Economists, Engineers, and Development

The author suggests that in considering development possibilities men schooled in engineering disciplines often take too restricted a view of the possibilities of economic choice, while economists are too little schooled in the technical aspects of evaluating projects. Despite difficulties of communication they must work more closely together.

Robert Sadove

ENGINEERS comprise almost 10 per cent of the professional staff of the World Bank, not a surprising figure considering their important function in its work. The primary responsibility of the Bank's 75 specialist engineers is to appraise the projects for which loans are requested, and in discharging it they must bear in mind not only the engineering, but also financial, managerial, organizational, and economic aspects.

The engineers, who come from many countries, work closely with economists and financial analysts in reaching judgments on the

An economist and engineer from the World Bank look over the site of the new Bank building now under construction in Washington.

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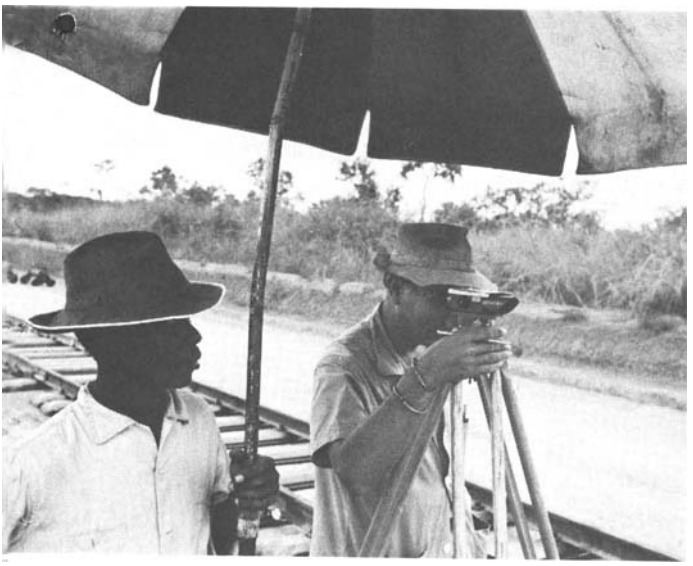
projects, the amounts of loans, the grace periods, and the contractual arrangements to ensure successful construction and operation of the projects recommended. After loans are made, the Bank's engineers visit the projects during construction to inspect progress, to determine if the various conditions set forth in the Loan Agreements are being observed and, in general, to get at the problems. If major problems are found, they recommend a course of action for the Bank to take, and on lesser problems they assist in ironing out the difficulties. The engineering staff does not undertake any engineering work for borrowers. This is almost always done by consultants retained by borrowers; the Bank merely reserves the right to approve the borrower's choice of consultant.

However, the Bank's technical assistance work involves it more directly with engineering firms. Besides lending for projects, it also carries on a small technical assistance program financed on a grant basis—currently running at about $12.5 million a year—and administers a much larger amount as Executing Agent for the UN Special Fund. Expenditures under these technical assistance programs are usually for feasibility studies designed to assess the potentialities of resources within a defined area or sector of an economy or to identify and formulate projects. When the Bank is meeting the costs of such studies, it selects the consultants itself.

To assist it in judging the ability of consultants to carry out proposed tasks the Bank maintains a comprehensive file of the names and experience records of all firms desiring to be included—about 1,800 of them at present. The Bank takes a wholly impartial view in the selection and approval of consultants; it wants only to be assured that any assigned task will be performed with full professional competence.

Problems of New Projects

An increasing proportion of the World Bank work has been in the poorest of the developing countries, in Asia and Africa. These countries are likely to become an increasingly important part of the total international market for engi-



Surveying in the Congo (Brazzaville): "An increasing proportion of the World Bank work has been in the poorest of the developing nations, in Asia and Africa."

neering know-how. To work effectively in an environment of such extreme proverty is far from easy. One has to start with very basic matters; for example, food may have to be distributed to local employees if costly sicknesses are to be avoided. Difficult climatic conditions and poor accommodations can seriously impair the effectiveness of incoming engineers who are used to a less rigorous standard of living. The scarcity of statistical and factual information—especially accurate information—can cause enormous waste of time and money. It is imperative that a carefully planned survey of all available data first be carried out; and then great care must be taken in drawing inferences from it. Resistance to change and innovation is a serious problem; it may be worth employing an individual who is particularly knowledgeable in fields such as anthropology and sociology and use his knowledge to get around obstacles posed by local tradition. However, a firm must have a staff that is knowledgeable about the area. Probably it will still need to work jointly with local partners if it is to avoid costly mistakes resulting from ignorance of local language, laws, customs, and traditions.

Economy is, of course, the very essence of engineering and this is particularly so in the developing countries. To paraphrase the words of the Duke of Wellington, "an engineer can do for one dollar a job that any bungler can do for two." But the concept of economizing involves more than trying to meet a given need at the least cost.

Sampling silt from a river bed in Thailand: "The scarcity of the statistical and factual information can cause enormous wastes of time and money."

Defining the Task

To get a problem into manageable form engineers naturally try to define it in as specific terms as possible—for instance, the construction of an urban water supply system that is technically efficient and meets given technical standards of purity. Once the requirement has been precisely defined, the problem boils down to finding the least costly way of meeting it. The most obvious alternative paths leading to similar results are carefully considered; each path is costed in detail and then the costs are compared to show which is the cheapest, given some discount rate. Straightforward as this type of job may appear, it is not always performed well. Often the Bank finds that techniques are recommended which are inappropriate to countries which have abundant cheap labor but little capital—as most developing countries have. For instance, the design of a water supply system for a large Far Eastern city included the use of an advanced electronic control system for checking water levels. It was found that the job performed by the control system could be done adequately by a man with a pencil and paper and a bicycle to carry him from one check point to another. The engineers had obviously allowed their desire for technical perfection to run away with them, and in fact recommended a solution to the water supply problem that was not the least costly. Sometimes, of course, the most modern technique is so much more efficient than the old that the solution to a particular problem will be the same in advanced countries and less developed countries alike. Also, the skilled workers required by a plant may be even more expensive in the less developed country, which is desperately short of them, than they are in the advanced country where the general wage level is higher. Occasionally, an expensive modern production method may be preferable to an older and cheaper one even in a less developed country, because use of the modern method minimizes the need for lengthy training of skilled craftsmen.

Provided that engineers bear in mind the possibility of saving money by varying techniques of production according to local conditions, the problem of selecting an optimum technique for reaching a given objective can usually be solved reasonably precisely by calculating comparative costs.

But this type of procedure can also very easily be highly misleading. All too often and easily, the cost-comparison approach is combined with reliance on standards and technical and economic coefficients developed in other parts of the world. That is, of course, part of the purpose of employing an engineering firm from another country: you hope to get a transfer of engineering technique and judgment. These judgments and implicit references to standards and coefficients developed elsewhere may lead a country to invest in a project that is quite inappropriate to its over-all economic conditions. Objectives, standards, design criteria, technical coefficients, economic coefficients, "normal" growth rates—all have to be re-evaluated for application to a particular developing country.

To take the case of objectives and the standards used for defining them, can the engineer—or the economist—really count on his "fixed" requirements being fixed? To my mind the subconscious judgments of engineers and economists play a much bigger role in the evaluation of projects in the developing countries than they should do. Technical

standards used in the design of projects are often applied with little change from one country to another. Yet the costs of attaining these standards differ considerably. Furthermore, the benefits to be derived in the form of reduced risks or lower operating costs will also vary greatly among countries. Cost-benefit ratios are often misleading because they do not explicitly treat these points. It is poor economics to accept as unavoidable a specific requirement of a system without considering whether another higher or lower standard might not be more appropriate to local cost conditions and time horizons.

Clarifying the Standards

One way to handle this problem is to evaluate carefully the range of relevant standards or objectives and then to present a clear statement for each standard of the costs involved in attaining that standard compared with ones slightly below it and above it. It has been estimated, for instance, that to meet fully at all times of the year all the demands placed on one major water system would involve expansion of storage capacity by 20 per cent—an enormous investment. No such investment would be required if people could be persuaded to cut down their demand for water by a few percentage points for short periods. The question, therefore, is: would consumers be prepared to pay for the water that they received at these critical periods the full cost of providing that water? If the answer is no, as it probably would be, the supposedly fixed "requirements" dissolve. Requirements and standards must always be treated flexibly, as a variable, and *not* (as they too often are) as orders from on high which it would be an impertinence to question.

The range of possible choice in an investment program is often much wider than is readily apparent. Sometimes the problem is an institutional one: those with funds to spend see only a few of the alternative ways of spending them. Moreover, costs and benefits are not always calculated in such a way as to be comparable with the costs and benefits attributable to alternative uses of funds available for investment. In public projects the costs and benefits relevant to the decision whether or not to go ahead must be stated in such a form that they clearly indicate the benefit which the project will yield to society as well as to the individual or organization responsible for execution. The prices used in the analysis should be such as to indicate the cost and benefit of the project to society. Only then will the resultant calculation indicate the true economic return on a particular project so that it can be compared with the general economic rate of return that one would normally expect in the country in question—in whatever sector the investment might be made.

But often there is need to go beyond the generalized range of alternative uses for money to delve deeply into specific alternative projects and programs that may suggest themselves when a little imagination is applied. Many engineering reports handle this part of the job rather superficially. Consideration of too many alternatives is, of course, a waste of time and money. The line has to be drawn somewhere. But now it is sometimes drawn beneath one single course of action that the engineers have selected as "best." Engineers should consider—and present in reports—at least the main alternatives in each instance. They should explain the different implications

of each, in terms of capital required, employment needed, space, time, etc. This is essential if the decision makers are to be given a real opportunity to choose.

The Search for Alternatives

Ironic as it may seem, the first task of experts called in to appraise a project should be to ask whether the need for the whole scheme could not be totally eliminated by undertaking some other less costly course of development. If there is a proposal for a new power station, consider first whether the present one could not be used more intensively by stimulating off-peak demand. If there is an idea of opening up a new area of the country by constructing new roads, harbors, and so on, ask whether these might be given up in favor of intensifying the use of existing land, transport, power, and other facilities. Or should an attempt be made to divert prospective growth of demand away from an already developed area to another area? Should a major agricultural project, readily analyzable but costly, be deferred in favor of a crash program to persuade farmers in existing agricultural areas to use improved seeds, better cultivation practices, more fertilizer, and more pesticide? Could transport requirements be reduced by establishing processing facilities at the site of raw material production? Again, in the field of transport, is physical displacement essential or would the transport problem be adequately solved by expanding the electricity supply network or the area's communication system? Would some reorganization of industrial land-use reduce the need for expansion of communications and transport facilities and of power generating capacity? All these questions and many similar ones merit careful investigation not only to determine the real need for investment but also to bring to light the full effects which each alternative may have on developments over the long run in other sectors. Economists call these effects "external," to indicate that they do not bring any immediate change in costs or revenues to the organization undertaking the project, but that they do cause increases (or decreases) in costs and returns of other organizations and individuals.

This comparison of objectives is not a simple job that can easily be performed and forgotten while work proceeds more deeply on comparison of techniques. For any specific investment tends to be highly interdependent with developments in other fields and places. For instance, it may have a significant effect upon the way in which the pattern of demand subsequently develops. An investment in power or transport or large-scale manufacturing—chemicals or mechanical engineering, for instance—tends to generate needs for further investments in the same field and in other fields. This is indeed one of the main processes of economic growth. The greater availability of cheap power may, of course, have little attractive effect in circumstances where there are too many other factors, unrelated to price, inhibiting industrial development; but equally, the prospective growth of demand for power may be so seriously underestimated that within a short time costly additions to the original investment become necessary. Substantial miscalculations of the prospective growth in demand can have such serious effects that it might result in the adoption of an inappropriate pattern of investment. Roads, for instance, once built, tend to draw traffic to them-

selves; their very existence may encourage people to make some journeys that would otherwise have seemed too bothersome. Sometimes highways have been designed and built without sufficient attention to the traffic they were likely to attract in this way. When they have proven too small or the approach roads become too congested, costly additions have had to be made. Sometimes a whole series of such costly additions has become necessary. Had the long-run traffic build-up been correctly forecast from the start another form of transport, perhaps a railway, might in some instances have been preferable from the economic point of view.

Development by Stages

While projects should be considered together with all the likely expansion and developments in other fields which may result from their initial construction, it is equally necessary to consider the development of projects in stages. It has often happened that a long road, a large power plant, a steel mill, an irrigation system have been built at one time even though it would have been better to stage the

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development over a number of years in line with the gradual build-up of demand.

Long-Term Programs

This points up the relationship of many projects—and especially public works projects —with long-term regional programs. Of course it is possible to go along doing many individual projects, each serving their own purpose, as and when they become obvious. Power is needed and the river is there, so build a dam and install a powerhouse. Later, when other needs appear, raise the dam for greater storage or provide adjuncts to it. But, as has often been indicated by my closest colleagues in the World Bank when we discuss large river basin projects, the sum of the results from this type of procedure is usually a good deal less valuable than those obtainable by careful comprehensive programing, with full consideration from the start of the alternative directions possible.

If, then, engineers are to meet the demands that the less developed countries will be putting upon them, they must give increased attention to the making of balanced long-run assessments of alternative courses of action. At present, they are not giving enough attention to economic considerations. Men schooled in the engineering disciplines often take too restricted a view of the possibilities for economic choice. Economists, who are trained to keep in mind the wide scope for choice—among ends as well as means—that nature provides us, are too little schooled in the technical aspects of evaluating projects. The addition of a few economists or a senior economic advisor to an engineering team is not an entirely adequate solution to the problem; any economist who has had contact with project work is acutely aware of the difficulties of communication between engineers and economists. Yet what is needed is continuous and close communication throughout the successive stages of preparation of a project.

If economists and engineers are to make this communication truly fruitful then they must be more critical of one another's work and at the same time more tolerant of one another's criticism. Statistical manipulations—benefit-cost ratios, response rates, consumption and production functions, etc.—are a convenient common language. But this language should never be used without an acute awareness of the lesson drawn from the history of economic development by one well-known policymaker—that "an active response to an unpromising technical economic setting may produce a better result than a sluggish or complacent response to a more promising setting."