

Dierkes, Meinolf

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The role of technology assessment in the process of development

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The role of technology assessment in the process of development

Meinolf Dierkes

The purpose of technology assessment

Traditional attitudes towards technological progress are being increasingly questioned as countries at all levels of development reorient themselves from purely economic goals to a broader range of societal interests. There is a growing demand for the development of environmentally sound technologies that minimize the use of resources and respond to a broad spectrum of human needs. In both the public and the private sectors, decision makers in research, development and innovation—the key determinants of technological progress—are having to re-evaluate and change the criteria and calculations on which policies are based. At the same time, a need is being expressed for the thorough reform of existing institutions and the establishment of new ones to ensure that societal considerations are better integrated into decisions

relating to the research and development process and the large-scale use of technology.

Until the 1970s, government support of technological development was largely based on the assumption that every technological innovation represented progress for society. For that reason, only rudimentary mechanisms had been developed to assess the social consequences and desirability of new technologies. Moreover, less industrialized nations have often attempted to catch up with more advanced nations by simply following technological developments in those countries. As a source of future innovation, however, research and development should be guided by human needs in the society it is to serve; it should not be guided by options chosen by a different culture.

In industry, the development of new technologies is traditionally determined by the criterion of economic profitability.

Because of society's changing objectives, however, profitability has increasingly come to be regarded as too limited a criterion. In all major industrialized countries, the growing concern for the integration of a broader spectrum of considerations in industrial decision-making—under the banner of social responsiveness—indicates how important it is to reorient decision-making, planning and marketing in industry.

This concern is intensifying the discussion of the need for new management tools to facilitate adjustment to new criteria for, in both the public and the private sectors, traditional decision-making tools and criteria relating to the nature, scope and direction of technological progress suffer from the following weaknesses:

(a) The needs of the population are included in the decision-making process only to the extent that they are perceived by the relevant scientific, political, ad-

ministrative or business élite. In the past, these groups have accorded higher priority to technological and economic considerations and have neglected at least some of the social consequences of technological developments;

(b) Decision-making processes are not intelligible, so the general public and specific constituencies affected by the decisions cannot raise their concerns and views;

(c) Decision-making criteria are too limited and are not linked to a broader definition of the quality of life;

(d) In some areas there is virtually no feedback about the needs of the population; in others, it is either too little or too late to be of great use in the decision-making process.

Certain results ensue when decisions on the acceptability of new technologies are based on an outlook that is too narrow and one-sided. Environmental degradation, psychic stress and the exhaustion of limited resources are just a few of the social costs involved. Furthermore, the problems caused by the unequal distribution of the costs and benefits of technological progress are now receiving attention.

In response to this growing awareness of the dangers of technological development oriented towards unidimensional economic growth, policy makers and researchers in government and industry have sought broader concepts for assessing the effects of technologies. Technology assessment has been defined as "the integrated and systematic assessment and forecast of the most important (positive and negative, direct and indirect) consequences of newly introduced or modified technologies on the central sectors of a society (economy, specific groups of the population)" and has been experimented with by Governments and innovative business corporations to maximize desirable and minimize undesirable effects of technological development on society at large and on specific groups and concerns (for example, the environment). These experiences have increasingly brought out this instrument's process-related character. It is clear, therefore, that technology assessment needs to be institutionalized at various levels of society in a continuous advisory capacity and as a process for forging consensus.

The use of technology assessment has so far been limited mainly to developed countries, specifically, the United States, Australia and certain European coun-

tries, and it has been applied primarily to large-scale, government-initiated technologies. However, in view of the rising concern for the social consequences of its activities, industry should consider the concept a useful tool for learning as much as possible about the broad range of desirable and undesirable side-effects of the technologies it is developing and marketing, for anticipating social conflicts and for minimizing both these aspects during the development process. Industry, therefore, should use technology assessment to analyse (a) the effects of changes in products (especially the introduction of new products); (b) changes in production technologies (particularly the introduction of new production processes); (c) other changes in business policy that could have a significant effect on the social and physical environment (such as major changes in marketing and personnel policy); (d) investments in large technical complexes (steel works or nuclear plants); and (e) siting decisions, specifically with respect to environmental considerations.

Thus far, procedures similar to technology assessment have been required in only a few industrial sectors, often being restricted to health effects (in the pharmaceutical field) or to aspects of safety, energy consumption and durability (in the field of transportation). Increasingly, however, the need for a broader approach by both industry and government is being felt. This is reflected in concerns over the effects of toxic substances on health and the environment and over the large-scale application of information, communication and biotechnology.

The relevance of technology assessment

Technology assessment is not by nature limited to highly industrialized societies. Forecasting and assessment in development planning enable all countries, particularly developing countries, to make more effective choices in the deployment of technologies which are best suited to specific cultural and social environments. The concept provides a framework within which the benefits and risks involved in the application of a technology can be evaluated on the basis of national priorities and values.

Technology assessment makes it possible to identify the effects that both imported and indigenous technologies

have on a country's society, economy and environment. It therefore provides a means for choosing appropriate forms of technology in accordance with the three key elements of the concept of ecodevelopment promoted by the United Nations Environment Programme: a technology can be assessed for the extent to which it contributes to satisfying basic human needs, for the degree to which it promotes the concept of self-reliance through the use of domestic human and natural resources and for its environmental soundness.

Environmental, economic, social, political and cultural factors vary from country to country. Therefore, the effects of a particular technology in one setting can differ greatly from those in another. In addition, the introduction of a new technology often involves trade-offs between economic growth and the disruption of social, cultural or environmental structures. By conducting a technology assessment, a nation can examine the risks involved in implementing an endogenous or an imported technology.

Utility and institutionalization

The concept of technology assessment has been welcomed by Governments, parliaments and the general public as a useful means of evaluating and managing the direct and indirect effects of a technology. The technology assessment process can help decision makers avoid serious problems that might arise if such analytical tools were not available. Technology assessment can only be effective if it is properly integrated into the decision-making process. If the results of such a study are not used as input into the decision-making of government and industry, the effort is of very little value. Due to differences in scope and objective, a distinction must be drawn between technology assessments conducted in the public and private sectors.

The public sector

A variety of ways have been devised by countries to institutionalize the process of technology assessment in the public sector. In 1974, the United States Congress established an Office of Technology Assessment to provide it with unbiased information concerning the physical, biological, economic, social and political effects of specific actions.

In the 1970s, the Government of the Federal Republic of Germany formulated recommendations and performed tasks that resemble technology assessment, even though the term itself is rarely used. Since 1973 the German Bundestag has debated the possibility of institutionalizing the capacity to conduct technology assessments. To create a more solid basis for the participation of the legislature in decision-making processes pertaining to technology assessment, the Bundestag decided in 1985 to establish a Commission of Inquiry on Technology Assessment to improve Parliament's level of information and expertise where important technological lines of development are concerned. With the assistance of external experts, the Commission conducts representative technology assessment studies and makes proposals for the investigation of individual technologies and fields of technology. The Commission also advises Parliament on the form that future permanent institutions for technology assessment could take.

In France, the Government has long been active in evaluating technologies and their consequences, particularly with respect to environmental protection and land use. The Bureau parlementaire d'évaluation des choix scientifiques et technologiques was established in 1983 to inform Parliament about technological developments. It does this by gathering information, commissioning research and taking action on previous evaluations.

The Governments of Australia, Denmark and Sweden and the Parliament of the European Economic Community, for example, are also endeavouring to institutionalize technology assessment.

Industry

Industry has long used a variety of methods to evaluate technical or economic aspects of new products or processes for planning, management and marketing purposes. Only recently, however, have some innovative firms begun to study the effect of their activities on society and the environment. Industry has gradually become aware that it is responsible for the secondary consequences of its activities. Innovative companies that have experimented with technology assessment have also emphasized the usefulness of the concept. They have expressed their intention to integrate the process as a standard procedure in the examination of questions that involve

technological options that cannot be answered by traditional economic or market analyses.

For the past few years a number of large European corporations have been compiling baseline data on the effects of their products and production processes on the physical and social environment. They are finding technology assessment a useful means of identifying these effects in order to alter corporate strategy and behaviour. The scope of this new awareness is limited, however, as only a few corporations are involved in experiments on a large scale. Very few industries have conducted extensive technology assessments and even most of the active companies have prepared only partial assessments (such as environmental effect statements). Experience in quite a number of companies has shown that public pressure is needed to increase industry's commitment to technology assessment and to ensure that the results of the assessments are used in decision-making.

Transferability

Methodological considerations

When defining the function of technology assessment in the development process, one must distinguish between endogenous and imported technologies. Clearly, an individual country is best suited to collect and analyse the data relevant to technologies developed through the research and development efforts of its own public and private sectors. Although it can draw on the methodological experience gained abroad in conducting and applying technology assessments, it must go through the seven steps described below on its own.

When a technology is imported, it is only reasonable for the developing country to look for ways to avoid costly duplication of effort in preparing a comprehensive assessment. Technology assessments require highly qualified personnel and often demand expensive field work. These considerations pose significant problems for both developing and industrialized countries if resources are limited. Appropriately trained personnel, specialized equipment and the means to fund such research are often not available or are urgently needed in other sectors or for other functions in the development process.

To a certain extent, developing countries can draw on the experiences gained

by industries and Governments of industrialized nations. Some of the information produced by technology assessments in the countries from which a given technology is imported can be used in the technology assessment process for development purposes. An examination of the steps taken in conducting a technology assessment and of the social, economic, environmental or other key differences should reveal the points in the process at which government and industry in developing countries can use the information provided by foreign technology assessments and those points at which they must carry out their own assessment.

General procedure and specific tasks

Industries and government agencies have experimented with a variety of approaches to technology assessment. As practised by both industry and government, the "classic" methodology, from which other approaches have been derived, has seven steps.

Step 1. Define the task. As with every research undertaking, the first step is to determine the necessary scope and depth of the assessment. The definition of the specific task must be based on domestic values and conditions and must be determined for each situation. The types of effects to be examined must be identified. In examining technology assessment conducted abroad, experts in developing countries should pay particular attention to the range of social, economic and environmental conditions as well as to the political and cultural values implied by the scope and depth of the assessment. Examples of specific aspects to be considered include differences in production factors, transportation to markets, climate, market structure, prevailing social values and specific interest groups.

Step 2. Describe relevant technologies. To describe the technology to be assessed, it is necessary to obtain technical and production data, describe the current level of advancement in the research and development process and identify the technical, social and economic barriers to the realization of the technology. It is also necessary to specify related and supporting technologies, define time horizons and select areas of potential application. Almost all of these data can be obtained from the producer of the technology and developing countries should require that this information be provided together with the product. The availability of

related or supporting technologies in the developing countries and the relevant areas of application and markets might vary, but research on these points should not pose significant problems or require tremendous resources.

Step 3. Develop state-of-society assumptions. Technology influences society and society often affects the development and application of a technology. For this reason, a number of factors must be considered in developing a process for technology assessment, including purchasing-power relationships, the real and potential behaviour of consumers or users and their attitudes, needs and values. Other factors to be considered are locale, and safety, legal and administrative requirements. These elements are culture-specific and their assessment must be conducted for or by the individual country in which the technology is to be introduced. The developing country must therefore compile existing information relevant to its situation and gather new domestic data for each technology.

Step 4. Identify affected areas. This involves the identification of those areas that can be affected positively or negatively by a technology. Six key areas—values, environment, population, economy, society and institutions—could provide a general point of departure in this process, supplemented by specific case-studies which would examine educational, geographic or transportation aspects, for example.

Step 5. Prepare preliminary effect analysis. Once this information has been collected, it is possible to conduct a preliminary effect analysis. At every possible point, the short and long-term effects on the individual areas should be described in quantitative terms, and interdependencies between areas identified.

Step 6. Identify possible action options. On the basis of step 5, programmes could be devised to maximize the positive and minimize the negative effects of the technology in question. This assumes an understanding that a range or change of technologies is always involved at the same time. The contribution of the individual programmes is evaluated on the basis of comparable standards, and an "optimal" programme is compiled. The valuation of the positive or negative effects is likely to vary significantly between countries that do not share the same values, social and economic characteristics or environmental conditions.

Step 7. Complete effect analysis. The final

step in the procedure for conducting technology assessment is to correct the conclusions arrived at in step 5 by considering the changes proposed in step 6. Here again, a certain amount of information cannot be condensed quantitatively. In those areas in which a change in the attitude of the population might be expected, probable trends should also be discussed. The conclusions drawn at this stage are bound to be value-laden. The decision to introduce a technology in view of perceived risks and benefits should be a matter of national policy based on domestic conditions and priorities. The conclusions of an assessment may vary significantly in different contexts.

On balance, a developing country can draw on a producing country's technical information about a technology, but at every step in the assessment process it must analyse data which define a technology's national context. The risks and benefits associated with a technology must be weighed according to national values and priorities. In many developing countries, many of the necessary data have probably not yet been obtained and the task of technology assessment will be particularly difficult until these countries establish a sound data base.

Institutionalization of technology assessment functions

The public sector

Experiences in industrialized countries have shown that three major elements must be assured in order for technology assessment to be efficient and successful in the public sector. The assessment must be conducted (a) within a flexible structure and (b) by interdisciplinary teams, and (c) public discussion of the results must be provided for.

Given the limited resources available, the following special aspects should be considered when attempting technology assessment:

(a) Task forces under the leadership of a government agency or affiliated with a specific institution for technology assessment should be established for each project. They would be composed of representatives from relevant ministries, staffs of academic, government or industry experts with training in appropriate areas and foreign consultants, and provide liaison with the legislature and with

the producer of the technology (domestic or foreign). This structure would make use of existing resources without drawing personnel away from the universities, industry or government. It would also avoid the risk of over-bureaucratization inherent in assigning such a task to a specific governmental agency;

(b) A network should be established between developing countries to share the results of technology assessments. Countries with similar ecology, geography and levels of industrialization should avoid duplicating effort wherever possible. In certain cases, the environmental and even social and economic effects of a technology may be very similar in some developing countries, and an effort should be made to co-ordinate the collection of these data. Some developing countries may have more to learn from each other than from the industrialized nations in these respects.

Industry

In order to prevent technology assessment from becoming "technology arrestment", potential legislation requiring industry to pursue technological assessment in the process of development must be implemented in a flexible fashion. Incentives should be introduced to encourage industry to conduct technology assessments for those products and processes that could have a major effect on the social and physical environment.

With respect to procedure, industry should go through the seven steps outlined above. The risk of over-bureaucratization also exists in the private sector, and efforts should be made to avoid it; to this end, in industry as in government, the task force seems to be the most appropriate concept. The establishment of *ad hoc* groups of experts drawn from inside a firm as well as from external sources is the most flexible and promising approach to technology assessment.

Conclusion

Experience in a number of countries has shown that technology assessment is a valuable decision-making tool in the public sector and in industry. It provides a framework within which to anticipate the social and physical environmental consequences of a technology so that benefits can be maximized and negative side-effects minimized. While experience has so far been limited mainly to innova-

tive corporations and Governments in highly industrialized nations, the concept is just as relevant for developing nations. By identifying the effects that domestically developed and imported technologies have on their societies, economies

and environments, developing countries can choose and manage technologies according to the three key elements of the concept of ecodevelopment advocated by the United Nations Environment Programme. It is recommended that technol-

ogy assessment be conducted by flexible task forces in the public sector and in industry so as to make the most appropriate use of available resources and to avoid over-bureaucratization and the danger of "technology arrestment".