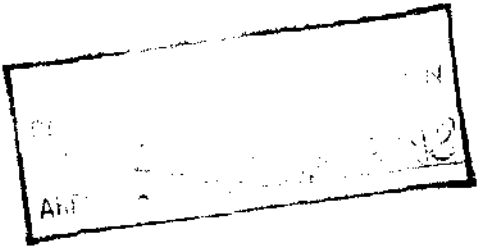
Technology and Economic Development



Westview Special Studies in Social, Political, and Economic Development

Technology and Economic Development: A Realistic Perspective
edited by Samuel M. Rosenblatt

The authors focus on the technological choices that confront both less developed countries (LDCs) and multinational corporations (MNCs) in establishing new industrial enterprises. They also discuss the underlying economic realities in developing countries, particularly the necessity to calculate appropriate relative factor prices for production resources, establish realistic exchange rates, and provide adequate protection of proprietary technology. The book is intended to postulate hypotheses as well as conclusions relevant to overall U.S. policy toward international flows of technology and the strategy and tactics of development.

Samuel M. Rosenblatt is project director for the International Economic Studies Institute's Technology Studies and chief economic consultant to the International Economic Policy Association. He has served on the White House Council on International Economic Policy, with the Department of Commerce's industrial analysis and regional economic development components, and as an economist with the Federal Reserve Board. The contributors include several of the United States' leading academic scholars in the fields of technology, development, and international business.

Technology and Economic Development: A Realistic Perspective

edited by Samuel M. Rosenblatt
with a Foreword by Harlan Cleveland

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Dr. Ranis received a B.A. from Brandeis, and a M.A. and a Ph.D. from Yale. He has been both a Social Science Research Council and a Ford Foundation fellow and served as a consultant to U.S. and international development agencies. He served as assistant administrator for policy and planning in AID from 1965 to 1967. In 1976 he organized the NAS Bicentennial Symposium Panel on "The Role of Science and Technology in Economic Development." He was recently appointed to the Council on Science and Technology for Development.

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Acknowledgments

This is the second major book resulting from research by the staff of the International Economic Studies Institute in its less than four years of operations. Like the *Raw Materials and Foreign Policy* project which preceded it, this is a team effort, and is a part of a larger study program which has resulted in other reports, data compilations, and *Contemporary Issues* essays.

The Institute was established at the recommendation of the Board of Directors of the International Economic Policy Association to study longer-term international economic issues of concern to Americans. It seeks to accomplish this objective with government as well as academic, foundation, and business participation and support. The institute's trustees selected technology transfer as an appropriate subject for study because of its controversial nature and its economic importance in several dimensions of U.S. international relations.

This portion of the project, dealing with the "North-South" or development dimension, was made possible by a grant from the National Science Foundation (NSF) in support of the State Department's preparations for U.S. participation in the August 1979 United Nations Conference on Science and Technology for Development. Thanks are due to the State Department and NSF officials who encouraged our revision of the institute's report to the NSF on "Obstacles and Opportunities in Technology Utilization for Development" into this book, to the editorial staff at Westview Press, to Ambassador Harlan Cleveland for his perceptive foreword, and to all who

have contributed financial support to the institute's research and publications.

Particular credit for this effort belongs to Dr. Samuel M. Rosenblatt, the institute's senior economic consultant and technology project director, who also served as editor and a coauthor of this book, developing most of the case study materials and the overview. We are grateful to Professors Gustav Ranis, Howard Pack, and Nathaniel Leff, who wrote Chapters 2, 3, and 4, respectively, for their cooperation in making this an integrated and productive effort. As the institute itself takes no positions on policy issues, the views expressed in each chapter are those of the individual author. Albert P. Toner and N. Ethelyn Thompson deserve the credit, respectively, for the manuscript's editing and production supervision.

Helpful suggestions and criticisms were received from several of the institute's trustees and from members of its Senior Advisory Committee on Technology, and particularly from the experts (listed in Appendix C) who participated in the institute's June 1978 workshop. To all of the above go our thanks, and an exoneration from any responsibility for the study's conclusions or for any deficiencies in the final product, which the undersigned must accept.

Timothy W. Stanley
President
International Economic Studies Institute

Foreword

Much of the literature about "technology transfer" and "technology for development" has a disembodied quality, as though technology were detachable from the people who design it, the culture of which it is a part, the incentives that pay for it, and the people who install it and manage it and relate it to the rest of what is going on in their time and place. The purpose of this book is to bring technology for development down to earth.

Reading about technology for development is currently quite fashionable in pre-technology societies, where technology appears as a kind of magic that the rich are hoarding and not sharing with ("transferring" to) the poor. The Third World caucus—the "Group of 77" that now numbers 110 or more in United Nations assemblies—thought for a while that OPEC's oil price fixing and perhaps other commodity cartels would give them a tool to pry loose the resources for their development. But other commodities were hard to make into tools for world politics. And in practice higher oil prices not only milked the "developed" cows but siphoned from most of the "Group of 77" the foreign exchange they would have used for development; it was used instead for development and arms purchases by the oil producers. A little of the considerable surplus became aid to the non-oil-producing poor, but most of it was invested in the high-technology economies of the West.

With "resource diplomacy"—a subject explored earlier in the International Economic Studies Institute's book, *Raw Materials and Foreign Policy*—proving to be a disappointing source of leverage, technology came to be seen as a

useful approach to raise in a different way the "fairness" question in international economic relations.

The writing about technology for development has come mostly from the societies which have it in profusion—societies, however, where this modern magic also has been viewed as damaging, dehumanizing, and dangerous. The humorists had already caught the mood. "Progress was a good thing once," Ogden Nash wrote, "but it went on too long." Or, as E. B. White asked in the 1920s, "Have you ever considered how complicated things can get, what with one thing always leading to another?"

The revelation that scientists bent on discovery and engineers bent over machines could make trouble, as well as progress, came as a shock. And we who live and die by technology have hastened, in our right-minded way, to tell the pre-technology folk about it. The words and music come straight out of the old spiritual: "Nobody knows the trouble I seen."

So the conditions for a collision are already in place. Planners in developing countries see technology as the key to doing something about poverty. Planners in industrial countries still think of information as a depletable resource to be conserved, and want other people's technologies to be "appropriate," or "intermediate," or something else that their own is not. The predictable collision is scheduled for the summer of 1979, at an intersection called the United Nations Conference on Science and Technology for Development.

It was under a grant from the National Science Foundation, in support of the State Department's preparations for the UN conference, that the International Economic Studies Institute engaged in an ambitious effort to examine "Obstacles and Opportunities in Technology Utilization for Development," and undertook the research on which this book is based as part of its longer-term program to look at technology's role in international trade, development, and security. The institute has had the good fortune to supplement its own expertise on international economic relations with the insights of three of the leading scholars in the field, and to draw through not-for-attribution interviews on the experience of a number of

knowledgeable business executives. The findings were independently reached, but they turn out to be mutually reinforcing.

The net conclusions are pragmatic, and a breath of fresh air on a subject stale with politicized rhetoric and "blackbox" mythologies. Transnational enterprise turns out to be neither hero nor villain, neither all-important nor negligible, just a necessary if uncomfortable conveyor belt. The latest technology is not invariably inappropriate nor the most basic invariably appropriate. It is better to start from where we are, not from somewhere else.

Much can and should be done to maximize technology's contribution to development; but little will be done unless both the "northern" and "southern" sides of the transaction work with, rather than against, the underlying economic currents, and thoroughly understand the realities of international business.

Magic would be more fun. But when it comes to technology for development, economics is more effective.

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Introduction and Overview

Samuel M. Rosenblatt

In August 1979 the United Nations will convene an international Conference on Science and Technology for Development (UNCSTD), which is awaited with both hope and concern. UNCSTD is one of a series of efforts to address the role of science and technology in the economic development process. While the immediate focus of the conference is on this role of science and technology, its broader context includes such fundamental matters as the changing relationships between developed and developing countries and the different perspectives from which each nation views this relationship.

Consequently, the conference must be cognizant of a host of overlapping issues. They embrace the more technical questions of science and technology enhancement in developing countries and the improved application of scientific capabilities to the needs of the developing world. They have to do with improving the network for the dissemination and utilization of the findings of science and technology within developing countries. They also deal with the contribution that technology can make to economic progress generally in the developing world, and with the institutional changes, internationally and within individual countries, that might be needed to utilize this technology more effectively for economic development purposes. The broader issues of other public policies and programs that have a direct impact on economic development, and consequently on the contribution that technology can make to this end, are also germane to the conference. In essence, while UNCSTD will be dealing directly with narrowly technical

matters, in the end its success will depend on how well it relates these issues to the broader concerns of overall economic development and the varying needs of the individual developing countries.

In a sense, there is also a "hidden agenda" for the conference reflecting the controversies and confrontations of the "North-South" dialogue between the world's rich and poor countries—and especially the frustrations of the latter group over what they regard as past exploitation and monopolistic practices by the industrial countries and their international business firms. The latter feel that the developing countries tend to ignore the economic realities of the modern world and seek to establish a double standard of behavior and obligations which will retard, rather than promote, the use of modern technology for human advancement on a global basis. However, the conference comes at an interesting time, when attitudes in both camps may be evolving toward less dramatic and inflexible positions. How much this hidden agenda comes to dominate the UNCSTD proceedings may largely determine the relative success or failure of the conference.

While it once was common practice to view the separate developing countries as a homogeneous whole, it is now widely accepted that there are great differences among them in terms of their relative stages of economic and political development and their basic infrastructures, and that consequently their needs for various technologies vary considerably. Among many of the poorer countries, emphasis should continue to be placed on satisfying basic human needs, such as needs for nutrition, housing, health care, and electricity. The accomplishment of these tasks requires that the technology provided be of the simpler and more direct variety, rather than the so-called "high" technology, which is relatively new, highly research-intensive, and therefore comparatively expensive. The latter type of technology is also likely to be the most controversial from an international legal standpoint, since it is the most likely still to be under patent protection and control. It is essential that UNCSTD keep these distinctions in mind as it proceeds. (Some useful definitions of technology—what it is,

as well as what it is not—are contained in the succeeding chapters.)

The most direct antecedent of the present conference, the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas (UNCSAT), took place in 1963. Its purposes were broadly similar to those outlined for UNCSTD. However, for a variety of reasons, this conference failed to produce the desired results. For one thing, it suffered from some overestimations of the potential contribution that technology could make to economic development. Hence, no matter what the actual outcome of the conference, persons with high and unrealistic expectations were bound to be disappointed. Another reason for the failure was rooted in the limited focus of the conference discussion. One analyst observed that UNCSAT was "a symposium presenting views on narrowly conceived scientific and technologic options. The presentations usually were isolated from the complex factors affecting the actual social settings in which 'development' takes place."[1] UNCSTD, and its member nation participants would do well to review this experience as they proceed to develop the preparations for the forthcoming conference.

Related contemporary multilateral exercises on technology which could profoundly affect the atmosphere in which UNCSTD takes place, as well as its outcome, are the efforts in the United Nations Conference on Trade and Development (UNCTAD) to draft "codes of conduct" on technology transfer and on restrictive business practices.[2] Meetings of ad hoc groups of experts have been underway since early 1975, and initially tended to be opportunities for the Group of 77, or developing country group, to engage in considerable amounts of political and ideological rhetoric and make unrealistic demands against the multinational corporations in the industrial countries. The press release issued after the conclusion of the fifth session of the Ad Hoc Group on Technology Transfer, held in July 1978, spoke to the progress made but also recognized that considerably more was needed and that resolution of differences among the Group of 77, the Group B

(industrial) countries, and the Group D (Communist) countries would require "political decisions."[3]

Although such decisions have not yet been made, a negotiating conference nevertheless got underway in the fall of 1978 at Geneva. As this book goes to press, this conference seems unlikely to eliminate either the "square brackets" (reflecting disagreements over many of the key substantive provisions) or some of the more basic underlying differences, such as whether such codes should be voluntary or mandatory, should impose obligations on governments as well as "enterprises" (and whether the latter category includes government-owned as well as private entities), or should call for international arbitration of disputes. The disposition of this exercise in a reasonably satisfactory fashion seems a logical prerequisite for creating a conducive atmosphere for the UNCSTD discussions.

The restrictive business practices exercise has made faster progress, with considerable agreement reached among the antitrust specialists from both the developing and the industrialized countries. A final diplomatic negotiating conference is anticipated on this code within the next year and a half.

The UNCSTD agenda, as originally approved by the Economic and Social Council, contains three items (see Appendix A). The first deals with science and technology for development, the second with institutional arrangements in science and technology, and the third concerns the utilization of the United Nations and other international organizations. A much more detailed, annotated agenda was issued subsequently (see Appendix B). Its purpose was to provide guidance in the preparation of individual national papers and to help focus the ensuing discussion at the conference itself. The research presented in this study addresses a number of these items and subitems, especially the following [in 1(a)(b)]:

> (i) . . . state of technological dependency; difficulties in the transfer and selection of technology; the role of multinational corporations; and (ii) . . . assessment of national measures to enhance technology transfer and adoption of integrated national policies for technology transfer and development.

Other subitems also touched upon, in part, include:

> (iii) . . . obstacles to the successful adoption of a technology transfer policy; and I(c)(d)(ii) . . . national measures that might be taken to overcome some of the obstacles.

Appropriate Technology

It long has been recognized that the choice of technology and technical change plays a vital role in contributing to the economic development of all nations. Other key elements of such development include increases in the supply of resources and improved efficiency in their use, including technologically induced shifts in the sectoral and industrial composition of production. Institutional changes that support competitive conditions and economic incentives and objectives, as well as more traditional non-economic goals, such as educational systems, class status, and societal stability, also play a part in this process.

In the immediate aftermath of World War II, a feeling of euphoria about the world's ability to solve its economic development problems seemed to have taken hold.[4] This attitude may, in part, have been due to the success of the U.S. program of financial aid and assistance to Western Europe which, however, started the post-war reconstruction from a much higher and more sophisticated base than applied to developing countries. It also reflected an over-optimistic assessment of the role that technology could play in the developing world. With the passage of time and the accumulation of experience, disillusionment set in regarding the ease with which traditional societies could be turned around to become industrialized, modern states through the judicious use of private investment, foreign aid, and what has been termed "sweat equity," or the involvement of local human resources. Attitudes toward technology also altered. Instead of focusing upon the transference of large-scale industrial modes of production from developed to developing countries as quick and effective solutions to economic development problems, discussions turned to the use of a more appropriate type of technology. As noted by Nicolas

Jéquier, this shift had both immediate and historical derivations. "The most conspicuous of these immediate origins," he notes, "is the realisation, shared by aid-giving and aid-receiving countries alike, that development aid and a Western style of industrialization have neither fulfilled the initial hopes which were placed in them nor been fully capable of solving the basic problems of development."[5] The quest then turned to other and more appropriate forms of technology.

The United States has been among those in the forefront of this movement. Public Law 94-161, the International Development and Food Assistance Act of 1975, specified that a portion of the funds authorized for fiscal years 1976, 1977, and 1978 could be used to develop activities in the field of intermediate technology. This technology is defined as being "neither so primitive that it offers no escape from low production and low income nor so highly sophisticated that it is out of reach for poor people, and ultimately uneconomic for poor countries."[6] This attitude was more recently expressed and reconfirmed as part of the U.S. preparations for UNCSTD. Section 507(a) of the Foreign Relations Authorization Act, Fiscal Year 1978, P.L. 95-105, says:

> The President shall take appropriate steps to ensure that, at all stages of the United Nations Conference on Science and Technology for Development, representatives of the United States place important emphasis, in both official statements and informal discussions, on the development and use of light capital technologies in agriculture, in industry, and in the production and conservation of energy.

The following section of this law goes on to define light capital technologies and lays out some of the intended goals and objectives that might be achieved by its expanded use.

> The term "light capital technologies" means those means of production which economize on capital wherever capital is scarce and expensive and labor abundant and cheap, the purposes being to insure that the increasingly scarce capital in the world can be stretched to help all, rather than a small minority, of the world's poor; that workers will not be displaced by sophisticated labor-saving devices where there is already

> much unemployment; and further, that poor nations can be encouraged essentially to produce their own capital from surplus labor time, thus enhancing their chances of developing independently of outside help.[8]

On its face this appears to place a heavy burden on technology, in whatever form and however defined, in a manner similar to the earlier highly optimistic expectations for modern technology transfer. Indeed, the concept of "light" technology, "intermediate" technology, or "appropriate" technology, however it is labeled, seems to have evoked ideological and missionary zeal from some of its proponents. Over-selling a program in this manner may once again dash expectations and undercut a reasonable assessment of the role technology can actually play in assisting the developing world to achieve greater economic development. In this regard it should be noted that "appropriate technology" may, in some contexts, mean capital-intensive techniques and that "light" technology may embody highly modern and efficient production processes. If these distinctions are not recognized and the temptation is not avoided to prescribe doctrinaire solutions, such support for this concept as is growing in the developing countries could well be dissipated. Many of these countries have moved from negative or skeptical attitudes about appropriate technology to a cautious acceptance of its possibilities. Misspecifying or overselling it can once again cause exaggerated expectations to be followed inevitably by disappointment and cynicism.

The concept of appropriate technology has been variously defined. One definition describes it as "the set of techniques which makes optimum use of available resources in a given environment. For each process or project, it is the technology which maximizes social welfare if factors and products are shadow priced."[9] Another definition calls technology appropriate when "factor proportions . . . are roughly in line with the overall factor availabilities in an economy. The poorer the LDC the less capital (physical and human) relative to labor and, hence, the more labor intensive the 'appropriate' factor proportions would be."[10]

The second definition emphasizes the labor-intensive char-

acteristics of appropriate technology, an approach that is taken by many advocates of appropriate technology. One limitation of both definitions is their static nature, especially when viewed from the vantage of policy analysis and policy development.[11] This point is discussed by Frances Stewart in her book, *Technology and Underdevelopment*, where she emphasizes that there is not a single alternative or appropriate technology for a developing country.[12] Rather, what is appropriate for that country must be compared with the existing techniques in use in the capital-intensive, or modern, sector as well as in the more traditional labor-intensive sectors. The simultaneous presence of both of these technologies in developing countries is at once a cause and effect of the unbalanced nature of their economies and the problems associated with these imbalances. These problems are the familiar ones of developing countries today: a dualistic economy with modern and traditional sectors; a dichotomy between urban and rural areas associated with this dualism; widespread underemployment in rural areas and growing unemployment in urban areas; generally low labor productivity; extremes in the distribution of income; and limited internal purchasing power for broadly based consumer goods with emphasis on the availability of high quality consumer goods to satisfy the small, but wealthy, upper income groups.

The approach toward a solution to these problems does not lie solely with technology in any of its forms, appropriate or otherwise, even though there is no doubt that more effort could go into making the "right" technology choice and that the range of these choices is wider than traditionally thought. This last point is developed below, and in the sections by Pack and Ranis, as are suggestions on how to improve the frequency of choice and the likelihood of success for these choices. However, these discussions should be fitted into the context into which Stewart placed them. She noted that, "the question of whether or not an 'efficient' alternative technology exists is closely tied up with the whole strategy of [a country's] development, and can only be assessed within the context of a particular strategy."[13]

Alternative techniques exist or can be readily devised; for example, if a strategy calls for a rural, small-scale, self-reliant pattern of development, then techniques can be developed. Or if the objective is to pursue a policy of rapid, export-oriented, and internationally competitive industrialization, a more advanced technology can be applied. However, each strategy, once established, tends to be self-reinforcing, and its continuation tends to make the alternative appear to be less attractive and less feasible. Stewart sums up the ultimate underlying implication of this discussion as follows:

> Implicit behind some of this discussion is what might be termed the political economy of technical choice. The political economy of a system may be defined as the distribution of the control over resources—both consumption and investment—to which it gives rise. Associated with each technique is a particular distribution of benefits.[14]

The inference from these statements is quite clear. In a very narrow and technical sense, it would appear possible for the developing countries to choose more appropriate technologies and techniques from among the given set of available techniques, and perhaps even broaden the range from which choices are made. This would have the effect of increasing the demand for labor, raising the real wage level, and increasing the volume and scope of producer and consumer goods available to satisfy the mass market. However, before a significant breakthrough and restructuring of a country's technological base could occur, decisions and actions of a non-technology nature would have to be made and taken that would redirect the energies and resources of a developing country toward a series of economic development goals and objectives that were conducive to the widespread adoption of such technologies and techniques.[15]

It should also be noted that development goals themselves are not static, although they are often so treated for analytical purposes in the literature. Rather, they are inevitably dynamic functions of the country's political processes, and may change

over time in their scope and content and in their relative priorities. This argues for a country to maintain some degree of flexibility in its technological inputs.

Technology Choice—Actual and Potential

Within the broader policy constraints just described, a major issue is the extent to which a range of technology options actually exists from which the developing countries can make choices, the degree to which they exercise this prerogative, and the actual outcomes of such choices. Initially, there was a fairly widespread presumption that because of the obvious dependence of the developing countries on the advanced industrial countries for technology, the receiving countries had very little choice regarding the type of technology they could acquire. In effect, they were thought to exist in a state of "technological determinism" and "technological dependence" on the industrial countries. Therefore, the technology the developing countries were likely to obtain, especially from multinational corporations (MNCs), would be highly capital-intensive, geared to large-scale operations, and capable of turning out only high quality, sophisticated products that were more suited to the economies of the industrial countries themselves. Such technology, according to the "dependencia" literature of recent years, would control and dictate the path of economic development that the developing countries could pursue. With the passage of time, the acquisition of experience, and the accumulation of analytic studies, this attitude has changed, although doubts—and doubters—still exist.

A 1974 study by Walter Chudson and Louis Wells, prepared for the United Nations Secretariat, found some intermediate technology in selected industries in developing countries used side by side with more automated techniques.[16] They noted, however, that "most of the evidence concerns light manufacturing in which adjustment is presumably easier, and even here it occurs mainly in the 'peripheral' operations (materials storage, handling, and packaging) rather than in 'core' processes involving the physical transformation of material."[17] However, their conclusions on this point are cautious because

of the limited research on the choice of technology by the industrialist.

More recent research has come to somewhat stronger conclusions. In a series of case studies undertaken for the International Labour Office, A. S. Bhalla concluded that, "The studies demonstrate quite clearly that substitution possibilities exist in industry in both core and ancillary operations. This conclusion, based on empirical evidence, is important, since it has often been assumed that there is no choice of techniques in manufacturing industry."[18] In a review article on the existence and application of alternative appropriate technologies in manufacturing industries in developing countries, Lawrence White also concluded that these countries had such alternatives and did not seem to be limited to contemporary capital-intensive methods of advanced industrial countries.[19] Gustav Ranis and Howard Pack, in their respective chapters of this book, also support this conclusion.[20] It should be noted that a somewhat different view persists regarding the existence of this range of choice of technologies, and especially regarding the possibilities of effectively utilizing appropriate technology for development purposes.[21]

Nevertheless, on balance, the developing countries do indeed appear to have a wide range of alternative technologies from which to choose. In effect, there is a supply of alternative technologies. These cannot necessarily be taken "as is" off some "international shelf." They may require minor modifications and the application of local ingenuity, as well as certain management techniques, but they do exist. How actively the developing countries are exercising these choices and making these adaptations is discussed below.

Demand Limitations on Choice

Within this range of technological alternatives, the question is what factors impede or encourage the adoption of appropriate techniques. As Ranis puts it: Given this wide choice, why is it that "we are nevertheless confronted with the empirical fact that the selections actually made in most of the developing countries still appear to be substantially 'inappro-

priate' by any known quantitative or judgmental standard."[22] Most authorities who attempt to answer this question would cite inappropriate factor prices and the absence of competitive markets in the developing countries among the major explanations for this behavior.

There are indeed differences between the capital-labor price ratios in developed and developing countries across comparable industries and goods; that is, capital is relatively more expensive in the developing countries than in the industrial countries, and labor is relatively cheaper. However, these differences are less than might be expected given the larger differences in relative factor supplies in these two groups of countries. These results come about because the cost of capital in developing countries tends to be underpriced, relative to its true or market opportunity costs, for such reasons as government subsidies, overvalued and other exchange rate policies that encourage capital imports, and tax preferences and depreciation policies. At the same time the cost of labor is inflated (again relative to its opportunity cost) by such policies as minimum wage legislation, mandated social welfare programs, and restrictions on firing employees.[23] The absence of competitive market pressure minimizes, or eliminates, the necessity for entrepreneurs, whether local or associated with a foreign multinational corporation, to seek out and adopt either the most efficient techniques by which to produce a product or the most appropriate goods needed to satisfy market demand.

There are, of course, other factors that affect the demand for appropriate technology. Among these is the market demand for particular products. This demand, in turn, is affected by the developing countries' macroeconomic policies, including their policies regarding income distribution. Such policies have a direct influence on the effective demand for various types of appropriate or inappropriate goods.[24] Other factors that limit the demand for appropriate techniques include an engineering bias toward capital intensity—a desire for the newest and best; management bias toward capital intensity—a desire for better control over sudden changes in output, given the developing country environment in which the firm

operates; and product quality bias—which places emphasis on automated and controlled production techniques needed to establish and maintain high quality.[25] Finally, the very inefficient information network that exists in most developing countries leaves many entrepreneurs totally unaware of the existence of alternative, and more labor-intensive, techniques.[26] Conversely, if the costs of obtaining information are too high, it may be rational for the entrepreneur not to expend his time and energy seeking alternatives. On this point, Pack notes that multinational corporations may have an advantage, since their costs for information searches would be lower than those of locally-owned firms.[27] The multinational corporations could therefore afford to seek out a more appropriate alternative.

The scale of operation also enters heavily into this discussion of demand. On this point, Pack contends that a larger scale of output per firm need not necessarily lead to greater capital intensiveness.[28] On the other hand, Stewart has argued that scale of operation is decisive in the choice of appropriate technology and that, given the size of the market in the developing countries, small scale is often more appropriate.[29] Finally, in his chapter of the book, Nathaniel Leff contends that, regardless of the type of technology considered, the aggregate effective demand by the developing countries for this technology is likely to be quite limited.[30]

A new factor has entered the equation since OPEC's successful cartelization of the world oil supply and the quintupling of its price. The several-fold increase in the cost of imported oil has created additional constraints on the already scarce foreign exchange resources of many non-oil-producing developing countries. This has meant less money for most of the developing world to spend on imported technology of any type (which may account, in part, for the renewed emphasis in UNCTAD and elsewhere on improving the developing countries' "terms of trade" for such technology). The premium price for energy inputs has also altered the market demand for technology. Energy-intensive technologies now strain a scarce and expensive resource, and for countries like Brazil (which devotes about a third of its foreign exchange

to imported oil) also involve balance of payments constraints. Energy-efficient technologies, on the other hand, are in growing demand. This change has, in a sense, enhanced the role of multinational corporations in the selection and choice process because they are the source of many of the key technologies for both energy production and its industrial utilization. Their opportunities—and responsibilities—may therefore be proportionately greater.

Enhancing Technology Choice Outcomes

Consideration could be given to a wide variety of means of improving the supply and demand sides of the technology equation. Introducing the correct pricing signals for capital and labor and intensifying the degree of competitive market pressures would undoubtedly result in more rational decision making within the developing countries. Similarly, creating a more effective aggregate demand for a wider variety of appropriate goods and services that are compatible with the social, economic, energy, and natural environments in which the developing countries operate would also be conducive to this end. Decisions on these options must be made principally by the developing countries themselves. U.S. and other industrial countries' policies could be more supportive of these choices, however, taking into account the learning curves that are inevitably involved.

Vast impediments exist in the developing countries to a proper flow of information between the developers and users of technology. Virtually all analysts of the problem agree on this point.[31] The research communities in these countries tend to be isolated from the potential users of their output, and, equally important, they tend to respond to their own systems of rewards that seek approval and affirmation in research communities located in the more advanced industrial countries.[32] This means they have little or no appreciation for the scientific and technological needs of their own industries. These research communities should direct more effort toward the practical needs of their domestic industries (including their energy situations) in order to encourage the local adaptation

of imported technologies. Chudson and Wells cite a study of innovation in Argentina that illustrates the importance of these local innovations and incremental adaptations.[33] Similarly, Ranis stresses the importance of gradual and unspectacular change. Moreover, such an approach could expand the innovative and productive contribution of the science and technology community of the developing countries.[34]

Denis Goulet speaks of the so-called "Sabato triangle," named after an Argentine physicist, Jorge Sabato, that could provide a model for technology policy in this regard. This model "aims at creating practical linkages among research, production, and development-policy actors. . . . Each . . . must be linked by a flow of information with the other two; each must take initiatives in demanding or supplying technology."[35] According to Goulet, this concept enjoys widespread acceptance among Latin American specialists in technology.[36] The political, economic, and organizational implications of such a model are complex, however.

Technology Transfer

There are many ways to transfer technology to developing countries. One way is through direct investment by a multinational corporation in a wholly-owned or majority-owned subsidiary. Another is through a joint venture where the multinational has a minority interest. Other ways include the use of licenses and patents, turn-key operations, management contracts, equipment suppliers, and consultative arrangements that may be done independently or in combination with some of the other modes of transfer. The essence of all these methods however, is that the technology moves from a private entity in the industrial country to the recipient, public or private, in the developing country. While the developing countries may resent this dependence, "the harsh truth is that poor countries do need technology, and there exist few alternative sources outside the TNCs [transnational corporations] where they may obtain it."[37] (Such technology as may be public property, by virtue of government-financed research or otherwise, could, of course be contributed as part of government foreign assis-

tance. But its relevance to development needs tends to be limited.)

As described below by Rosenblatt and Stanley, multinational corporations have a variety of reasons for entering into technology transfer arrangements. These include export potential, market protection, market penetration, and increased production to reduce unit costs, but the common denominator is the objective of a satisfactory economic return. Developing countries are attempting to alter their relationships with the multinational corporations, focusing on what they call the restrictive business practices of these entities, as in the aforementioned UNCTAD discussions on the transfer of technology. These discussions concentrate on such matters as patents, licenses, marketing restrictions, and other devices that, from the perspective of the developing countries, may appear to limit their economic options and slow down their economic development. The evidence on these points is mixed, but some would agree that, in the past, patents have been used in part to protect markets and restrict entry by the developing countries.[38] However, regardless of this history, the balance between the multinational corporation and the developing country has now shifted so that the developing countries are in a much less dependent position.

There is now considerably more competition among the multinational corporations in the quest for markets and entry into the developing countries. Moreover, developing countries such as the Andean Group in South America and the Association of Southeast Asian Nations (ASEAN) provide individual countries with greater bargaining power. The United Nations Center on Transnational Enterprises has as one of its purposes the providing of expert advice to developing countries in their negotiations for technology and other arrangements with international firms.

Finally, it is important to note that an active involvement by a developing country firm with a multinational corporation involves much more than the use of patented, proprietary knowledge. The multinational corporation's intangible managerial insights and "know-how" in the end may prove to be the most valuable contribution it makes to the developing country.

In the vast majority of cases, the multinational company makes its decisions in the context of a long-term relationship with the host country and particular partnership arrangements within it. Where the essential ingredients are lacking, there is little that industrial country governments can do to change the judgmental factors influencing the private sector. They can, of course, assign a higher priority to technological inputs in their public sector aid programs; but there are practical limits here as well.

Policy Framework and Recommendations

The chapters which follow develop the points discussed above. Each of the authors has approached the subject from a somewhat different vantage point and reached somewhat different conclusions. Nevertheless, throughout these papers and at the workshop that was held to review them, a certain consensus emerged on the proper approach that the United States, the other industrial countries, and the developing countries might take toward UNCSTD.[39] In many respects, then, the independent work of the several authors has reached quite parallel conclusions.

In abbreviated fashion, these are the principal elements of this consensus:

1. There should be a wariness of exaggerated claims and expectations regarding the contributions that advanced country science and technology can make toward solving the economic development problems of developing countries.
2. While much of the technology that will be used by the developing countries will come initially from the industrial countries, and specifically the multinational corporations, much of the successful adaptation of this technology will depend on the efforts of the developing countries themselves.
3. Multinational corporations, by and large, have not operated in a manner destructive of the efforts of developing countries to achieve economic development, and they have not attempted to impose a "technological

determinism" on these countries. Indeed, the evidence suggests that the multinational corporations have been at least as adaptive as indigenous firms, if not more so, in seeking to install appropriate labor-intensive and, more recently, energy-efficient, technologies.

4. The successful development of an appropriate technology policy by the developing countries will generally require a major realignment of their other economic and social policies. Responsibility for bringing this about must necessarily lie with the developing countries themselves.
5. There should be an awareness that appropriate technology is best applied at the working or operating level of a plant and that it achieves its results in an incremental and unspectacular fashion. This will require the developing countries to display considerable forbearance in their expectations of spectacular technological breakthroughs.
6. There are major differences among developing countries regarding their degree of development, their needs for technology, and their internal science and technology competence. The policies advocated by the United States and the other industrial countries must reflect these differences.
7. A major effort needs to be directed toward improving the flow of information among researchers, producers, and policymakers within developing countries so as to emphasize the availability, value, and utility of appropriate technology. Research centers of excellence should be carefully planned to focus on the practical application of technology in the production process of a limited number of industries. But this emphasis need not exclude a more imaginative search for technologies to solve particular problems important to the mass of people in a given region.
8. Given the information gaps and discontinuities noted above, industrialized country and multilateral aid programs can play a more productive role in the application of technology to development. Many industrial firms

evolve and apply technology exclusively or mainly in a direct relationship to their own products or processes and are normally willing to "transfer" it only as part of a larger and longer-term pattern of business relationships with a host country (or more specifically, with a local partner in the country). But there are some areas where the technology itself is the product, and credits for its acquisition by aid recipients—or via competitive bids for purchase by an aid agency for onward transfer to countries or to regional centers—could play an expanded role. Also, multinational corporations may be able to contribute appropriate technology innovations and expertise to development tasks as a voluntary expansion of their normal business operations, *if* suitable incentives can be structured.

Other major points and recommendations put forth by the individual authors include the following items:

1. Achieving a better balance between urban and rural development programs in developing countries would greatly assist in stimulating demand for appropriate processes and goods. Developed countries should take every opportunity to assist this process when their advice is sought. Energy conservation may be an especially promising field.
2. Developed countries should attempt to do a better job of assuring that their foreign aid and foreign investment support programs are administered so as to encourage the wider application of appropriate techniques in developing countries.
3. Developed countries might restructure their own tax and incentive systems in order to encourage their science and technology communities to undertake more effort to apply appropriate technology in developing countries.
4. Developing countries should reexamine their entire institutional structures for research and development, including their reward mechanisms, to assure that they

are as responsive as possible to the practical needs of their own producing community.

5. It would appear to be a misallocation of limited resources to attempt to establish a computerized technology-information system, highly centralized and bureaucratically controlled, as a means of informing developing countries of the range of technology choices they have available.
6. A more fruitful partnership between industrialized, advanced developing, and less developed countries could be created to utilize the middle group's experience and insights on technology for the benefit of the poorer countries.
7. More imaginative use of the experiences and contacts of multinational corporations with the developing countries should be encouraged, emphasizing the tangible and intangible strengths these corporations have displayed in such relationships. Heretofore, the political emphasis has been mostly on reducing the negative aspects. Perhaps not enough effort has been devoted to the possibilities of "optimizing" the affirmative contributions, which could be made either on a voluntary basis to improve investor-host country relations, or be stimulated by tax or other incentives.

The bottom line of the overall study is a truism with which UNCSTD participants must come to grips: Economic forces themselves are the best "conductor" of technology for development. Other factors can create impedances and short circuits, and these should be removed or minimized wherever possible; but neither goodwill, incentives, nor political decisions can substitute for the basic disciplines of competitive economic forces in the developing countries themselves.

Notes

1. See Mary M. Allen, "United Nations Conferences on Science and Technology for Development, 1963-1979," draft, George Wash-

ington University, Washington, D.C., May 1977.

2. Ibid., p. 5.

3. UNCTAD, press release, TAD/INF/977, July 26, 1978.

4. Richard S. Eckaus, *Appropriate Technologies for Developing Countries* (Washington, D.C.: National Academy of Sciences, 1977), p. 6.

5. Nicolas Jéquier, ed., *Appropriate Technology, Problems and Promises*, Development Centre Studies (Paris: OECD, 1976), p. 25.

6. U.S. Congress, House Committee on International Relations, Hearings, Agency for International Development, *Proposal for a Program in Appropriate Technology*, 95th Cong., 1st Sess., February 7, 1977, p. 2.

7. U.S. Foreign Relations Authorization Act, Fiscal Year 1978, Public Law 95-105 (August 17, 1977).

8. Ibid.

9. David Morawetz, "Employment Implications of Industrialization in Developing Countries: A Survey," *Economic Journal*, Vol. 84 (September 1974), p. 517.

10. Lawrence J. White, "Appropriate Factor Proportions for Manufacturing in Less Developed Countries: A Survey of the Evidence," in AID (see note 6), p. 117.

11. Frances Stewart, *Technology and Underdevelopment* (Boulder, Colorado: Westview Press, 1977).

12. Ibid.

13. Ibid., p. 109.

14. Ibid., p. 110.

15. On this point note the following statement by Richard Eckaus: "Since the use of any particular technology is not an end in itself, the criteria of appropriateness for the choice of technology must be found in the goals of development. These goals are concerned not only with the volumes of output and income generated by an economy but also with the way they are produced and distributed among the population; they include, as well, particular patterns of national political change and national independence." Eckaus, *Appropriate Technologies*, p. 10.

16. Walter A. Chudson and Louis T. Wells, Jr., "The Acquisition of Technology from Multinational Corporations by Developing Countries" (New York: United Nations, 1974).

17. Ibid., p. 3.

18. A. S. Bhalla, ed., *Technology and Employment in Industry, A Case Study Approach* (Geneva: International Labour Office, 1975), pp. 6-7.

19. White, "Appropriate Factor Proportions," pp. 131, 135.
20. See Chapter 2 and Chapter 3.
21. See Chapter 4 and Eckaus, *Appropriate Technologies*.
22. See Chapter 2, p. 27.
23. White, "Appropriate Factor Proportions," p. 150.
24. See Chapter 2 for a discussion of this point.
25. White, "Appropriate Factor Proportions," p. 152; and Chudson and Wells, "Acquisition of Technology," pp. 7-10.
26. White, "Appropriate Factor Proportions," p. 153; and Bhalla, *Technology and Employment*, p. 7. Also see the reference to the bamboo tubewell in Chapter 2.
27. See Chapter 3 for a discussion of this point.
28. See Chapter 3.
29. Stewart, *Technology and Underdevelopment*, pp. 92, 103.
30. See Chapter 4.
31. Eckaus, *Appropriate Technologies*, p. 17; and Bhalla, *Technology and Employment*, p. 7.
32. See Chapter 2 on this point.
33. Chudson and Wells, "Acquisition of Technology," p. 20.
34. See Chapter 2 on this point.
35. Denis Goulet, *The Uncertain Promise* (IDOC North America, 1977), pp. 81-82.
36. Ibid., p. 82.
37. Ibid., p. 60.
38. See Chapter 2 on this point.
39. See Appendix C for a list of participants at the workshop. None of the points in this consensus should be attributed to any of the individual participants at the workshop.