INFORMATICS AND DEVELOPMENT

Selected Programmes and Considerations

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by
Robert L Valantin
and
Michael D Arkin
Ottawa, Canada

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Robert L Valantin
Associate Director
Information Sciences Division
International Development
Research Centre
Box 8500
Ottawa, Canada
K1G 3H9

Michael D Arkin
Consultant
Box 1432, Station B
Ottawa, Canada
K1P 5P6

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Introduction

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 rôle 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 now are re-evaluating the attention which they focus on information sciences. This re-evaluation inevitably must bring national and regional planners and policy-makers to the conclusion that the disciplines which constitute the information sciences represent the principal tools with which to channel towards their development goals the force for change created by the new information technologies.

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 "sensibilisation" 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 undoubtably will be different than those of Northern countries, and suggest that the experiences of the North may not hold much value for the South. On the other hand, the experience of Southern countries can (and many would argue, must) both 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.

In part I, we present a description of selected agency programmes which address these issues of informatics and development. 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.

Part II also speaks to these considerations for informatics and development. The voices are chosen from, and are representative of, the recent literature. Their observations are offered, without comment, on the issues raised above, and on an issue inextricably bound to them all: the rôle which the new information technologies play in ongoing North-South relations.

I. Notes on Selected Agency Programmes

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Bostid

The Board on Science and Technology for International Development (BOSTID) of the US 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 US AID 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. The Board also hopes to aid in the assessment, by donor agencies, of 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 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 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 the Board's programme of investigation will be written so as to 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 capacity." As an aid to these discussions, the Working Group has drafted recommendations concerning national decision-making, adjustment policies, technologies for basic needs, creation of 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 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 (IBI) 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." In doing so it is guided by the needs of developing countries in the formulation of its programme of activities.

For the biennium which ended October 1984, IBI 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, IBI 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, IBI 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, Columbia, the Club of Cali 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 training of professionals and officials in current informatics developments, and the definition of a series of pilot-level experiments.

IBI's present programme of work continues to be directed towards 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 social, 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; the existing public policies which have an effect on the microelectronics sector of Argentina; and 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 the use of, information for research and planning. Recent activities in this programme include support for:

- an information centre on development-policy modelling, which disseminates information about computer-based modelling techniques for socio-economic development;
- a feasibility study on a Latin American regional information network to manage information about informatics;
- the development of microcomputer software for the management of developing-country debt information;
- the transfer of remote-sensing technology to China; and
- 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 Organisation 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 undertaken, 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 rôle 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 agricultural sectors; a investigation of methodologies for studying secondary linkage effects of the industrial and commercial application and use of microelectronics 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 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 UN 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 semi-annual 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 automation 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 advanced-technologies information, in a cooperative effort to improve the capacity of developing countries to assess the effects of new technologies. In cooperation with the Deutsche Stiftung für Internationale Entwicklung (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) is, for the biennium ending this year, concentrated in five principal actions. These are (1) the formulation of strategies for the development of informatics, (2) the strengthening and development of institutions and means of education, training and information concerning informatics, (3) the study of the social consequences of the applications of informatics, (4) the acquisition and adaptation of technology, and (5) international cooperation for the development of informatics. Examples of current Informatics Section work include:

- support for regional and national seminars on priority fields for the application of informatics, such as the First National Conference on Computer Applications held in cooperation with the Committee of Directors of Nigerian University Computer Centres;

- 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;

- preparation of four case studies on the sociocultural effects of informatics, including the application of microcomputers, in cooperation with IBI, IFIP, and ICSU, inter alia;

- 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;

- 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 1984 meeting of the Interim Intergovernmental 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 participate 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 fall.

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 rôle of transnational corporations, the effects on telecommunications and other informatics-technologies 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 databases.

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 likely will 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 towards 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 commercialists.

To this end, the UNCTAD studies will consider the effect, on export prospects of developing countries, of the three identified technologies and their transfer; the effect, on transfer of these technologies to developing countries, of the nature of international markets for these technologies; and the factors which enable developing countries to utilize and assimilate these technologies.

UN 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 training in computer-related management techniques, to the undergraduate-degree level, 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 BIS 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 effort 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; and to this end

involves expert consultants and professionals only from other developing countries. As well, INTERACT has 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 towards 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. Advanced-technologies work 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 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;

- 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;

- 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;

- 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;

- to sensitize and inform policy makers, scientists, and technologists, especially those in developing countries, the Microelectronics Monitor has been published quarterly since January 1982.

II. Considerations for Development

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"Sensibilisation"

Is microelectronics revolutionary? . . . microelectronics represents a quantitative improvement in a principle (information processing and storage) that has been around and in use for decades. Though it could be argued that the quantitative improvements have been so extensive as to be tantamount to a qualitative leap, the fact still remains that it does not allow us to do anything radically different, but rather to (a) carry out known processes more efficiently and (b) to make processes and activities previously considered unfeasible to become economically and technically feasible. . . . it is not altogether clear how society will be transformed and how pervasive this transformation will be. Though the proponents of the "Second Industrial Revolution" point to the increasing number of "information" workers and the growing automation of the factory, these are not necessarily radical social transformations and could be seen as the culmination of a continuing process of rationalisation that began with the first Industrial Revolution. (Wad, 1982, p. 680-681)

The microelectronics revolution will only be truly revolutionary if it succeeds in creating a society of equity, with a high degree of industrial democracy and the possibility of creative fulfilment to the many. (King, 1982, p. 336)

. . . the general transition of developed societies towards an economy based on information and the provision of services . . . is not a post-industrial stage, just as the industrial stage is not a post-agricultural one. Industry, like agriculture, will remain central to society. . . . the shift towards an information economy is more related to the

"Sensibilisation" (cont'd)

amount of information embodied in material goods than the simple reproduction of information services. (Rada, 1982a, pp. 102-103)

An economy can be separated into two domains. The first is involved in the transformation of matter and energy from one form or another. The second is involved in transforming information from one pattern to another. . . . The systematic marriage of these two domains is absolute. The question is the relative contribution of each partner in producing wealth. (Porat & Rubin, cited in Vitro, 1985, p. 2)

Information technology is a reality, and a rapidly expanding one. Therefore, the question is how to master the changes and deal with the issues it raises to the best advantage for development strategies. (Rada, 1982b, p. 237)

Awareness of information as a resource must be cultivated in the whole population but especially in the business community and in the government service. . . . The awareness should be of information of all kinds as a resource, not just of the new technologies as a fashion. (Data for development/Unesco, 1983, p. 18-19)

. . . informatization is the consequence of development and not its cause. (Eres, cited in Slamecka, 1985, p. 182)

. . . the development of microelectronics and its probable widespread application in economic and other fields will constitute a major political force within the next few decades, with considerable influence on the international distribution of labour and eventually with impact on all countries, irrespective of their ideological and cultural traditions. (King, 1982, p. 329)

"Sensibilisation" (cont'd)

[The] most important characteristics [of information technologies] is that they save capital, manpower, raw materials, and energy, and simultaneously increase quality. They permit the optimal use of all production factors. Furthermore, they simplify and reduce the cost of maintenance and the repair of installations. This savings effect is a great incentive to use these technologies. It definitely should facilitate industrialization in the developing countries. Yet this is a road full of obstacles. (Krugmann-Randolf, 1983, p. 3)

The information sector of the economy is the mechanism through which value -- information -- is added to the factors of production. An Information Sector Hypothesis emerges from this perspective: the growth of the information sector reflects the capacity of an economy to add value to the factors of production and thereby create new wealth [and] distribute this new wealth more efficiently and equitably. The capacity to add value and create new wealth is [a] vital condition for economic and social transformation. (Vitro, 1985, p. 2)

For the least developed half of the world's nations, the following desiderata would seem to be amongst those of the highest priority:

[1] In view of world technological and industrial trends, . . . there is an urgent need for such countries to reassess their policies, industrial and otherwise, and to search for new paths to development which will make full use of the new possibilities and avoid their dangers as far as possible.

"Sensibilisation" (cont'd)

[2] They should seek to create a critical level of awareness of and effort in science and technology, without which substantial indigenous development is improbable.

[3] In pursuance of [2] they should endeavour to create regional groupings which would have a much greater probability of achieving the critical threshold in the not too distant future than would the efforts of the individual members of the grouping separately.

[4] Once formed, these groupings should seek to forge links between themselves and also with friendly bodies within the industrialised countries; these linkages might take the form of mutual inter-dependence treaties for cooperation on development strategies, scientific and technological reinforcement and allocation of tasks, access to data banks and information pools and the training of technological and managerial skills. (King, 1982, pp. 328-329)

It is necessary to warn that at present the benefits of the new technology remain largely on paper. To secure these benefits requires both short- and long-term policies. It necessitates an active search for alternative development strategies and this, in the final analysis, is related to the power structure within and between countries. If this structure is not altered in most countries and internationally, there is little hope that desirable benefits will materialise. (Rada, 1982b, p. 242)

"Sensibilisation:" the technologies

. . . microelectronics and related innovations are almost exclusively based on the synergic interaction of several scientific disciplines and discoveries. . . . As the performance of the productive infrastructure becomes dependent on innovation, the basis of economic performance grows in abstraction. This has resulted in the creation of "knowledge-intensive economies." . . . electronics is becoming a convergence industry, that is to say, a sector on which most economic activities will become dependent to varying degrees -- a sort of heavy industry of the future. As a result, electronics will condition the productive system, alter skill requirements and remain, for some time to come, the main locus of innovation (Rada, 1982a, p. 99). The growing "abstraction" of the technology is reflected in the following two ways in the case of microelectronics: the incorporation of parts and functions into the manufacture of electronic components; [and] . . . a radical alteration in the incidence of "embodied" and "disembodied" technology (Rada, 1982a, p. 101). . . . The grouping of growing numbers of functions into single components also alters applications, because this grouping permits and indeed requires system design for full economic utilization in products and processes. Thus, the adequate management (in the broadest sense) of one particular stage of production or part of a product is no longer sufficient in the light of the application of microelectronics. (Rada, 1982a, pp. 100-101)

. . . Singapore's industrial strategy for the decade of the 80s is built upon high value-added, technology-based, knowledge-intensive industries. In addition to concerted efforts to raise the skill level for our workers, all sectors in our economy were called upon to automate, mechanise and computerise in order to increase productivity. (Yeo, et al., 1984, p. 7)

"Sensibilisation:" the technologies (cont'd)

The relevant technological developments are three-fold: (1) A steady and substantial increase in the cost-effectiveness of the technology. . . . (2) Use of information technology in a programmer-free environment. . . . (3) Developments in telecommunications and networking. (Slamecka, 1985, p. 178)

Software, system design and management resources are crucial "disembodied" technologies . . . (Rada, 1982a, p. 51)

"Sensibilisation:" policies

A correct policy is the most important thing that would guarantee the rapid development of informatics. (Qin, 1985, p. 23)

Broadly stated, informatics plans harness the essential elements of information resources in much the same way a nation might approach its coal or oil. In the name of national interest, informatics plans or strategies generally encourage the development and robust use of computer and telecommunications technology. (Eger, 1981, p. 222)

Particular attention must be given to the conceptual issue of how [microelectronics] technology should be interpreted in light of the historical experiences of the Third World with technologies from the advanced countries and the current political economic climate of development. There are also the methodological concerns of monitoring, studying, assessing and developing policies to address this and similar technologies from a development perspective, given the rapid rate of change in the field and the increasingly interdisciplinary content of the knowledge embodied in these

"Sensibilisation:" policies (cont'd)

technologies. (Wad, 1982, p. 678)

One major shortcoming in most countries is the absence of sufficient or sufficiently accepted machinery for overall policy coordination and planning. (King, 1982, p. 331)

Prospective and indicative technological assessment is becoming essential for planning and to ensure medium- and long-term development. (Rada, 1982a, p. 107)

A further matter for which institutional innovation will be necessary if microelectronics is to be used deliberately and constructively for the improvement of society is to ensure that a sufficiently long-term perspective is taken in preparing for changes which are inevitable but may not always seem pressing. . . . The probable impact of microelectronics is so great and its probable societal consequences so profound . . . that policies are needed in terms of decades rather than of years if it is to achieve the benefits which are possible for humanity as a whole. (King, 1982, p. 332)

In the case of microelectronics and other new technologies, the need for . . . a proactive strategy is essential -- one that is based on a careful, systematic and intelligent appraisal of the complex nature of the technology and its implications. This is contrary to the recommendation of many proponents that no time be lost in identifying, developing and implementing microelectronics applications. (Wad, 1982, p. 691)

Evaluation of utility for development: overall effects

. . . today there is little awareness of the socio-economic and cultural consequences of [microelectronics] technologies. Yet these consequences are likely to be extremely serious. . . . (a) a reduction in demand for basic skills and an increased demand for higher level skills . . . (b) an increased demand for and dependence upon information which is produced in the North; (c) the erosion of cultural values . . . (d) the increased emphasis on non-cognitive skills . . . (e) an increased level of socio-economic inequity. (Wad, 1982, p. 690)

Because of the growing abstraction of the technology, production is becoming more and more dependent on capital rather than labour. (Rada, 1982a, p. 102)

. . . information sector growth is due in a nontrivial way to the shifting to it of functions and jobs from the service sector, not by the demise of these functions and jobs from the world. This being so, some anticipate that the largest impact information technology will have is in the operation, commercialization, and distribution of services. The essence of this impact lies in information technology rendering services more rational and transport-able. (Slamecka, 1985, p. 180)

With the advent of microelectronics, it has become possible to automate a number of the labour-intensive operations in [certain] industries, thus eroding the low labour-cost advantage enjoyed by the developing countries and creating a tendency for off-shore industries to return "home". . . . Nevertheless, there is no evidence that a massive return of industry to the industrialised countries is occurring. Labour costs are not the sole determinant of geographical location of production facilities. Tax incen-tives, access to raw materials, energy and markets, govern-

Evaluation of utility: overall effects (cont'd)

ment fiscal policies, international legislation and "start-up" and "sunk" costs are also important factors and could dilute the cost-saving opportunities of automation. (Wad, 1982, pp. 682-683)

The diffusion of microelectronics in developing countries implies a sophisticated technology for most products and processes, employing few people. At the same time, the use of the technology by developing countries will widen the gap between technology and its application, because entire processes will have to be imported on a turnkey basis. The net result could be islands of high technology within economies characterised by low-productivity and artisan-based production systems. This dichotomy, and the interlink between the two areas, represents one of the existing dilemmas of industrialisation. (Rada, 1982b, pp. 235-236)

[There is a] growing danger of technological discontinuity as the advanced countries push equipment to obsolescence and discontinue the production and supplies of spare parts and systems. In most developing countries this equipment could remain economically viable for a long time, but unable to operate because of lack of adequate supplies. (Rada, 1982b, p. 218)

. . . one can say that it is unlikely that the Brazilian capacity as a producer of equipment will offset the cost in social, economic and educational terms produced by the use of information technology. However, Brazil is different from many other developing countries and certainly from Argentina, in that it has developed both its capacities and a set of policies -- although somewhat contradictory -- that put it in a good position to face the issues arising from information technology.

These capacities, however, have not yet been able to

Evaluation of utility: overall effects (cont'd)

generate a proper technology assessment in terms of the overall impact of microelectronics. So far, the main preoccupation has been to maintain a certain independence through hardware and developing software.

The path chosen involves a number of costs which can only be turned into benefits if the overall assessment considers all aspects in such a way that a competitive strategy is implemented. This strategy needs to consider the implications of current changes for development strategies as a whole and not only the sectoral aspects. (Rada, 1982a, p. 95)

. . . the gauge by which to measure the positive impact of the new technology is the national capacity to absorb its applications, rather than the simple importing of complete systems. (Rada, 1982b, p. 220)

Evaluation of utility: sociocultural effects

The dilemma which the information revolution raises can be put as follows: on the one hand, no development process of any kind can take place without a heavy reliance on information and communication technologies; on the other hand, these technologies and the information which they carry are highly value-loaded, they disrupt development patterns and seriously affect the socio-cultural environment of the industrialised as well as of the developing countries. (Elmandjra, 1985, p. 3)

. . . [first,] the analysis of effects of microelectronics on the Third World must be based on a clear understanding of the different types of countries that constitute the South and their relative strengths and weaknesses with respect to this new technology. . . . Secondly, the

Evaluation of utility: sociocultural effects (cont'd)

analysis should not be confined solely to applications in traditional industries but should examine also the potential effects of second generation innovations. Finally, the effects of microelectronics are not likely to be confined solely to shifts in comparative advantage but may also include other social and cultural implications which may be of far greater significance and demand systematic investigation. (Wad, 1982, pp. 684-685)

. . . the real problem is not that too rapid introduction of the new technologies will generate socio-cultural difficulties, but rather that they will be insufficiently taken into consideration in development strategies. . . . The acceptance of Northern advanced technologies by the South . . . will greatly increase the dependence of these countries on the North and on its transnational corporations, will make the emergence of indigenous technologies more difficult and, in the end, will erode local cultural values. (King, 1982, p. 320)

. . . the use of data bases implies the need to import services and in most cases the hardware to receive the service. To the extent the values embodied in information are not independent of its format and system of storage, this will also involve the import of cultural patterns and interpretations. (Rada, 1982b, p. 220)

The best way to protect cultural identity which is the most vulnerable part of the edifice of most Third World countries is by making culture one of the key motors of the development process and by encouraging an endogenous and creative use of the new information technologies. (Elmandjra, 1985, p. 3)

Integration into national development plans

Perhaps the greatest obstacle to the inclusion of an information policy in a national plan is the way it reaches into the concerns of other policy matters. . . . The difficulty rests upon the central role which information plays in every aspect of development. (Data for Development/Unesco, 1983, p. 15)

. . . there is the practical question of the types of institutional, political, economic and social strategies that need to be developed and adopted in order to best deal with [microelectronics] technologies -- what steps can the South take at the national, regional and global levels with respect to microelectronics? (Wad, 1982, p. 678)

To be owned technology must first be mastered, locally produced and totally integrated to the socio-cultural environment. (Elmandjra, 1985, p. 4)

The transfer of technology can be a very important channel of technological training and information, but only if the technology really is transferred, that is to say, if the country paying for it really does come to master its substantive and operational aspects. (Lahera and Nochteff, 1983, p. 179)

A socioeconomic command of the development of science and technology is needed (Rada, 1982b, p. 237). Three general principles apply to the use of the technology within countries. First is the need for a national policy based on a careful selectiveness in applications. . . . Second is the need to assure diversified sources of supply in the market and to avoid becoming dependent on a few companies. . . . The third element is to monitor the national integration of locally assembled or partly manufactured electronic-based products. (Rada, 1982b, p. 239)

Integration into national development plans (cont'd)

Tasks which [an] information policy group must deal with include the following:

[1] investigating the role which information plays in the country's economic development and the current state of its relevant infrastructures;

[2] investigating the implications of other aspects of the national plan in information terms and to propose modifications and extra investments;

[3] formulating priorities which need to be accommodated in other plans (e.g. for education, power supply, construction, etc.) which determine the infrastructures for the information sector. (Data for Development/Unesco, 1983, p. 16)

Integration into national development plans: strategies

There are several possible steps which international organizations and nations might consider in order to focus on the information sector and development project planning. One step could involve funding a series of feasibility studies designed to enhance a nation's capacity to understand, measure the size and evaluate the possibility of integrating the information sector into the national planning process. These studies would focus on macroeconomic analysis of the information sector and could be carried out with the increasing involvement of local economists and planners. This approach would assure that each nation [has] its own qualified specialists to define and measure the information sector. . . . If the business of development is information, then the tools and techniques to define and measure the information sector must soon become a part of

Integration into development plans: strategies (cont'd)

development planning. (Vitro, 1985, p. 2)

There are three areas where a prospective and public policy is required:

1. Incentives for R & D in advanced technology at the national and regional level, particularly long-term technological evaluation of those areas of concern to the country. . . . The links between R & D, scientific activities and production deserve particular attention . . . Particular incentives should be given to encourage utilization of national human resources. . . .

2. In the area of advanced technology a public policy for R & D production and creation of demand is essential. . . .

3. The realities of current and future technological change show that a national approach to the production of equipment is clearly insufficient and that a broader regional approach is required. . . . The first steps should be the uniformization of standards, the development of regional trade/scientific/technological information links and pilot regional programmes in areas such as software and information-technology peripherals. (Rada, 1982a, pp. 107-108)

. . . the [Singapore] National Computer Board (NCB) was established in September 1981 to formulate, coordinate, implement and monitor national computerisation policies. Having been established to spearhead Singapore's national computerisation efforts, the NCB was hence tasked to perform three main statutory functions:

Integration into development plans: strategies (cont'd)

[1] to implement the Civil Service Computerisation Programme;

[2] to establish and maintain standards of computer education and training in Singapore;

[3] to promote and develop the computer services industry in Singapore with the objective of making Singapore a computer software centre. (Yeo, et al., 1984, p. 11)

The transnational corporations must be brought in line with national development policies, objectives and local priorities, to the achievement of which they must make a positive contribution, as well as helping to create scientific and technological capacity in the host countries. In order for this to take place, it is essential that the countries should define their objectives and priorities and specify in them the particular contribution of the transnational corporations. Once the role assigned to such corporations has been defined, their cooperation can be actively sought, both in the case of firms already installed in the country and in that of other enterprises of different size and origin. . . . [there are] important points of coincidence between those enterprises' desire to optimize their profits and the fulfilment of national objectives. (Lahera and Nochteff, 1983, pp. 180-181)

The priority given to particular applications will depend on the appraisal made of the problems which microelectronics can help to solve. . . . These applications should seek to make better use of the existing conditions available within the electronics complex and back-up national strategies which have already brought about some degree of consolidation of a particular sector of it. They should also give preference to those applications which

Integration into development plans: strategies (cont'd)

involve a closer approach to the basis of this technology, that is to say, integrated circuits. (Lahera and Nochteff, 1983, p. 176)

. . . decisions should not be based on the purchase cost of goods so much as on an analysis of their suitability for national needs and possibilities and the indirect effects of each option on development as a whole. (Lahera and Nochteff, 1983, p. 179)

Whatever type of action the Latin American countries take with regard to microelectronics should be aimed at overcoming the exogenous nature of the present form of incorporation of such technology. It is necessary to overcome the passivity and lack of discrimination which currently characterize this process and to orient it towards the satisfaction of the region's needs. If this is done, microelectronics can become an endogenous factor which generates development.

This endogenization process must be selective, both because of the diversity of local situations and national objectives and because of the disparity between the resources available and the impossibility of achieving simultaneous development in all aspects of this technology. (Lahera and Nochteff, 1983, p. 175-176)

The current distinction between hard- and software permits a certain degree of dissociation between production of components and applications. One possible strategy would be to concentrate on innovative applications rather than production of components buying the parts from established suppliers. (Rada, 1982a, p. 87)

Integration into development plans: strategies (cont'd)

The policy of Brazil in digital equipment can be summarized in three main points: (a) state intervention to encourage and create local initiatives in hardware and software; (b) diversification of technological dependence among a wide range of international producers in order to minimize the risk of total technological dependency; and (c) protection of the market for national products through use of tariff and airport restrictions as well as by regulating the sphere of activities of the main transnational companies in the field. . . . there is a clear policy of encouraging national developments in software and services as well as in R&D. CAPRE [a Ministry of Planning coordination commission for data processing activities] has mapped out a three-point strategy: (a) to commercialize and promote nationally developed software; (b) to develop courses and training on software in cooperation with universities; and (c) to assist financially and encourage government enterprises to invest in new software companies. (Rada, 1982a, pp. 89-90)

China's electronic industry includes the manufacture of computers, transistors, integrated circuits and other electronic products. . . . In computer production, the main products of China's electronic industry are small computers, the proportion of medium and large production is relatively small. . . . the production of microprocessors is one of the poorest links in China's electronic industry; part of the reasons that induce this situation, lies on the relatively low levels of microprocessor application and microchip production. (Qin, 1985, p. 22)

. . . only one third of the computers in China are efficiently used. . . . The lack of microprocessors and a range of useful peripherical equipment, and the shortage of professionals, a very low rate of telephone popularity, and the processing of Chinese characters, also exert their

Integration into development plans: strategies (cont'd)

influences on the application of information technology and the shaping of information network. . . . Most of the computers that are being used confine their fields of application to calculation and design in science, data processing, testing and controlling. (Qin, 1985, p. 23)

Integration into national development plans: absorption

When all factors are taken into account, it is evident that a relatively rapid diffusion can be foreseen in computers and telecommunications and in some industrial applications. This, however, does not necessarily imply that developing countries will be able to absorb microelectronic technology at a pace that will put them in a position to compete with the industrialised countries. They lack the awareness, the skills and capital requirements. In this respect developing countries are bound to benefit less from current changes. (Rada, 1982b, p. 235)

. . . microelectronics tends to displace low-skilled labour in favour of smaller numbers of high-skilled workers, thus increasing the difficulties of many countries both in absorbing the low skills and training the high skills. (King, 1982, p. 319)

The shift towards systems rather than discrete components has implications which go beyond skills. . . . these constitute barriers, not only to the diffusion of microelectronics in general but more specifically to the capacity of developing countries to absorb and exploit it. (Rada, 1982a, p. 51)

Integration into development plans: absorption (cont'd)

The "packaging" of technology into single components produces a chain of effects. Firstly, the value which was previously added in the process of manufacturing and assembly is transferred to the manufacturing of components. Secondly, the grouping of a growing number of functions into single components compels system design. This transformation further reduces the capacity of developing countries to absorb technology, particularly at the application stage. The alteration of managerial requirements also reinforces one of the traditional advantages of developed countries. Developing countries are further affected by the obsolescence of many mechanical skills. (Rada, 1982b, pp. 219-220)

Development of human and scientific resources: human resources

The society of information is less dependent on natural resources and it reduces globally their strategic importance; it highlights, on the other hand, human resources which become more vital than ever before, it amplifies their potential and demultiplies their productivity. (Elmandjra, 1985, p. 3)

Transfer of technology is possible only if the absorption capacity exists from the human resource side. (Rada, 1982b, p. 225)

The brain drain in connection with the electronics complex is particularly intense because of the growing disparity between the development of the electronics complex in the developed countries and in the countries of the [Latin American] region, as well as the relative scarcity of software in the developed countries, which leads them to increase the offers designed to secure the migration of skilled personnel. (Lahera and Nochteff, 1983, p. 180)

Development of resources: human resources (cont'd)

The information revolution drives home some obvious lessons . . . the need for very substantive investments in human resources (including the eradication of illiteracy) and in R & D . . . (Elmandjra, 1985, p. 4)

[Singapore has] a national concerted effort to prepare Singaporeans for life in an Information Society. We have identified three major areas of computer training that are vital to our successful entry into the Information Age:

[1] training of dp [data processing] professionals;

[2] end-user training;

[3] promotion of computer culture. (Yeo, et al., 1984, p. 12)

[At the National University of Singapore, the computer science] curriculum has just been revised to include courses that will prepare the students for more than just the technical aspects of computing, eg., Information Science rather than Computer Science per se. [The Institute of Systems Science] offers many courses and programmes encompassing management education, advanced technical topics, end-user education, consulting services and applied research in information systems. (Yeo, et al., 1984, pp. 13-14)

Although the effect of information technology on employment has been in the centre of debates in the developed countries, the issue is rather different for developing countries. . . . More important than the direct utilisation of equipment, which affects a small proportion of the labour force, is the narrowing of industrialisation alternatives resulting from the erosion of comparative advantage. (Rada, 1982b, p. 235)

Development of resources: human resources (cont'd)

The incorporation of skills into equipment, such as in precision machinery, will save skills which are often difficult and costly to acquire. In the case of some precision engineering activities where labour is required in great quantities, new opportunities to leapfrog traditionally low- and medium-grade mechanical skills have become available. (Rada, 1982b, p. 221)

A more practical problem with the "leapfrogging" argument [leapfrogging stages of development] is simply the lack of finance in the Third World to pay for all these applications. . . . A related problem is the shortage of skills to use the applications. (Wad, 1982, p. 686)

. . . the incorporation of skills into equipment concentrates them with the manufacturer, producing a skill-saving effect in the production process, although . . . with an increase in the skills required for the programming and design stages. Hence, a polarization of skills takes place that appears not only at the plant level but also on the international scale, inasmuch as the suppliers of equipment are mostly in developed countries (Rada, 1982a, p. 102) . . . . What occurs is a shift in skill requirements towards software abilities and system design. . . . Software and system-design require more than the understanding of specific stages of production. (Rada, 1982a, p. 101)

The automation of manufacturing and control shows decreases in the demand for supervisory repair and maintenance skills. (Rada, 1982a, p. 53)

Development of resources: scientific and technical infrastructure

The control of technology often means the control of development, the definition of its aims and even its pace. (Rada, 1982b, p. 214)

. . . comparative advantages will increasingly be determined by scientific and technological know-how. . . . Science and technology are becoming the underlying base of industrial production, determining its structure and output, and therefore are increasingly the base of wealth creation. (Rada, 1982b, p. 217)

. . . the critical factor [in accessing world knowledge] is a critical capacity for science and technology and for management. (King, 1982, p. 322)

The essential starting point is the development of a system of scientific and technological assessment, scanning and policy design. The capacity for prospective assessment permits not only a better bargaining position but also puts the elaboration of development strategies on a more solid basis by developing a more refined conceptualisation of short-, medium- and long-term comparative advantages. (Rada, 1982b, p. 238)

There is perhaps no more practical field for research and development investment in a developing country than in the field of methodology. It is cheap and the results have been proven worthwhile. One motivation for each country investing in R & D in methodology is that many methodologies are sensitive to the culture in which they are used. (Data for Development/Unesco, 1983, pp. 18-19)

Transnationals tend to make no systematic effort to encourage local research and development, or to reinvest profits beyond the minimum needed to maintain the plant

Development of resources: scientific infrastructure (cont'd)

running. Governments therefore need to negotiate with companies for greater local R & D content, while at the same time encouraging basic research and a closer link between technical institutions and local firms. As technology becomes the basic asset of companies, their willingness to transfer it will decrease even further and turnkey projects will increase. (Rada, 1982b, p. 225)

Mexico and Brazil may . . . be approaching the critical threshold of scientific and technological competence and, with their high natural resource potential, should have a bright future and, if they succeed in evolving integrated economic and technological policies, should . . . be able to develop modern industries using microelectronic devices. (King, 1982, p. 324)

North-South relations

No other field is contributing more heavily to the increasing gap within the North and between the North and the South as the information and communication sectors. . . . In no other area is the dependency of the Third World as great as in that of information; and in no other field is the concept of self-reliance so neglected. . . . Information dependence is much harder to overcome because it is multifarious. (Elmandjra, 1985, p. 3-4)

. . . we can be certain already that the new technology with its wide span of application will create a major discontinuity in both the industrial development of the North and the economic growth of the South (King, 1982, p. 311). . . . the concentration of a new and vital technology [microelectronics] in the main industrialised countries, with massive efforts of research and development in

North-South relations (cont'd)

support and with its direct stimulus to a wide spread of economic sectors, is likely to increase the gap between the rich and the poor countries. (King, 1982, p. 318)

In the case of microelectronics or, more accurately, information technology, at least three different areas of disparity are apparent. . . . distribution of scientific and technological capabilities . . . industrial capability . . . the information infrastructure of society: the system that binds together different activities of a social, cultural, political and economic nature. (Rada, 1982b, p 214)

While all countries proclaim the sanctity of their sovereignty, in fact it is being slowly eroded by the necessities of international trade, international agreements necessary for the operation and management of an intrinsically interdependent world, the activities of the transnational corporations and, perhaps more importantly, by technological development. The applications of microelectronics, which we have described, cannot but accelerate the erosion. As Stanley Hoffman, the political scientist, has said: "the vessel of sovereignty is leaking." (King, 1982, p. 335)

The relative disadvantages for developing countries can be summarized under seven main headings:

1. . . . the relative reduction of the developing countries' advantage of having an abundant supply of low-cost labour. . . .

2. The shift in relative importance between embodied and disembodied technology alters traditional approaches to the transfer of technology, particularly to

North-South relations (cont'd)

"unpacking" technology. . . .

3. . . . there are growing difficulties for developing countries in absorbing microelectronics technology at the hardware and software level, although in the case of software there is considerable room for adaptation and absorption. . . .

4. Current changes also alter managerial requirements because of changes from products to systems, shorter product cycles and utilization of automated equipment. . . .

5. The reliance of production on science, technology and research and development will widen the gap between developed and developing countries. . . .

6. The utilization of computer and information technology seems to have an impact on employment. However, it is minimal when compared to changes in agriculture. . . .

7. There is a growing concentration of information-intensive sectors in some developed countries. . . .

The relative advantages for developing countries, due to technological change in information technology, can be summarized under two main headings -- economic advantages and the utilization of human resources:

1. From an economic point of view capital savings per unit of output that seem to take place through the utilization of microelectronics-based equipment are important in capital-scarce situations. . . . In addition, the incorporation of skills into equipment,

North-South relations (cont'd)

> such as in precision machinery, will save skills that are often difficult and costly to acquire. . . .
>
> 2. In human-resources utilization there are two major advantages for developing countries. First, there is the utilization of low-labour cost, highly educated labour in areas such as conversion and development of software, which remain extremely labour-intensive . . . Second, there is the use of information technology, particularly interactive links, to increase the critical scientific and technical mass within countries and across countries without changes in geographical location. (Rada, 1982a, pp. 104-106)

The technological centres of the [Latin American] region have insufficient links with the major users of electronics and local producers. This is due largely to the very limited demand for technology deriving from the exogenous nature of its incorporation, which makes it difficult to coordinate the efforts of the centres, as there are no poles of demand sufficiently important to influence trends in the supply of technology. One of the fundamental ways of reversing this process would be to concentrate efforts to set up technological centres among major public users and bodies which take decisions on matters directly linked with priority areas of the electronics complex, such as the centres dealing with technical regulations regarding information services, communications, education or health, or those dealing with policy on the electronics industry. In order to be effective, these centres should have decision-making power or be closely linked with those responsible for taking decisions, and they should establish formal relations with the private sector so that interaction with local supply possibilities is a central and not a residual function. (Lahera and Nochteff, 1983, p. 180)

North-South relations (cont'd)

Perhaps a starting point in the identification of realistic options for the South is to accept the need to approach the problem from within the framework of dependency. . . . To deny the spread of microelectronics would only increase an already wide technological gap. . . . The critical issue is that the applications must be identified after a careful analysis of their direct and secondary impacts and long-term implications and must, therefore, be approached very selectively and critically. . . . a meaningful approach would be one that is based upon the principle of South-South cooperation. (Wad, 1982, pp. 691-692)

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