three different groups - government employees interested in the processing, filing and retrieval of information; students and researchers in universities

and schools with specific instructional or programming needs; and a wider public interested in gaining some hands-on experience with different kinds of software. The instructional program was thus centered on application software for text editing, budgeting, and planning and less heavily on programming languages.

What does a computer center manager need to know? Our answer was that, in addition to center management issues and some primary maintenance on the machines, the training program should cover software applications of interest to prospective users.

It is likely that such centers will grow in appeal, because they and can make efficient use of both different ons of the public. A booklet meet the needs of many hobos on the running of such a center, including at Center drawing for training managers, is now being prepared by on the experience with our latest training program in Tunis.

Videodisks for Instruction

Visually interesting programs for instruction can be run interactively with computers without recourse to the alphabetic keyboard. Such programs are accessible even to illiterate audiences. We have bec ome of extent to eyboard tordefinehresponses far•exceeds the needs of certain programs. For many uses, even the small key-Set of a telephone - ten to twelve keys - is more than sufficient. In a in light pen, mouse or finger touch is enough videodisk of program density. great an work with the simple st of interfaces for programs read storage About the size of an LP record, the videodisk has g capacity: 54,000 images on one side, enough to hold all the volumes

of a great encyclopedia. The stored information is not under various instructional purposes unless it can be accessed rapidly,

headings, and properly displayed. A microprocessor unit is needed for access to the images and sound tracks, and a television screen or

pry. Very shortly, it should be possible player to and to place the micro have a work rocessor controls within the videodisk plc. la er unit.

station that consists of only the screeno begin to learn from a
No more skill is currently required videodisk program than is needed to listen to a television program,

change the station, raise and lower volume. Instructions bout what what s questions the viewer n, whatrareass ofaknowledge should be opened
should be shown ago the up, can be given by non-alphabetic screen control devices like have mouse. Text messages do appear on the videodisk programs produced because we found them useful, but they can be replaced by
voice and icon cues.

We have been producer or co-producer of three videodisks, one in the field of public health and the other two in the area of farm management. The first of these, and the only one that has had a year of trials in different settings, won a prize for its quality as a teaching program in emergency medical care. The other two will soon enter their trial phase. In each of these cases, our use of the videodisk is an experiment to explore educational uses of the medium, to encourage investment in this technology and to produce programs of high quality.

Interactive videodisks are a useful device for conveying visually interesting educational material even to illiterate viewers. But without experimentation, there will be little pressure for the improvement of technology, and in a commercial sense, little priming of markets. Production costs are high. The authoring of software that places images and sound tracks in particular sequences, and the graphics card hardware that permits the user to access the sound and images, are an investment whose cost can be recovered from royalties. But the storybook, production and pressing costs are specific to each videodisk.

Portable Microcomputers in Rural Areas

Most makers of portable microcomputers have addressed themselves to the market offered by executives and other professionals in the developed world. They have created a briefcase tool, like a dictating machine or a calculator, that can be carried home or taken on business trips. To meet the needs of this market, attention has been paid to size and weight, the number of lines on the screen, memory, the readability of the screen, and easy linkage to other computers, telecommunications and printers. Some of the needs of developing areas are reflected in these features, others not at all. Although the capabilities of the portable continue to evolve, and prices are declining even as improvements appear, the specific needs of the South have not received adequate attention.

The environment of the developing world is not that of the executive in the industrial North. Machines in the North can live in power-rich and often air-conditioned comfort, traveling in automobiles with *shock* absorbers on smooth road surfaces. In the South, those machines must live in a ruder, less accommodating environment. They must be able to survive very high temperatures for long periods; they must resist the penetration of dust and moisture; they must be able to resist shock; they must generate very little heat themselves; and they must be easily rechargeable.

Some of the improvements in the portable over the last three years will benefit North and South alike. Relatively large internal memories, readable screens, rechargeable battery units and communication with larger standard machines are now possible on many models. What has not received adequate attention is how to make the machine more rugged, dust-resistant, shockproof and *imper*vious to moisture.

The Center has been a pioneer in the development and trial of medical software that can serve health needs in developing areas. For this purpose, we needed a very rugged portable computer with good battery life that would function well in high temperatures, rough terrain, dust and sand. We identified only one machine that met our specifications and *have* continued to work with it in field trials. It now offers up to 352K of memory, an eight-line LCD screen and safe data storage. A bottom-of-the-line model with 80K of memory sells for about $[,600; the 352K model is available at $5,000. Such machines have a variety of uses for data collection and analysis in field studies.

The computer, equipped with appropriate software and data banks, can be an important way to bring expert knowledge into "bush" areas for the training of health workers, the gathering and maintenance of patient files and the diagnosis and treatment of diseases. Experiments are needed, however, to establish the quality of what has been produced, its relevance to the user and its effectiveness in altering health care.

For Chad, our group designed software programs to create and access a data bank containing the symptoms of about 500 tropical diseases. To this was added a data bank of medicines recommended by the World Health Organisation. The program proposes a step-by-step procedure for diagnosis and relates diagnosis to rec-
ommended medicines for treatment, where appropriate. The rural health worker thus has an opportunity to model his own procedure and judgement on that offered by the program, which tries to offer expert medical consensus, where this exists.

Devices of this kind can be excellent aids in the training of medical and paramedical personnel in developed and developing sites, but we recognize that a good deal of human resource development in the health area may be necessary before they can be effective in saving lives. It is easier to *reduce* error in diagnosis than it is to make treatment more effective. More error-free diagnosis may call for special medication, hospital procedures and medical expertise. But if the medication is not available or is past its shelf life, if the hospital is too distant or expensive and the medical expertise absent, better diagnostic aids can do little to improve treatment.

Micros and Human Development in the South

Health and education investments have no short-term payoffs and are difficult to justify in terms of two or three-year perspectives. It is evident from World Bank statistics that central government expenditures for health and education have been declining as a portion of total expenditures in developing countries over the past decade. Fiscal constraints imposed by international lending agencies have contributed to the scarcity of funding. How, then, can we expect microcomputers, which will add to the cost of health and education spending, to assume a place in human resource programs in the developing world?

Funding for investment in computer technology is likely to become, available before the larger issues of priorities for human resource development are resolved. The largest single explanation for this is to be found in the current gear-saturation, at least in the short tern, of markets for microcomputers in the developed world, and the intense competition for new outlets that has developed among the major producers in the U.S., Western Europe and Japan. The competition for new markets has brought pressure on development agencies to favour computer-aided development programs. In some cases, manufacturers are negotiating directly with foreign states and agencies; in other cases, they are working through their governments and international agencies. In all cases, there is interest in stimulating the growth of markets in developing countries, particularly those that are middle-income.

Receiving unwanted, unnecessary or poorly chosen technology can launch national computer development on an irrational and unproductive course. It is not simply that the recipient country may have to work with outdated models and inappropriate equipment; the larger problem is that each piece of computer equipment (gift or purchase) entails an investment in collateral costs at least equal to the value of the machine. These costs will develop in the areas of maintenance, personnel training, software acquisition, site and power source preparation and communication with other computers.

Moreover, because the operating systems are not yet standardized, it is conceivable that public administrations may find themselves with different systems, accepted in part as donations, which cannot communicate with one another. Files developed on one may not be transferable to the other, and training programs developed for one machine may not be appropriate to others. Although this problem is on its way to resolution, the question of compatibility must be considered from the moment the first investments are made.

A number of developing countries addressed this issue in meetings as early as 1978. The clearest policy statement, with recommendations for practical action, came from a report of a conference held last *year* in Colombo, Sri Lanka. Two groups organized in 1982-83 Btnded this gathering, one Sri Lankan and the other American. The Sri Lankan group was the the Computer Information and Technology Council, responsible for computer and informatics policy. The other patron and organizer was the Bureau for Science and Technology of the U.S. Agency for International Development, which funded the Board on Science and Technology for International Development (BOSTID) of the National Research Council, National Academy of Sciences, to discuss the place of this technology in international development.

Technology gap or technology trap? The authors of the Colombo report *are* convinced that micros are coming, and that they -will greatly benefit developing countries. The hardware is likely to be

produced outside the country by foreign suppliers, but if the terms of access are monitored, national computer industries will also develop, especially in software production and hardware maintenance.

Gap or trap? The historical experiment that will allow us to answer this question may never be completed. Protectionist strategies and donor agency resistance, both tied to the current economic crisis, may *have* the last word. But the industries thit make computers are tapping at the door - sometimes pounding - in the search for new markets. If they succeed in opening the door, it will be up to watchdog advisory commissions in international agencies and developing countries to see that the benefits return not only to the exporters of the North, but also to the peoples of the South.

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CHAPTER 7

Informatics and Development: Notes on Selected Programmes

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Variously described as informatics technologies, microelectronics technologies and information technologies, the advanced products and processes emanating from the laboratories, research institutes and factories of the developed countries represent a formidable challenge to the developing world. These products and processes, which collectively constitute a quantum improvement (some would say "revolution") in systems for the creation, manipulation, analysis and distribution of information, raise information itself to a position of paramount importance in the improvement and reconstruction of national and regional economies - the process which we call "development."

While the role of information in the process of development has always been great, the advances of the newly emerging information technologies have created a force for change of such magnitude that countries of both the South and the North are now re-evaluating the attention *which* they focus on information sciences. *This* re-evaluation must inevitably bring national and regional planners and policymakers to the conclusion that the disciplines *which* constitute the information sciences represent the principal tools with which to channel the force for change created by the new information technologies toward development goals.

In the rush of events caused by the advance of these new technologies, it is sometimes forgotten that information is at their root. Yet information is the resource which the new

technologies bring to bear on the problems of agriculture, health and rural development suffered by the poorest of the poor countries; information is the value which is added to new products in order to expand the export markets of the newly industrialized countries; and it is information which all countries of the South must employ in their efforts to develop.

In order to employ information in the service of development, developing countries need to raise their awareness of the state of the new information technologies. Such an awareness-raising must include the "sensibilization" of those in all sectors of a country's economic and social life - including, but not limited to, those in government, commerce, science and culture - in order that a realistic evaluation of opportunities, benefits, limitations and liabilities can be made.

This evaluation of the utility of the new information technologies-for development must be made within the constraints of each country's own culture, aspirations and abilities. These constraints undoubtedly will be different from those of the porthem countries and suggest that the experiences of the North may not hold much value for the South. On the other hand, the experiences of southern countries can (and, many would argue, must) be shared usefully and exploited to foster regional cooperation.

The successful integration of the new information technologies into the development plans of southern countries will require careful consideration of several important issues. These include strategies for technology adoption, the problems of technology transfer and absorption, the provision of adequate scientific and technical infrastructure'and the development of human resources. This paper describes selected agency p$_{rogrammes}$ which address these issues. The information summarized in the agency descriptions was drawn from agency-published materials and from discussions with agency staff. While by no means exhaustive, this selection is fairly representative of development agencies which have identified informatics as a distinct component of their work.

BOSTID

The Board on Science and Technology for International Development (BOSTID) of the U.S. National Research Council is conducting a three-year programme of investigation into the use of microcomputers in and for developing countries. The principal activities of this programme are a series of four related symposia focused on specific topics and a companion series of studies and reports. The goal of the programme is an examination of the issues involved in the "rational dissemination of microcomputer technology in developing countries."

The origins of this programme of investigation lie in an inquiry from the U.S. Agency for International Development (USAID) about the application of microprocessor-based technologies in international development. While it is expected that such technologies will be adopted for use by developing countries without special encouragement by donor agencies, it is recognized that the rational transfer of these technologies to developing countries requires an examination of several policy and technical issues.

Through the mechanism of the symposia series, BOSTID hopes to help developing countries assess the potential and limitations of microcomputer technology. It also hopes to aid donor agencies in assessing the need for, and the effect of, microcomputers on development projects. In addition, BOSTID expects that its programme of investigation will assist in the evaluation of potential microcomputer applications in diverse fields of social and economic development.

The, first symposium in the BOSTID series, held from 4-9 November 1984 in Sri Lanka, dealt with microcomputer applications in the fields of agriculture, energy and health. The second in the series, to be held in November 1985 in Mexico, will deal with microcomputer-based technologies for education and training in primary schools, universities and vocational programmes. The remaining symposia in the series will address developments in higher-order microprocessor-based technologies such as robotics, expert systems, remote sensing, biomedical instrumentation and CAD/CAM, as well as issues of public and private sector policy.

The published reports and studies arising from BOSTID's programme of investigation will be of use both to specialists in microprocessor-based disciplines and to nonspecialist policy-makers in science and technology.

Commonwealth Working Group

The Commonwealth Working Group on the Management of Technological Change, affiliated with the Commonwealth Secretariat's Economic Affairs Division, studies and

reports on the effect of technological change on industry and industrialization and on the effects of such change on economic growth, employment, international trade and social matters. The principal product of the Working Group is a collection of reports which emphasize the broad implications of these effects for both government policies and society at large and which speak with particular relevance to the needs and problems of developing countries.

In producing this collection of reports, the Working Group seeks to support discussions among members of the Commonwealth which will lead to the initiation of national and international actions to harness new technologies for the provision of the basic needs of "the majority of humanity: people who have little purchasing power and who live in' countries with small indigenous technological capaccity." As an aid to these discussions, the Working Group has drafted recommendations concerning national decision making, adjustment policies, technologies for basic needs, the creation of an indigenous technological capacity, importation' of technologies, and Commonwealth and international cooperation.

The Working Group observes that a realistic assessment of technological changes involves recognition of the negative consequences and painful adaptations which such changes may cause and argues that "a principal objective of public policy should be to mitigate them." It is posited that through a programme of technological forecasting and assessment, strategic responses to new technologies can be formulated by governments, and that such responses can minimize the need for the adoption of ad hoc and post ad hoc policies. Consideration of education and training requirements for the use and development of new technologies is seen as the necessary first component of governments' strategic responses to technological change, followed by consideration of policies to ameliorate the resulting economic and social changes.

One technology which the Working Group affords special attention is microelectronics, arguing that "since microelectronics relies on digital logic, it is essentially an information processing technology, and (that] information processing is crucial in almost all productive activities." In addition to the Working Group's own work on microelectronics technology, a report on the *effect* and policy implications of microelectronics technology has been written for the Working Group by the University of Sussex Science Policy Research Unit.

Intergovernmental Bureau for Informatics

The Intergovernmental Bureau for Informatics (181) is charged by its charter to "assist people, in the field of informatics, to help them live in the context created by this discipline, to understand better its impact on society, and to derive the maximum benefit from its possibilities." It is guided by the needs of developing countries in the formulation of its programme of activities.

For the biennium which ended in October 1994, 181 directed its programme towards the transfer of informatics technology by engaging in specific development projects and by providing the training necessary to strengthen the human infrastructure required for successful technology transfer. In addition, 18! participated in technical assistance programmes, the formulation of informatics strategies and policies, the dissemination of information about informatics, efforts at regional cooperation and assistance, and limited development of informatics technology itself.

As part of its programme to keep abreast of the leading edge of informatics development, 181 created a series of "reflection groups" to meet, study and report on a range of topics, including the sociocultural repercussions of informatics, informatics and intelligence, informatics prospects and development, and informatics and sovereignty in Latin America;,As a direct result of a meeting held on this last topic in Cali, Colombia, the Club of Call was founded to promote the use of informatics as a strategy in support of Caribbean and Latin American regional integration.

In preparation for the Second Intergovernmental Conference on Strategies and Policies for Informatics (SPIN II), a series of meetings were held to discuss a variety of thematic and logistical matters and to initiate the Special Programme of Informatics for Development (SPINDE). In one of several activities for the development of basic informatics infrastructures, an IBI analysis of computer-assisted learning (CAL) methodologies for developing countries resulted in both a series of proposals for the training of professionals and officials in current informatics developments and the definition of a series

of pilot-level experiments.
IBPs present programme of work continues to be directed toward the transfer of technology, with an emphasis on contemporary requirements. It considers that the fluid nature of current informatics technology and application precludes IBI from concentrating now on the longer-term effects of informatics.

International Development Research Centre

The International Development Research Centre (IDRC) was established in 1970 by the Parliament of Canada to "initiate, encourage, support and conduct research into the problems of the developing regions of the world and into the means for applying and adapting scientific, technical and other knowledge to the economic and social advancement of those regions." In pursuit of these corporate objectives, the Centre's Social Sciences Division and Information Sciences Division support programmes of problem-oriented research into the use and effects of informatics technologies.
One such programme investigates the socio, economic and cultural effects of microelectronics and other informatics technologies on developing countries. This investigation involves a series of studies on the local informatics sectors in Korea, India and other countries; on trends in technology, price and international trade for products and components used in the telecommunications industry; and on the long-term effect of informatics on Argentinian society. Other studies include examinations of the effect of computers on patterns of organization and education in a number of different sectors in Chile; of existing public policies which have an effect on the microelectronics sector in Argentina; and of the development of computer related indicators to provide information about the informatics sector in Latin America.
Another IDRC programme assists in the development of endogenous research capacity in such fields as computing, telecommunications and remote sensing. Emphasis is placed on the development and use of tools and methods which improve access to, and use of, information for research and planning. Recent activities in this programme include support for:
a) An information centre on development policy modelling which disseminates information about computer-based model ling techniques for socioeconomic development.
b) A feasibility study on a Latin American regional information network to manage information about informatics.
c) The development of microcomputer software for the manage ment of developing country debt information.
d) The tranfer of remote-sensing technology to China.
e) The first extensive international scientific conference to be conducted using computer-based techniques.

International Labour Office

The International Labour Office (ILO) of the International Labour Organization has a Technology Programme which, guided by the recommendations of the Vienna Programme of Action, has the objective, inter alia, of improving "patterns of international technological relations to ensure that appropriate employment-generating technologies are developed and applied, and that the adverse effects of technological innovations on social and labour conditions in advanced and developing countries are minimized." With reference to "new" technologies such as microelectronics, the ILO is emphasizing activities related to the development of human resources, consideration of effects on skill requirements and North-South relations, strengthening of the endogenous technological capacities of developing countries and maximization of the contribution of new technologies to development objectives.
Concerned about the employment-reducing effects of new technologies, especially on female workers, and aware that the international division of labour will be affected by the application of new information technologies in developed countries, the ILO has under-taken, among other activities: the construction of a conceptual framework for analysis of structural and technological change in preparation for a series of empirical studies on the role of electronics in newly industrialized countries; a research study on the effects of new

information technologies on the service sector, including the effect of promoting growth in service-like activities within the manufacturing and agrieulturaal sectors; an investigation of methodologies for studying secondary linkage effect of industrial and commercial applications and use of micro-electronics technologies; and an examination of the consequences of microelectronics use in the automobile industry.

The ILO has also studied the potential and limitations of blending new technologies with traditional economic activities. The results of this work were published as a collection of case studies as diverse as consideration of the use of numerically-controlled machines on traditional lathes in Brazil and the application of microcomputers to agricultural planning in Portugal. Current work related to the blending of technologies concerns conceptual issues, policy considerations and training requirements.

Other areas of ILO endeavour relevant to informatics include assistance to national governments in establishing technology institutions, the dissemination of research results and the development of training packages concerning the use of computers.

UNCSTD/Advance Technology Alert System

The Advance Technology Alert System (ATAS) was created by the United Nations Centre for Science and Technology for Development (UNCSTD) in response to its charge by the U.N. General Assembly Intergovernmental Committee on Science and Technology for Development to implement a programme in accordance with the recommendations of the Vienna Programme of Action that arrangements be initiated "for the early identification and assessment of new scientific and technological developments which may adversely affect the development process, as well as those *which* may have specific and potential importance for that process and for strengthening the scientific and technological capacities of the developing countries." The ATAS programme of work is composed of three principal parts. These are *the ATAS Bulletin,* the ATAS network and assistance to member states.

The *ATAS Bulletin* is a semiannual publication designed to reach science and technology policy-makers and planners in developing countries. The emphasis of the *Bulletin* is on advanced and emerging technologies, and each technology chosen for treatment in the *Bulletin* becomes that issue's sole focus. The upcoming second issue of the *ATAS Bulletin* deals with microelectronics-based automaion technologies. This will be followed by an issue dealing with new information technologies.

The ATAS network is an attempt to join together technology forecasting and technology assessment institutions, individual forecasters and assessors, and sources of information on advanced technologies in a cooperative effort to improve the capacity of developing countries to assess the effects of new technologies. In cooperation with the Deutsche Stiftung fur Internationals Eniwicklung (the German Foundation for International Development), ATAS is planning an international meeting at which the possible objectives, strategies and activities of such an effort can be discussed and evaluated.

In order to provide information to national planners and decision-makers and to sensitize them to the likely effects and applications of new technologies, ATAS works with member states, regional organizations and others to undertake studies, prepare reports and convene meetings of relevance to developing countries. Recent examples include an examination of the effects of advanced technologies on Caribbean regional development, prepared for the Caribbean Council for Science and Technology, and a meeting of experts to assess such effects on the Lagos Plan of Action, as requested by the Organization for African Unity.

UNESCO

The work of the Informatics Section of the United Nations Educational, Scientific and Cultural Organization (UNESCO) for the biennium ending this year is concentrated in five principal actions. These are (i) the formulation of strategies for the development of informatics, (ii) the strengthening and development of institutions and means of education, training and information concerning informatics, (iii) the study of the social consequences of the applications of informatics, (iv) the acquisition and adaptation of technology and (v) international cooperation for the development of informatics. Examples of curtenl[m]lnforrnatics Section work include:

a) Support for regional and national seminars on priority fields for

the application of informatics, such as the First National Con ference on Computer Applications held in cooperation with the Committee of Directors of Nigerian University Computer Centres.

b) Pilot experiments in the teaching of microinformatics in primary and secondary education, in cooperation with the China Association for Science and Technology and the Conseil de la Recherche Scientifique of Algeria.

c) Preparation of four case studies on the sociocultural effects of informatics, including the application of microcomputers, in cooperation with IS!, IF!?, and ICSU, inter olio.

d) Pilot and research projects to strengthen national capacities for informatics technology acquisition and adaptation in Angola, Benin, the Dominican Republic, Morocco, Pakistan, Syria and Tanzania.

e) Contribution to a workshop organized by the World Federation of Engineering Organizations in Nairobi on microcomputer controls in irrigation, industrial production and other fields.

In addition, the Informatics Section is proceeding with the work arising from the 1954 meeting of the Interim Intergovernmen tal Committee for the Intergovernmental Informatics Programme (IIP). This includes publication of the amended main working document under the title *Framework for Informatics in Developing Countries* liaison with UNESCO member states wishing to par-

ticipate in the IIP; and the stimulation of South-South cooperation in potential IIP activities. The formal proposal to establish the IIP will be submitted to the UNESCO General Conference this autumn.

United Nations Centre on Transnational Corporations

The United Nations Centre on Transnational Corporations (UNCTC) is engaged in a programme of research and technical assistance concerning informatics technologies and their effects on both developing and developed countries. As part of a larger investigation into trade in data services, the Centre has undertaken the coordination and sponsorship of a series of studies which investigate transnational corporations and transborder data flow.

These investigations involve the collection and analysis of data concerning the emergence of informatics technologies, the infrastructure of transborder data flow and the structure of the international data market. As well, UNCTC studies assess the implications of transborder data flow for host countries, the actions taken in national and international fora concerning the transborder flow of personal and nonpersonal data, and the economic effects of transborder data flow.

In addition to these investigations, the Centre is studying the case of transborder data flow in five countries, including Brazil. These case studies evaluate the role of transnational corporations, the effects on telecommunications and other informatics technology infrastructure, and the development of national policies adopted in response to transborder data flow. Other areas of research undertaken by UNCTC include trade and foreign direct investment in data services, the use of remote-sensing data by transnational corporations during negotiations with developing countries and access to international online data bases.

Along with its research studies, the Centre provides technical assistance to developing countries wishing to establish policies concerning trade in data services; sponsors major workshops on negotiations with transnational corporations; and participates in activities designed to raise awareness of informatics technologies in developing countries.

United Nations Conference on Trade and Development

The United Nations Conference on Trade and Development (UNCTAD) is involved in a programme *of* activities designed to complement the work of other United Nations bodies related to new and emerging technologies. In particular, consideration is being given to the economic, commercial and developmental aspects of these technologies in order that governments may be given a basis for the formulation of appropriate actions. To date, the work of UNCTAD has focused on the effects of these technologies on the capital goods sector in both developing and developed countries.

In March 1985, approval was given for the financing and undertaking of studies of three new technologies which are likely to have great *effect* on many sectors of developing country economies and on the process of development itself. These *three* technologies are

biotechnology, materials technology and microelectronics. The definition of microelectronics employed by UNCTAD is oriented strongly toward informatics: technologies "essentially concerned with the production, processing, transmission and storage of information that is used in the production of goods and services."
Observing that most microelectronics technologies originated in the developed countries, that the consequent shaping of these technologies was to meet the needs and demands of developed country economies and that the rapid diffusion and application of these technologies in developed countries has led to a widening of the technological distance between developing and *developed* countries, UNCTAD seeks to improve knowledge and understanding of the potentially profound implications of this state of affairs and to promote national and international consideration of suitable policies and strategies of relevance to development planners, politicians and entrepreneurs.
To this end, the UNCTAD studies will consider the effect of the three identified technologies and their transfer on the export prospects of developing countries; the effect of the nature of the international markets for these technologies on their transfer; and the factors which enable developing countries to utilize and as similate these technologies.

U.N. Financing System for Science and Technology

The United Nations Financing System for Science and Technology for Development (UNFSSTD), established in 1980 by the United Nations General Assembly to assist in the Vienna Programme of Action and administered by the United Nations Development Programme, finances "a broad range of activities intended to strengthen the endogenous scientific and technological capacities of the developing countries."
Of the approximately 100 projects financed by UNFSSTD since its establishment, somewhat less than 10 per cent have been in disciplines related to informatics. Of these projects, three are of particular interest. The first, the establishment of the Beijing Institute for Software Research and Training (BIS) by the State Commission on Science and Technology of China, has resulted in the undergraduate degree-level training in computer-related management techniques of 40 managers from the industrial corps. In addition, technicians trained in the maintenance of the Norskdata computers installed at BIS have progressed to a level of competence which allows them to maintain these and all other Norskdata computers in China. In the HIS research division, Chinese-language character processing and English-Chinese file translations are being effected with microcomputers connected to the Institute's main computers.
The second project involves the implementation of INTERACT (International Education and Research for Application of Computer Technology) at the public sector Computer Maintenance Corporation in Hyderabad, India. As part of its mission to support India's national efforts to develop a software industry and to support similar efforts in other countries, INTERACT is assisting in the development of computer software systems for railway management, electric power distribution and weather forecasting. To this end, the project involves expert consultants and professionals exclusively from developing countries. INTERACT has also offered training courses, workshops and executive seminars to more than 150 developing country nationals.
The third project of interest resulted in the creation of a pilot health information system in Egypt. This system, based on the use of microcomputers, operates at the village level: basic health statistics are collected, recorded and analyzed to provide essential health indicators. Use of the data collection network and the resulting database of statistics then makes possible the management and monitoring of health care on a reliable basis. The experience gained from this project may facilitate the establishment of similar systems across Egypt.

United Nations Industrial Development Organization

The United Nations Industrial Development Organization (UNIDO) has established a programme to deal with advanced technologies and developing countries. This programme considers both the potential of these technologies for carrying industrial development toward the Lima target of 25 per cent of world industrial production and the adverse effects on global, regional and national patterns of production which the use of these technologies may cause. Work on advanced technologies at UNIDO recently has concentrated on the promotion of developing country access to, and use of, microelectronics technology. This technology is defined broadly to include such aspects of informatics as

the manufacture of computer hardware and software, systems analysis, telecommunications, microprocessor manufacturing, equipment maintenance, and various industrial and information applications.

UNIDO's activities in microelectronics encompass conferences, missions, studies, technical assistance projects, mechanisms for cooperation and dissemination of information. For example: a) A series of country case studies is being published in order to identify the scope for regional and international cooperation and to survey national microelectronics industries. The countries studied to date are Bangladesh, Brazil, India, the Republic of Korea, Pakistan and Venezuela.

b) With the Economic Commission for Latin America and the Caribbean (ECLAC), a regional microelectronics network (REMLAC) has been founded as part of a cooperative Latin American programme of action in the field of microelectronics.

c) With financing from the United Nations Financing System for Science and Technology for Development (UNFSSTD), the Mexican government is being assisted in the creation of a permanent national structure for the monitoring of technological advances.

d) To coordinate the activities of organizations and professional societies, a Consultative Group on Information Technology (COGIT) has been formed to review ongoing activities, exchange experiences and formulate joint programmes.

e) To sensitize and inform policy-makers, scientists and technologists, especially those in developing countries, the *Microelectronics Monitor* has been published quarterly since January

CHAPTER 8

A Note on Harmonization of Standards for Telecommunicated Messages

Barbro Beer

Over the last decades computers have been used for a large number of administrative procedures in enterprises and government offices. Computer systems, run on large mainframes, were based on standards supplied by the hardware producers and further developed by in-house programming experts.

The linking of computers was achieved by the interchange of tapes using in-house system standards. Later, technology permitting, and when the economic benefits from direct computer links could be calculated, enterprises invested in systems compatibility for transborder data flows. Smooth-running direct computer contacts required large investments in common hardware and software, as well as the creation of international administrative organs, e.g. SWIFT for bankers and SITA for airlines. More incidental contacts between non-harmonized systems and data bank searching were arranged by service bureau.

Transnational corporations were amongst the first users of direct computer links; quite early they began interchanging data over leased lines, using the expert knowledge of their data processing departments to achieve enough compatibility between computer and transmission systems to allow data capture without re-keying. Enterprises of this magnitude could also afford to reach agreement with government agencies concerning electronic transmission of required information, usually in the form of computer tapes with data supplied in accordance with the in-house standards of the agency in question.

Much smaller, much cheaper and better performing computers, as well as improvements in data networking, brought great changes into these relatively stable conditions. The requirements for making full use of the economic benefits arising from the possibility of providing information by linking computer systems caught many governments largely unprepared, nationally and internationally. Developments are swift, and there is an urgent need for *better* coordination nationally and more cooperation internationally.

The Present Situation

We are now near the point where the knowledge held by isolated computer systems for the operation of an enterprise will be shared, i.e., all systems will have access to a common store of data about the products manufactured and the administration of the business. Examples of operations using computer systems for production include draughting, engineeringanalysis, robot

operation, stock levels, testing, etc. Administrative uses include payroll, accounting, purchasing, reporting to government agencies, sales procedures, invoicing, banking, etc.

To obtain the gains in productivity available through Computer Integrated Manufacturing (CIM), transnational corporations invest huge sums to achieve compatibility between internal computer systems. In view of the cost, CM is expected to be introduced in stages by other companies; the great number of non-harmonized hardware and software standards in existing systems must be changed or transformed at the lowest possible cost.

Compatibility with external systems lies outside the control of any single enterprise or group of enterprises, but the productivity gains of direct computer dialogue are such that many large manufacturers are trying to persuade their suppliers and subcontractors to adopt their newly developed CIM standards (such as those for graphic exchange specifications) and their trading standards (such as those *for* invoices, orders, price lists, transport instructions and payment procedures). However, most outsiders have their own standards and may not want to change them or to invest in a transforming) translating system before they can be assured that the standards can be used in a wider context. However, no international CM standards exist, and the international standards for trade data interchange that do exist are either not known or not accepted.

The current situation is thus characterized by the development of non-harmonized CIM standards and trade data interchange standards within different sectors of industry in different parts of the world. The ultimate harmonization on the basis of international standards that is bound to occur sooner or later will be expensive for the world economy and will detract from the value of investment in computer processing in all countries. Where resources are scarce, the cost will of course be proportionally higher.

In the meantime, the high cost of paperwork will be increasingly well documented, and figures will soon become available related to the improvements in productivity that will arise from electronic trade data interchange systems that have been or are being developed within transnational corporations, within special sectors of industry (e.g.,, vehicles, aerospace and chemicals) and within the Common Market in Brussels, where important steps are being taken.

What, then, are the present requirements for non-related participants in an international trade transaction that will enable them to communicate electronically with one another, e.g., commercial partners, transporters, ports/airports, banks, insurance companies, licensing authorities, customs, statistical offices, etc.? The requirements are the existence of certain basic standards and their acceptance without national deviations. These basic standards, which are often missing, should ensure that:

a) Computers process data in the same way (main responsibility: manufacturers, i.e., ISO; governments, through public purchasing requirements. There is as yet no international forum for cooperation on standards.)

b) Computers transmit data in the same way (main responsibility as above).

c) There are compatible communication links, available at reasonable and stable prices (responsibility: national and international telecommunication agencies, i.e, national PTTs, ITU,
CCITT, etc.; manufacturers, as providers of machines for telecommunication services).

d) There are specialized data element directories and syntax rules for interchange (main responsibilities: computer users, i.e, ISO, INTUG, ICC and international sector-of-industry organizations; governments, through statutory requirements concerning the presentation of economic and social data by enterprises and by citizens; owners of personal computers).

It should perhaps be pointed out in this context that the constraints resulting from the lack of basic international standards for computer-to-computer dialogue in trade are the same for all types of external computer relations. Electronic mad is not for today, and those with vested interests in national postal systems need not feel threatened in the immediate future. The development of international standards for hardware operating protocols, for compatible, open systems architecture and for unhindered networking, i.e, local area networks (LANs) and integrated systems digital networks (ISDNs) are not in the interest of all manufacturers, or of those governments which hope that the lack of standards will increase the competitiveness of their national IT industries. *Other* difficulties may arise from policies adopted by telecommunications authorities. For example, favourable conditions for leased lines may be changed to increase revenue, and national deviations from international standards (such as the CCITT X25 protocol) may be introduced for the same reason. There are also policies linked to considerations of national sovereignty and the protection of personal data that must be taken into account.

Current Practices for Teletransmission

Against the background of technical and organizational con straints outlined above, there are at present mainly two *ways* in which trade partners can interchange data electronically without undertak
ing bilateral (or sectoral) harmonization:

a) By using *service* bureau. These charges commercial fees for receiving data from one participant's system and dispatching them to the addressee's system (in a transformed format so that they are understood by the system into which they are delivered). Apart from cost, there is one major drawback to this alternative: very confidential business data have to be released into an electronic environment that is not controlled by the owner of the data.

b) By transforming in-house standards into international standards to present the data elements in accordance with international syntax rules. The receiving partner will have access to these international standards and can in his turn adapt his computer system to them.

So far, the reaction to *these* alternatives has often been to opt for the service bureau approach. The reason given for this choice is that there are no international standards for data interchange. This is true for many aspects of electronic communications, as described in some detail above; and the captains of the IT industries can share the blame for this with the ministers of industry and telecommunications in developed countries. But it is not true for electronic trade data interchange.

Since 1981, there exists (in English, French, Russian and Spanish) a Trade Data Elements Directory (UNTDED) developed by UN/ECE, UNCTAD, ISO and CCC, as well as the main international bodies for transport, port and airport management, and cargo handling. It was adopted in 1985 as ISO 7372 (with only one negative vote - the USA). It presents about 500 trade terms and concepts in standardized form with numeric tags based on an analysis of international trade law conventions, transport conventions, customs conventions, and recommendations on concepts and definitions for international trade and transport statistics issued by the United Nations statistical office .This international standard has been endorsed by the Customs Cooperation Council (CCC), the relevant services of the European Community, some European transnational corporations, a large number of foreign trade organizations in CMEA countries, and finally, all facilitation bodies in developed countries as well as in developing countries, where *they* exist, established with technical assistance from UNCTAD's Special Programme on Trade Facilitation (FALPRO).

The International Standard for Trade Data Elements gives coded representations for the presentation of trade documents names, dates and periods of time, names of countries and some geographical entities, names of places of relevance to international trade (ports, airports, etc.) the INCOTERMS of the ICC, conditions of payment, modes of transport (water, rail, road, air, etc.), unit loads in transport, package forms and package materials, units of measurements (metric and imperial), and units of currency.

The International Standard for Trade Data Elements has a complementary instrument in the Directory for Trade Data Interchange (UNTDID) describing the use of standardized trade data elements in electronic procedures. Guidelines for trade data interchange (GTDI) are published in this UN/ECE-UNCTAD/FALPRO document and are expected to be adopted (in enhanced form) in 1985 and recommended to ISO as the International Standard for Electronic Interchange in International Trade.

Difficulties Encountered

The following questions must be asked: Why are these standards not well known? Why are they not used within large enterprises that are aware of their existence? Why are they not promoted by national and international organs responsible for information policies? Why are they not noted and endorsed in worldwide trade bra such as UNCTAD and GATT?

The main reasons is probably a lack of knowledge by those who should be supporting these standards about the huge costs of *non*harmonized trade procedures. This is slowly changing under the pressure of such events as the 1984 protest action by European truck drivers, and the investigations by regional economic groupings of the high cost of nonautomated border controls. Examples of regional action already taken include the

CADDIA project of the European Community and the Northern Corridor Transit Agreement of 1985, signed by Burundi, Kenya, Rwanda and Uganda under the auspices of UNCTAD. The standards for information exchange in these projects-whether paperborne or transmitted electronically-are those developed by UN/ISO as described above (data elements, document design, interchange protocols).

Another reason is the relative lack of official support and recognition given to the national bodies responsible for the facilitation of international trade procedures. These are the organs that should ensure the introduction and acceptance of the new standards in their respective countries. They are the only national bodies which consider the different phases of trade transactions as a whole and which study and analyse how official and commercial practices affect trade procedures. They are called "trade procedures bodies;" e.g., SIMPRO-FRANCE in France, SITPRO in the U.K., FITPRO in Czechoslovakia, KENPRO in Kenya and JASTPRO in Japan, *They* meet in a UN/ ECE Working Party at Geneva, serviced jointly by UN/ECE and UNCTAD's Special Programme on Trade Facilitation (FALPRO).

These bodies *were* created in the 1960s and early 1970s to rationalize and standardize the increasing number of mandatory documents used in international trade. The work was successful, and at present, all important official documents *required* in accordance with international trade and transport agreements are modelled on a standard adopted by the Working Party in 1963 (the United Nations Layout Key for Trade Documents). However, since then, the national trade facilitation bodies have not received the high-level attention and increased financial support that their work on new standards for trade data interchange deserves.

Major standardization developments need a two-pronged approach: on the one hand, high-level political decisions laying down the mandates for cooperation to reach common standards, and on the other hand, good technicians for developing the tools. Good technicians are available, but political support has so far not been forthcoming, except in the services of the European Community and, to some extent, in EFTA, CMEA and some of the countries where (JNCTAD's FALPRO has assisted in the creation of national trade facilitation bodies. Another *exception* are most national customs administrations and the Customs Cooperation Council, *where* full support is given.

A consequence of the relatively mild interest shown by governments in UN/ECE and UNCTAD for trade facilitation work has been that neither secretariat has judged that it has adequate staff or travel funds to disseminate the work on new standards.

Additional reasons for lack of support and recognition are those most often encountered in the non-acceptance of standards:

a) Large *enterprises* prefer their own standards. Their data processing and standards producing department are centered on internal problems and consider the enterprise as the hub of the common wheel, not one of its radials.

d) Many government agencies are at present competing with other agencies for the upper hand in imposing standards for data elements, for their coding and for transmission protocols. This is reflected internationally, resulting in attempts to ram through multinational solutions that can be used nationally in support of the agency's views. However, when different parts of national administrations pursue their own solutions to interrelated aspects of the same problem in the (different) international organizations where each controls mandate, budget and policy instructions, then the result is most often two non-compatible international recommendations.

c) The attitude of many international bodies toward the standards of other international bodies is therefore often negative.

Some governments consider that standards for trade data inter change are the prerogative of private enterprise, and their customs administrations refuse to issue directives to traders for the harmonization of interchange standards. Most of these governments have subscribed to the GATT Standards Code (the Agreement on Technical Barriers to Trade), which obliges them to use their best efforts

to further the acceptance of international standards. However, it is not clear to what extent the UN/ISO Trade Data Elements Standard can be considered a product that is covered by the code. This matter could be discussed and agreed on by the GATT Council.

Agenda for Action

The ultimate goal of informatics is effortless, low-cost electronic interchange of data between interested parties, nationally and internationally. To reach this goal-whereby optimal

productivity gains can be obtained - there is an urgent need for more hardware and software computer compatibility for processing and sharing all types of data. It is the responsibility of such worldwide bodies as ITU. UPU, CCITT, IBI, ISO and INTUG, as well as the national members of these bodies, to develop and implement the standards needed for smooth-running compatibility. The ultimate goal of electronic data interchange cannot be reached in the absence of such general developments in informatics.

The present lack of basic standards for general data interchange, and the non-acceptance of the International Standards for Trade Data Interchange by one important trading nation, is probably more costly than the international business community and governments realize. However, the present international discussions concerning the possibility of including services in any next tariff round might highlight these costs.

Developments may also be speeded up by the growing understanding within governments that information technology is affecting society to such an extent that national institutions for analysis and coordination must be created. The mandate for these entities will be to ensure that the benefits of informatics are obtained, to regulate possible disadvantages and to steer the changes that are bound to occur in administrative procedures and power structures. The creation of such government units, which has already begun, will result in more international cooperation within an existing international body to be given a wider mandate, or within a new organ that is truly representative of the many different interests represented by the use of informatics for electronic data interchange both nationally and internationally. An international mandate to gather and analyse information on national and regional developments resulting from the informatics revolution and to recommend concrete action for better compatibility is urgently needed at the world level.

Any such body would, hopefully, note with satisfaction that for trade data interchange, much of the heavy standards spadework has already been done. It could thus take action to ensure harmonization of national standards on the basis of the UN/ISO International Standards described in this paper.

APPENDIX A

PARTICIPANTS IN THE CONSULTATIVE MEETING

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APPENDIX B
NORTH SOUTH ROUNDTABLE

The North South Roundtable, established under the auspices of the Society for International Development, is an independent intellectual forum in which key national and international policymakers, academics and eminent leaders of thought from 60 developed and developing countries get together to identify and analyze the major world issues, particularly those affecting North-South relations. It serves as

- A forum for the clarification of global development issues.
- A sounding board for new policy proposals in the mutual interest of North and South.
- A force for the mobilization of national and international support for such proposals, backed by solid analysis.
- A contributor to and monitor of North-South negotiations under way in official bodies.

- A public educator on global development issues through direct briefings and through the dissemination of Round table publications.

The activities of the NSRT take various forms, such as full Roundtable sessions involving over 160 members, smaller roundtables on specific issues, and country and regional dialogue missions. The ideas evolved in the Roundtable process are disseminated to all relevant national, regional and international organizations and associations and research and educational institutions.

The NSRT's activities are funded by governments, international organizations and foundations; its policies are determined by a Steering Committee. Maurice F. Strong is Chairman of NSRT, Saburo Okita and Enrique V. Iglesias are co-Chairmen and Khadija Haq is Executive Directbr. The Roundtable Secretariat is located in Islamabad, Pakistan.

SOCIETY FOR INTERNATIONAL DEVELOPMENT

The SID is an independent, nongovernmental organization whose purposes are to provide a forum for collective reflection and to encourage a mutually educating dialogue on development at all levels. The Society was founded in 1957 and has evolved into several interlocking networks -including its membership and chapter organizations - where individuals and institutions are linked in different ways around a varied range of activities. The SID'S major programs include The North South Roundtable, an intervention into the dialogue at the international level; The Alternative Development Strategies Program, along with the Society's journal, *Development: Seeds of Change - Village Through the Global Order,* acting as catalysts in the national level dialogue; and The Grass Roots Initiatives and Strategies, an attempt to link the knowledge and technology emanating from spontaneous people-oriented activities in industrialized and Third World countries at the local level.

UNDP STUDY PROGRAMME

The Development Study Programe of the United Nations Development Programe (UNDP) was established by the Governing Council of the UNDP in 1981 in order to promote a greater understanding of the issues concerning development and technical cooperation, strengthen public and governmental support for development and technical cooperation, and generate new ideas and innovative solutions to the problems of development and technical cooperation. The activities of the UNDP Study Programe take different forms, such as seminars, lectures and informal discussion groups. Participants at the various events held under the auspices of the Programe are drawn from among high-level national policymakers, government representatives, senior officials of the United Nations development system, leaders of public and private enterprise, representatives of the media and academics. The Director of the UNDP Development Study Programe is Uner Kirdar. UNDP Headquarters are located at One U.N. Plaza, New York, NY 10017, USA.