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TECHNOLOGY PLANNING IN DEVELOPING COUNTRIES*

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*The views expressed in this paper are those of the
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A. INTRODUCTION

A review of the modern economic growth experience of any industrialized country reveals the fact that a very large part of the growth of output can neither be explained by simple expansion of the labor force or additions to the stock of capital but rather by a third or residual factor known as technical progress. And yet, until recently few countries - especially among the market economy countries - have given systematic attention to the formulation of technology policies much less to the inclusion of a comprehensive technology plan within the framework of national development planning.

You can have import substitution, you can have domestic production and even some economic diversification but you cannot have a self-reliant, self-sustaining development without at some stage acquiring the ability to choose selectively, adapt, modify and generate your own technology. There is, therefore, a strong case for the conscious formulation of a technology policy and the preparation of a plan for strengthening national scientific and technological capabilities.

In order to assist developing countries in the methodological and substantive aspects of technology planning as an instrument for strengthening their technological capacity, the UNCTAD secretariat prepared a report describing and evaluating the science and technology plans recently drawn up by five developing countries: Brazil, India, Mexico, Pakistan and Venezuela. The resulting document which I have distributed to you is a preliminary treatment of the subject (TD/B/C.6/29). A more detailed study on technology planning in developing countries has been prepared by the UNCTAD secretariat which should appear in published form very shortly (TD/238/Supp.1).

Today I would just like to present a few general ideas concerning technology planning in order to try to convince you of the need for it and to give you a schematic view of its main components.

B. OBJECTIVES AND POLICY INSTRUMENTS

I would like to begin by emphasizing that nothing that I say in this intervention is intended to overlook the fact that developing countries will have to continue to be dependent on imported equipment and know-how for many of their technological requirements for some time to come. Self-reliance does not mean autarky but rather the capacity to make rational technological decisions in pursuit of national development objectives. If one scrutinizes carefully the situation in any particular sector, one can see that there are some highly advanced techniques that only can be imported as is, others that involve modification and still others that require either the upgrading of local processes and production techniques or the development of new ones. The identification and consideration of such options is part of what is encompassed in technology planning.

What then are the main tasks of technological development? In UNCTAD we have grouped them into four categories:

- (i) Unpackaging of imported technology
(This simply means for any given project, the breaking down of its various components - feasibility studies, engineering and design consultancy, plant construction, machinery and process know-how, plant operation etc. - and their acquisition from different sources, foreign or domestic, under the best terms and conditions).
- (ii) Adaptation to local requirements.
- (iii) Research and development for generation of indigenous technology.
- (iv) Provision of technical services.

The way that these tasks are accomplished will depend on the type of economic and political system, the extent of state intervention in the economy and the type of instruments available to governments for this purpose. There are a wide variety of instruments which have a direct or indirect influence on technological development. For example: foreign investment laws, industrial property and licensing regulations, consumer protection legislation, industrial and agricultural policies, fiscal policies, development lending policies,

education and manpower training and research and development. The point is that somewhere in the government machinery there should be an institution or authority responsible for coordinating these policy instruments in an integrated fashion so as to promote the development of the country's own technology.

C. THE NEED FOR A SEPARATE TECHNOLOGY PLAN

Technology is an integral part of the economy; every action of production and investment involves the use of and, therefore, the choice of technologies. The question arises, therefore, how there can be a technology plan distinct and different from a plan for production and investment which constitutes what is called an economic development plan. It is to this question that I now turn.

Technology planning should be considered in relation not only to the concept of development planning as a whole, but also to such concepts as education planning, health planning, manpower planning and transport planning. In theory, an economic development plan should encompass simultaneously all the aspects of social and economic development; and, of course, education, health and transport plans are not and cannot be independent of each other or of the economic development plan. Development in any one of these areas interacts with development in all the others. But neither in practice nor in theory is it possible to take care of all these aspects of development together. From the practical point of view each one poses a complex set of problems that call for concentrated attention by people who specialize in them and who, by that token, cannot have the competence or capacity to tackle the problems of the others.

From a theoretical point of view, the justification for separate plans for these different problem areas arises out of the undeniable fact that there has not been till now any theory of planning that can take into account the intricacies of the problems of all these areas in a single quantitative exercise. The most sophisticated mathematical planning models - those using input-output or linear programming models - are in

actual fact models not at all for the economy as a whole, but only for a relatively small part of it, namely the industries producing goods by making use of ^{other} goods, given the production capacities in these sectors. All such areas as education, health, transport, the professional services, and research and development are treated as "exogenous". It is simply not true that plan models can "solve" in the mathematical sense the investment allocation to those sectors, or take account of the feedback effects from these sectors.

As a matter of fact, even for the endogenously treated goods-producing sectors all that the mathematical models can ensure is a consistent, at the most an "optimal" (or economically most efficient), combination of production levels for a given time point. Capital formation even in these goods-producing sectors cannot be tackled satisfactorily, since it has to take place over time, and the phasing of capacity expansion is a problem that still eludes satisfactory treatment in any mathematical planning model. That is because there is always a time-lag (the gestation period) between an act of investment and the capacity expansion resulting from it. Hence, current investment activities can be related to current production only through one-way linkage - the goods necessary for carrying out the investment activities. But the other linkage - that between capacity expansion and increased production of goods resulting from that increased capacity expansion - cannot be endogenously treated in any finite horizon model. (This is recognized in theory as the "terminal year problem"). An infinite horizon model can by definition take care of all linkages, whatever the time lags. But infinite horizon models are of no practical use for plan-making purposes.

It is this time factor, along with the requirement of specialized information calling for the services of experts in each area, which calls for separate plans for different broad problem areas. Educational planning has to take into account the different lengths of time called for by different kinds of curricula some of which have to be in sequential order. Road planning has to take account of the fact that roads are intended to last indefinitely. Improvement in the quality of breeds of animals has to take into account the time gap between successive generations. None of these different time lags and interdependencies can be taken care of effectively in any programming model that ensures horizontal consistency or optimality.

It is for such reasons that in practice, and no matter what kind of overall economic development planning is employed, there are normally separate plans for particular areas. In India, alongside an overall economic development plan, there are water management plans, power-cum-transport plans, education plans, etc., some with time horizons extending up to 20 years (whereas the economic development plans have always been for 5 years). In the motherland of overall economic development planning, the USSR, an electrification plan was undertaken in the early 1920s well before overall economic development plans came to play any part.

The foregoing remarks have shown the need at a practical level for plans for separate problem areas. On the level of theory, recognition of the need is found in the literature on decentralized planning. But fascinating and challenging as the theoretical problems of decentralized planning are, it has to be recognized that no planning system in any country has as yet been able to make much progress in putting this theory into practice.

In strict theory, a technology plan cannot but be an integral part of an economic development plan. But in practice the problems of technology development have to be tackled as a task in itself. It is not true that the feedback effects of technology development can all be incorporated into the current production and investment plans, owing to the time lag, often uncertain, between technology development efforts and the probable results thereof in form of innovations. And for that very reason it is also not true that the resources allocation to technology development can be derived out of an economic development plan. They have, however, to be provided for: resources have to be allocated to technology development out of the overall resources available for the economic development plan. Also, in setting production targets, the likely results of technology development have to be kept in kind. But, the point to be emphasized is that the technology development plan cannot be expected to emerge as a by-product of the economic development plan. It has to be worked out separately.

D. MAIN COMPONENTS OF A TECHNOLOGY PLAN

In the remaining time I will try to present in a somewhat schematic fashion the different parts of what an ideal technology plan should comprise.

1. Identification of technological areas or sectors

A technology plan should first identify a number of technological sectors or areas. The sectors should be so demarcated as to make them relatively homogenous from the technology point of view. The classification could conceivably be different from that used for grouping products or industries (as in inter-industry tables or plan models). The sector classification need not be exhaustive: that is, certain activities in the economy can be left uncovered by any sector. The sectors to be considered are those which, a priori, are areas with potential for technology development. These target areas would be different, of course, in different countries and depend on their stages of technological development.

2. Profiles of existing technology

For every such sector the technology plan should present a reasonably comprehensive profile of the existing technology in that sector, partly in quantitative and partly in qualitative terms. It should describe the existing stage of affairs in a way which is useful from a practical point of view - in terms of processes, machinery types, vintages, etc. For every sector there should then be a discussion of the economic aspects of those different methods of production in use in terms of their cost and their benefits.

3. Institutional facilities for technological development

There should then be a critical account of the institutional facilities that may already be in existence for promoting technological development in each sector. These institutional facilities should include extension services, experimental stations, R and D laboratories and consultancy services, as well as various agencies for the propagation and diffusion of technological information.

4. Technological policy by sectors

This should be followed by statements of technology policy with respect to each sector. The policy of the sector would naturally be related to, and derived from, the overall technology policy for the country which should provide the very basis for the entire technology plan. But it should indicate in clear terms whether the sector is to be treated as a priority area for technology innovation/adaptation or not.

5. Short-Term targets

Next, the following short-term quantitative and qualitative targets should be drawn up:

- (a) Amount of additional capacity creation for different kinds of activities belonging to the sector, composed of two parts, namely:
 - to
 - (i) capacity requirements/fill the gap between increased demand and capacity of the pre-existing stock of capital; and
 - (ii) capacity requirements to compensate for such obsolescent capacity as may be decided to be scrapped;
- (b) Parts of the additional capacity requirements that could be met by new capacity installed, incorporating:
 - (i) freshly imported technologies (which should be specified);
 - (ii) unchanged pre-existing technologies (which should be specified).

6. Long-Term projects

The plan should then move on to projects of a more long-term nature of the following kinds:

- (a) Those designed to improve and adapt imported technologies. Technologies should be specified, as well as the improvements and adaptations sought indicated;
- (b) Projects for the improvement and modification of technologies already in use. Again the technologies should be specified and the improvements and adaptations sought indicated;
- (c) Projects for the improvement and modification of craft technologies, indigenous or traditional technologies (again with the same proviso);
- (d) Projects for the development of new technologies (indication should be given regarding the benefits aimed at and the likely costs).

Each project of all the preceding four kinds should be presented along with the techno-economic reasoning justifying its inclusion in the plan. It should also specify where the innovative activity is to take place, e.g., in R and D institutions, other

7. Manpower training programmes

The technology plan should also incorporate both long-term and short-term programmes for the training of manpower required to meet the short-term and long-term targets and projects under (5) and (6) above. Thus, for example, if a fresh technology has to be imported, the plan has to see to it that there exists the necessary personnel for using that technology. Similarly under long-term projects, if it is decided to leave out for the time being innovative efforts in, for example, the field of electronics, and include projects for the innovation of new varieties of high yielding seeds, the technology plan should provide for training programmes of agronomists and not provide for the training of too many electronic engineers.

8. Instruments for implementation

The technology plan should provide for the instruments that the government proposes to use to meet the short-term and the long-term targets. Some of the actions which have to be taken to meet the targets may involve public sector agents and others, private sector agents. If the short-term targets and the long-term projects are not to remain on paper only, the plan must provide for policy instruments that the planning authorities can wield for directly or indirectly inducing the agents to carry out the plan.