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AN OUTLINE OF A TECHNOLOGICAL STRATEGY FOR LESS DEVELOPED COUNTRIES*

by

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INTRODUCTION:

Although economists have long maintained that technology is one of the basic four factors of production (Labor, capital, land, enterpreneurship), its exact nature, measurement and relative contribution to the production process have been made vague by incorporating them into another factor of production; namely enterpreneurship. Unlike, labor, capital and land, whose exact roles in production were well-defined, and quantitatively determined, technology became so elusive that it was assumed constant by the vast majority of economists. So ,for more than 200 years since Adam Smith's publication of his treaties on the Wealth of Nations in 1776, substantial theoretical and empirical progress has been made on the other three factors of production except technology. In fact, Abramovitz in his 1956 pioneering research on the relative contribution of technology to output growth in the US called it the " measure of our ignorance". Today, Technology as an input to the production process is still in a fluid state.

Recently, and specifically during the last two years since the 1976 UN resolution to convene a global conference on the application of S & T for development, much has been written by economists and non-economists alike on technological needs, dependency, self-reliance, planning,monitoring, co-operation, etc While a number of specific courses of action have emerged from these conference, meetings, national and regional papers and independent research by non-governmental

organizations, the subject matter remains elusive due in parts to its complexity and in part to " our ignorance".

This paper suggests a tentative outline of a technological strategy for a developing country. Therefore, it will look into the subject of this meeting, " Planning for Technological Development and Self-Reliance in Developping Countries", through a step-wise plan of action. It also looks at it from the national view point, not the regional or the international. Our technology strategy, which consists of 4 steps,is at best suggestive. But, it represents an initial step in this direction.

In step 1, it is argued that each developing country must start by identifying and then prioritizing its development goals. In step 2, identification of technological needs in view of the results obtained in step 1 should be undertaken, followed by a subsequent process of prioritization of the country's technological needs in both the short and long term. The third step will be to develop a well-articulated, flexible technology plan along the lines of the country's national economic and social plan. This involves a detailed and thorough assessment of the available domestic scientific and technological capabilities in order to determine how much of the technology plan objectives can be met through local efforts, foreign technologies, or a combination thereof. Realizing the importance of reducing the country's dependency on foreign technologies, step 4 calls for an examination of the most appropriate and realistic policies required to strengthen indigenous scientific and technological capabilities in view of the outcome of the preceding three steps. Included in step 4 is an evaluation of the alternative

modes of co-operation at the regional and international levels. We shall now take up each of the steps for further elaboration.

Step 1. Identification and Prioritization of Development Goals :

The first step necessary to achieve technological self-reliance is to develop a list of the major objectives of development. In the past, developing countries determined their development goals in terms of certain percentage increase in GDP or per capita income over a given period of time. This however is not sufficient for the determination of technological needs. A more detailed delineation of specific objectives should be given. Perhaps, goals can be defined for each sector, where a sector is broadly defined to include such problem areas as outmigration from the rural areas, desertification of arable land, national internal security, improvements in certain services (e.g. sewage, electricity, water, telephones), etc. In other words, sectors should not be limited to the conventional economic classification of mining, industry, banking, trade, etc. Through a national debate where the masses can contribute to the overall objectives of development, a listing of short-term and long-term goals for each "sector" can be drawn up.

Obviously, it will be impossible to meet all the sectoral objectives at the same time in view of the limited resources available. Hence, a process of prioritization must be initiated, and this too must be a subject of national debate. We need not examine this process in detail for it lies outside the scope of this paper. Suffice to say that a detailed temporal

delineation of each sector's objectives along with its ranking among the other national priorities should emerge from this step.

Step 2. Identification and Prioritization of Technological Needs

Just as national economic plans develop models for resource allocation (resource availabilities and requirements) especially in regard to labor and capital the same should be done in regards to technology. Before proceeding any further, it is worth our while at this point to define S & T.

By science, we mean the software aspect of S & T. Here the emphasis is on the need to apply scientific methods for problems solving. These problems ne d not necessarily be li ited to the very mplex and technologically sophisticated areas such as in nuclear energy. In fact, scientific techniques can be much more useful and less expensive when applied to such daily problems as traffic congestions, bureacratic tangles in specific government agencies, mail distribution, transit systems, hospital administration, management of passport office, etc. Not only is the cost incurred in improving these services relatively small but also the benefit is substantial in that it reaches a large number of the people directly. Furthermore, these organizational improvements tend to have a far-reaching influence on the management of other public services through what the economists call the demonstration effect.

Technology, on the other hand, represents the hard ware component

of S & T. It r lates to the manner in hich labor, capita' and land will be combined to meet certain specific sectoral goals. Technology in essence regulates the relationship between man and the machine. In this sense, the man/machine relation differs from one sector to another within each sector. for instance, certain production processes within the manufacturing sector are universally similar. The same goes for telecommunication facilities. However, the technology required in the education sector differs widely from one country to another. Here, the options available are more numerous than they are when, say, the country aims at establishing a cement factory. Hence, it is important to examine the available technological alternatives for each sector so that the selection of the most appropriate alternative can be made rationally.

Technological needs differ from one country to another depending on their respective stages of industrial development. The more advanced the stage, the more complex and costly technological needs will be and vice-versa. Also, the degree of dependency on foreign technology tends to be an increasing function of the step of development. Technological needs, on the other hand, are linked to the sectoral goals and their national priorities as developed in stage (1) above. In fact, technological needs ought to dove tail with the priorities assigned to sectoral goals. Sectors with relatively high priorities should be given a team of scientists and technologist whose task will be to specifiy the alternative technological process available, their sources, costs, impact in the environments, requirements of complementary factors of production, etc. A temporal plan of action should then be developed in which specific technologies are matched with avaialble resources with the objective of achieving the production targets speficied in step 1. It is only in

this manner that an organic integration between national development goals and technological development can be attained.

Two related issues need to be examined at this juncture. The first deals with the need to develop a sufficient data base from which alternative technologies can be identified. This task may prove to be time consuming and financially burdensome, both of which developing countries can ill afford. However, there are several approaches that can be utilized to mitigate against the time and the cost required. First of all, only the few high priority sectors would require a broad data base as the one envisaged here. Second, if the team of scientists and technologist is selected on the basis of expertise and ability and not political connections, greater strides can be accomplised faster and at a lower cost. Third, regional cooperation among countries with similar problems and priorities can reduce the cost significantly. Finally, developing countries may utilize the UN system through a loan of technically competent experts for short durations in order to assist them in the identification process.

The second issue relates to the determinability of "appropriate" technologies*. The technology developed in the industrial world by virtue of being developed in a sophisticated-technology economy is in

* This segment relating to "selectivity" was previously reported in a paper by K. Behbehani and M.S. Marzouk, titled "Transfer of Technology and the Selectivity of Appropriate S & T", presented to the International Symposium on Science and Technology for Development, Singapore, January 1979.

most cases capital intensive and energy intensive. These traits are not consistent with many of the recipient developing countries' natural factor endowments. Furthermore, the technology developed in the exporting country is often designed to meet a demand pattern typical of a nigh consumption society, an attribute that does not meet with the needs of the developing economy. In addition, the technology - by being capital and energy intensive - usually has adverse environmental and ecological impacts a price that most developed economies are paying for being highly industrialied. It has further been argued that developed countries carry out technology transfer to serve their intrinsic objectives rather than the technological needs of the developing countries. The objectives include a wider monopolistic base, expansion of their profit making operations, exploitation of cheap labor in the developing economy, and most of all to escape rigid environmental legislation in their own countries.

When such technology is imposed on different socio-economic base, it leads to some adverse consequences. It results in accentuation of social and economic inequalities, greater malallocations and more concentration of economic power. By virtue of being capital intensive, it will tend to intensify the resource misallocation problem rather than alleviate it. It will tend to be environmentally harmful to the developing economy. Due to the monopolistic practise of the transnationals, the developing economy incurs a heavy foreign exchange burden to pay for the direct and particularly the indirect - cost of technology transfer. Finally, there is the subtle social impact of increased pressure to learn and perform in eveloping countries resulting from the ease with which unpackaged

technology can sometimes be acquired.

It is in view of this inherent conflict of interest that the issue of selectivity is brought into focus. The choice of technology should be made with a view to enhancing thier resource base; to suit their socio-economic setting; to be consistent with their natural factor endowments (capital versus labor intensive). It should also meet certain environmental constraints, promote self-reliant development, promote indigenous research capability and lessen technological dependency. Developing countries hould be selective not only in the choice of the type of technology, but also its mode of implementation (joint ventures, licensing contracts, turn-key plant, etc.) with a view to the national development objectives and their priorities determined in step 1.

Step 3 Technology Planning

Subsequent to identifying and prioritizing both the sectoral development goals and technological needs attendant upon them, there is a need for a national comprehensive technology plan. Not unlike the national 5-year plans, a technology plan specifies the over-riding objectives, annual targets, quality and quantity of available research capabilities at home, the economy's technological absorptive capacity, criteria for selecting suitable technologies, and the critical permissible level of dependency on foreign technologies. The latter incidentally does not refer to the place of its origin but to whether

it must be purchased from abroad or it can be developed internally and adapted to the local socio-economic conditions.

Having determined the national economic goals at the sectoral level in step (1) and accordingly identified the technological needs in step (2), step (3) has the dual task of taking stock of the indigenous research capabilities and specifying in more or less a broad way the main criteria for selecting appropriate technologies. By so doing a plan can be drawn up which will specify the relative contribution of local R & D institutions (private as well as public) vis-a-vis foreign technology suppliers. In addition, the plan will also include certain recommendations as to how the former's targeted contribution can be enhanced while that of the latter be minimized.

In surveying the local scientific and technological capabilities, an in-depth examination should be undertaken regarding the educational system, vocational training centers, size and quality of research institution, scientific and technological infrastructure (such as information centers, engineering and economic consultancies number of scientists and engineers, R & D funds, and the existing triangular modes of cooperation among the business sector, the government and applied research institutions. An assessment of the viability, potential and obstacles of the scientific community should then generate specific recommendations to strengthen the local capabilities in accordance with the nation's technological targets. We should emphasize however that, as is the case with any segment of the proposed technological strategy,

short of the involvement of policy makers at the highest political level, these efforts will have limited usefulness and, indeed, may end up more or less cosmetic.

Step 4. Measures to Strengthen Indigenous Technological Capabilities

On the basis of the results obtained in the preceding task, a list of reasonable and realistic recommendations will be made to enhance the local scientific and technological capabilities. This list must be comprehensive and must embody tentative annual targets. From an administrative point of view, we suggest the establishment of a technology development and transfer center which will be responsible, inter alia, for the drawing-up of the proposed long-term technology plan as well as the implementation and follow-up procedures. Though the establishment of such a center may represent a financial and human-resource burden on the economy, there is little doubt that its expected pay-offs to the communicty by and large will be appreciable.

Numerous recommendations have already emerged from previous conferences regarding technological self-reliance in developing countries. To avoid repetition, only a partial list of some measures which, in our opinion, have not recieved sufficient attention in the past is given below.

First, it is very important that a clear line of demarcation be drawn between the private and public sector's relative financial

and manpower contributions to the nation's technological needs and targets. Not only would this have the benefit of bringing into focus the role of the private sector, which has long been overlooked in many developing countries, but also it eventually results in increasing the private sector's awareness and involvement in this vital endeavor.

Second, in order to further the diffusion of technological know-how in the society at large and to the extent that the private sector is typically more cost-conscious than the public sector, developing countries should provide financial incentives to the private sector's research centers. Such a practise has been pursued rather effectively in the developed countries, notably USA.

Third, according to the already-determined short- and long-term technological needs, an allocation of the tasks with the required resources should be made to the nation's different research institutions. Once the task is specified and the responsible institutions selected, a periodical progress report should be monitored by the proposed technology center in an effort to help it reach its objectives . An essential ingredient however in the process of developing local technologies and encouraging indigenous institution is the introduction of an equitable incentive scheme. Another ingredient rests on the government's efforts in improving the scientific and technological infrastructure.

Forth, much effort has been expended recently to establish regional transfer of technology centers. These centers are charged with just about every element that falls under the transfer of technology umberalla. The

usefulness of such a "jack-of-all-trade" set-up at a time when specialization in every area is going full-steam around us, is indeed questionable. Instead, we propose the establishment of specialized regional technology centers. This proposition is supported by the fact that each economic region normally has certain factor endowments, development goals and national problems that are common to most of its member nations. If two or more of the member nations assign high priorities to certain problem areas, especially as they relate to the exploitation of abundant raw materials in the region, a specialized research institution in one of these areas has a much higher probability of producing tangible results. For instance, the Arabian Gulf countries, of which the State of Kuwait is a member, show relative abundancy of petroleum, natural gas, solar energy and fisheries. Meantime, they are all constrained by a small agricultural sector, water desalination, and shortage of manpower. Under these conditions, regional technological centers in any of these areas, if they are collectively financed and manned by the member states, are likely to be of substantial benefit to all parties concerned at a fraction of the cost to each State.

Fifth, it is incumbent on the governments of the developing countries to make more and better use of their own scientists and technologists before inviting foreign consultants in to do what, in many cases, can be done at home.

CONCLUDING REMARKS:

It was not our intention to develop a comprehensible technological

...rategy. Rather, we wanted to draw the attention to the need to ...ystemize a technological strategy for developing countries, which ...ust be integrated with their national development plans. Naturally, ...ur efforts represents one of the initial steps taken in that direction. ...e hope that part of the following debate and research on the transfer ...f technology will be channelled towards this particular area so that this concept can be refined, perfected and eventually applied.

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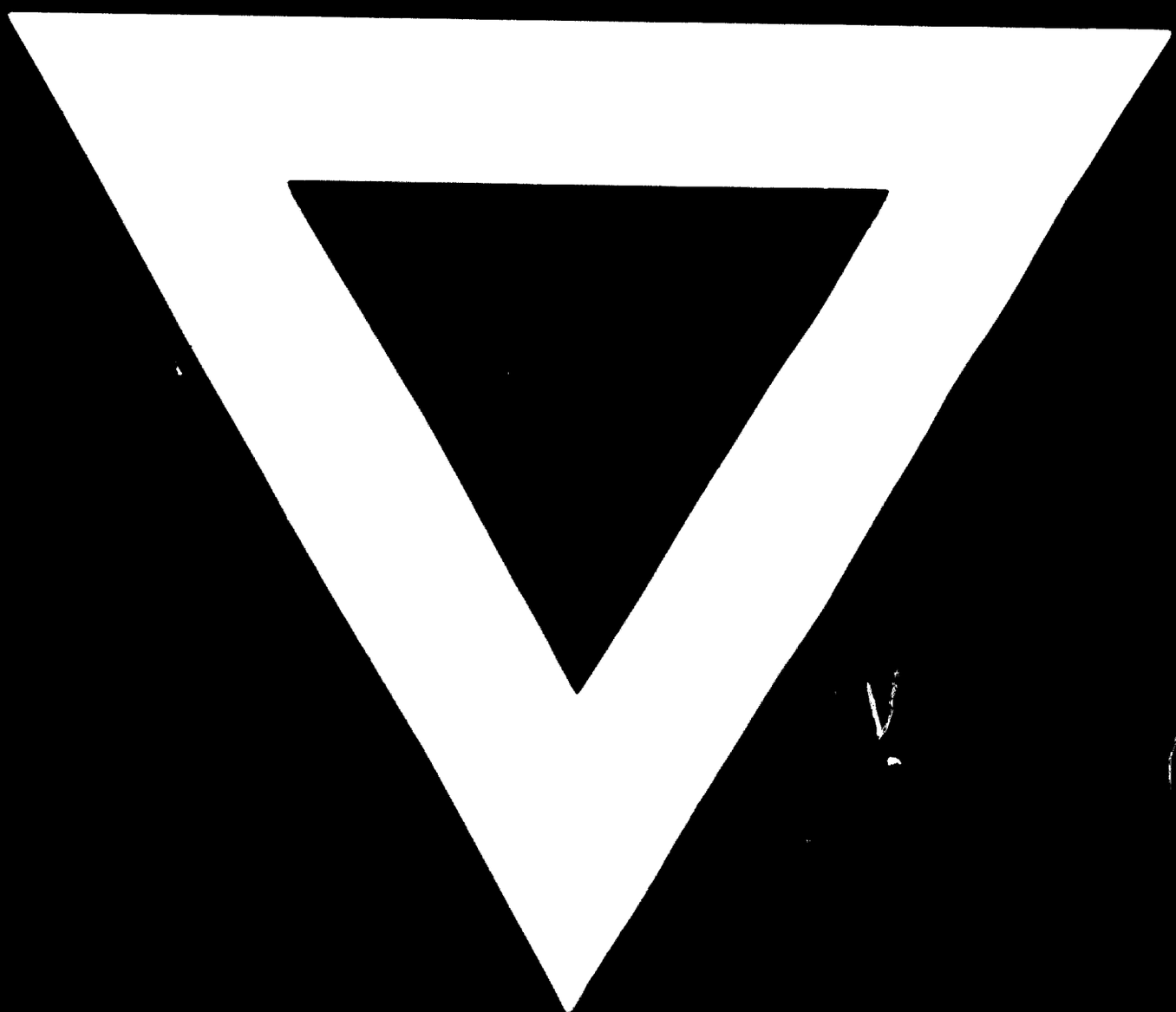

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