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# Science and technology for development:

planning in  
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# Science and Technology for Development:

## Planning in the STPI Countries

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## 13. A Framework and Format for Sectorial Science and Technology Plans<sup>22</sup>

Ashok Parthasarathi

The first step in preparing a sectorial plan for S&T development is to analyze the broad social and economic setting of the sector concerned. This is necessary because large-scale application of S&T has been shown in the highly industrialized countries to be related to the structure and organization of their economic and social systems. This step has two components: analyzing the development of the sector, looking at the way its structure and organization have evolved and have influenced the pattern of development; and analyzing the investment, employment, pricing, import–export, industrial, and similar socioeconomic policies that have been applied to the sector.

Against this background one should ask the following question: How do the prevailing structure and organization of the sector and the socioeconomic policies being followed affect the demand for S&T and the capacity of the production and service systems of the sectors to use effectively the output, particularly indigenous, of S&T?

This question should be applied policy by policy, and the changes in the policies (including legislation) that would permit intensification of the use of S&T should be identified. Although redefinition of development policy is very important, attention could also be valuably drawn to the parts of the sector in which structural and organizational changes and socioeconomic policies favourable to the use of S&T already prevail.

### Demand for S&T Input

#### *In the Existing Production and Service Systems*

In these systems R&D input is needed in the following areas:

- Substitution of domestically produced process and product know-how for imported, so as to limit the dependence on technical collaboration agreements.
- Substitution of domestic raw and intermediate materials for imported, whether these are used in production based on indigenous technology or production based on imported technology.

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<sup>22</sup> This essay is based on a document prepared for the National Committee on Science and Technology of India.

- Substitution of domestically produced capital goods for imported.
- Improvement of yield, conversion efficiency, and other technological factors involved in production, extraction, and utilization processes — for example, improvement in the percentage recovery in coal mining, and improvement in machinery efficiency through increased cutting speed of the tools.
- Waste utilization and byproduct recovery.
- Environmental control.

Import substitution efforts must involve not merely “one-to-one” substitution, but also adaptation of the imported know-how to suit Indian conditions of production and use, and improvement of the know-how to an extent consistent with available lead times. The starting point for such planning is most likely to be compiling a comprehensive list of foreign collaboration agreements in force, with their expiry dates, the nature and scope of the technology transferred, and so forth.

The areas in which it is worthwhile to commit indigenous R&D resources to the substitution of domestically produced know-how for imported must be chosen carefully. If, for instance, it is judged, with reference to either international trends or India's needs, that ferrite should be replaced by semiconductor magnetic devices in all electronic equipment that is to be made starting 2 years from now, then even if equipment containing ferrite is being manufactured now with imported know-how, no effort should be committed to the replacement of that know-how with domestically produced know-how.

S&T input into productivity enhancement and regulatory activity (PERA) would be directed toward improving plant maintenance and operation, plant utilization, cost reduction at all points, safety, standardization, and environmental control.

#### *In the Expansion and Diversification of Production and Service Activities of the Sector*

Forecasting of the demand 5 and 10 years from now for each product to be produced, each facility to be set up, each service to be provided, and quality control must be done primarily by the Planning Commission and an administrative ministry, but with important input of the National Committee on Science and Technology, particularly in relation to the choice of technology. Should the most advanced technology, which is likely to be highly capital-intensive and to demand a sophisticated infrastructure and often a large market, be used, or should less sophisticated technology involving higher labour content, use of local materials, and suitability to the relatively smaller market in India be used? What is the range of options available and what are the costs and benefits of each?

Policy preferences (social, economic, and political) should be applied to decide which elements in the demand forecast should be met and which should be deemphasized. For example, the development of electrical power generation resources should be regionally balanced even if this involves higher costs of generation and supply in certain instances; and products and services causing substantial environmental problems should

be replaced by those with less severe environmental adverse effects even if this means higher production and selling costs at the start. This again is a task to be undertaken by the Planning Commission in cooperation with the National Committee on Science and Technology and the National Committee on Environmental Planning and Co-ordination, under the direction and control of the cabinet.

“Policy legitimized” forecasted demand can be separated into that related to existing products, facilities, and services, and that related to new products, facilities, and services. Meeting the former would largely involve expansion of the existing production system, whereas meeting the latter would call for new investment.

The S&T tasks to be tackled to meet this demand for existing products, facilities, and services would largely have been taken into account in the exercise described earlier for existing production and services systems. As to the demand for new products, facilities, and services, some would require R&D efforts and others PERA; examples are the development of specifications and configurations of facilities, the development of process and product know-how, the development of trial and testing centres, the development of design engineering for each category of process or product, the development of production plant and equipment fabrication, the development of instrumentation, and determination of the nature and extent of extension and demonstration services to be provided and how they should be provided.

## **Supply of S&T Input**

S&T input can currently be supplied by all central and state government laboratories, central and state public sector companies, private sector companies, and universities and other institutions for higher education that are pertinent to the sector.

Institution-specific sectorial plan reports should include at least the following:

- Goals of individual tasks that are being worked on or have been completed, and the funds committed to them during the last 3 years, including foreign.
- Manpower resources deployed on each project during the last 3 years, in terms of level and number.
- Present status.
- Expected date of completion.
- Nature of output to be provided — for example, technical report or laboratory scale know-how, pilot plan sponsorship (if any), proven know-how, test procedures, standards, and so forth.

The report should conclude with a summary statement that consists of two main sections (process and product development, and PERA), each of which is broken down into two categories: completed tasks, and ongoing tasks. The tasks should be categorized in terms of the goals of the demand statement for S&T input into the existing production and services systems.



## Changes Necessary in the S & T Effort to Match Supply to Demand

### *R&D*

#### *Domestic effort*

- Identifying, in consultation with R&D agencies, production agencies, and others concerned, the goals in the demand statement for which R&D input had already been generated, whether in government laboratories or laboratories (or other installations) of public or private sector industry, and working out the means for commercialization.

- Identifying, in consultation with the concerned R&D agencies, production agencies and users, the R&D projects under way in government laboratories or laboratories of public or private sector industry that are directed at meeting one or other of the goals in the demand statement.

- Determining, in consultation with the concerned R&D agencies, the projects under way in existing institutions that should be terminated because their goals are at variance with those contained in the demand statement.

- Assessing, in consultation with the concerned R&D agencies and companies, whether the R&D resources (personnel, equipment, money) released as a result of such termination are adequate to meet all the requirements of the remaining goals in the demand statement.

- If it is found that the redeployable R&D resources are inadequate, determining the manner in which they should be augmented so as to meet the requirements of the remaining demand. For instance, specific groups in existing laboratories might be expanded, new groups in existing laboratories might be set up, or new laboratories might be set up.

- Establishing as a result the optimum mix of such supply-augmenting measures for the sector concerned in terms of the tasks now assigned to named groups and institutions. An important aspect of this activity should be identifying and meeting the internal requirements for success of the augmented S&T effort, such as concentration of the R&D effort so as to create research groups of a practical size, creation of points of contact between basic, applied, and developmental research, and coordination of R&D activities with PERA as well as extension activities, survey activities, and so on.

#### *Foreign input*

Tasks for which it is felt that production-worthy know-how cannot be generated in the available lead time, even with augmentation of the supply of R&D input, should be indicated as needing imported S&T. This should be done on a process- or product-specific basis. In each case either a government laboratory should be assigned the task of building on the imported technology (which requires the company that imports the technology to provide the laboratory with access to what it imports) or the importing company should be required to indicate, at the time of import, what measures it is taking to assimilate and build on the technology.

#### *Organizational and managerial reform*

It may often be found that supply-augmenting measures in terms of

personnel, equipment, materials, and so forth may not be enough; certain organizational and managerial changes may also have to be made in at least some of the R&D institutions in the sector. These changes should therefore be spelled out at this stage of the sectorial plan report.

Furthermore, new institutions of many kinds may also have to be set up. The nature of these institutions, a broad indication of their goals, and, when possible, the agency that should be responsible for setting them up should be indicated. If the plan is sufficiently well worked out, it may be possible to mention these institutions in the task assignment statement.

### *Design Engineering*

#### *Domestic effort*

- Identifying the processes and products for which the involvement of design engineering is necessary to commercialize either existing technology or the technology that is to result from R&D efforts under way or to be initiated.

- Determining in each case a design engineering company that would be willing and able to take over the know-how and commercialize it on a turn-key basis if needed.

- Establishing the design engineering lead time in each case, and the amount of design and engineering effort required in terms of personnel and money.

- When suitable design engineering organizations do not exist, as in the shipping industry, determining the amount of money and time required to set up such a company.

#### *Foreign input*

When it is felt that the design engineering capability is inadequate and that it cannot be generated through measures such as the preceding in the available lead time, even with augmentation of supply of design engineering input, these services should be imported. At the same time, however, the best existing design engineering company in the country should be assigned the task of being fully associated with such imported services and building on them.

#### *Organizational and managerial reform*

It may often be found that supply-augmenting measures in terms of personnel, equipment, materials, and so forth may not be enough; certain organizational and managerial changes may also have to be made in at least some of the design engineering and other institutions in the sector. These changes should therefore be spelled out at this stage of the sectorial plan report.

Furthermore, new institutions of many kinds may have to be set up. The nature of these institutions, a broad indication of their goals, and, when possible, the agency that should be responsible for setting them up should be indicated. If the plan is sufficiently well worked out, it may be possible to mention those institutions in the task assignment statement.

#### *Plant and equipment fabrication*

The plant and equipment needed may be itemized, with as many specifications as possible, and then passed on to special groups, such as those concerned with machine tools, heavy engineering, or instrumentation.

## **PERA**

### *Domestic effort*

- Identifying, in consultation with PERA agencies, production agencies, and others concerned, the goals in the demand statement for which PERA input has already been generated, whether in government laboratories or laboratories (or other installations) of public or private sector industry, and working out the means for commercialization.

- Identifying, in consultation with the concerned PERA agencies, production agencies and users, the PERA projects under way in government laboratories or laboratories of public or private sector industry that are directed at meeting one or other of the goals in the demand statement.

- Determining the manner in which PERA resources should be augmented so as to meet the requirements of the remaining goals in the demand statement. For instance, specific groups in existing laboratories might be expanded, new groups in existing laboratories might be set up, or new laboratories might be set up.

- Establishing as a result the optimum mix of such supply-augmenting measures for the sector concerned in terms of the tasks now assigned to named groups and institutions.

### *Foreign input*

Tasks for which it is felt that better maintenance practices or new service facilities cannot be generated in the available lead time, even with augmentation of the supply of PERA input, should be indicated as needing imported S&T. This should be done on a service- or facility-specific basis. In each case either a government laboratory should be assigned the task of building on the imported technology or the agency that imports the technology should be required to indicate, at the time of import, what measures it is taking to assimilate and build on the technology.

### *Organizational and managerial reform*

It may often be found that supply-augmentation measures in terms of personnel, equipment, materials, and so forth may not be enough; certain organizational and managerial changes may also have to be made in at least some of the PERA and other institutions in the sector. These changes should therefore be spelled out at this stage of the sectorial plan report.

Furthermore, new institutions of many kinds may have to be set up. The nature of these institutions, a broad indication of their goals, and, when possible, the agency that should be responsible for setting them up should be indicated. If the plan is sufficiently well worked out, it may be possible to mention these institutions in the task assignment statement.

## **Research and Personnel Training in Academic Institutions**

An important aspect of S&T planning must be how to ensure that the academic institutions train the right kind of personnel and that the research done in universities is related to the priority social and economic problems of the nation. Ensuring the former calls for review of curricula and teaching methods, provision of teaching facilities and equipment, and many related aspects of university education. Ensuring the latter calls for a

system in which a large part of the research done by the universities is basic research needed for government and industrial laboratories to make progress in their applied and developmental work. A possible way of establishing such a system would seem to be to ensure that a large part (say two-thirds) of the funds allocated to university research were committed to projects designed by university faculty in consultation with project leaders in mission-oriented government laboratories. Such an approach would require the mission-oriented agencies to work out appropriate policies and practices regarding the funds granted to university training and research. At least one agency is known to be working on such policies and practices.

There would also be a need to ensure that the rest of university research was undertaken on an open-ended basis, where the criterion of choice for financial and institutional support was the quality of the research worker or the importance of the problem from a long-range point of view.

It would be valuable if part of the output of this part of the sectorial plan was a list of themes for long-range, forward-looking scientific and engineering research, based on technological forecasting when possible. The output of these analyses should be finally presentable in the form of a task assignment statement.