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**THE CHALLENGE OF CIVIL AND SANITARY
ENGINEERING WORK IN UNDER-
DEVELOPED COUNTRIES**

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FIRST let me say how much we in the World Bank and the International Development Association, which have both been in existence a relatively few years, appreciate the invitation to address the members of such an old and distinguished society as your own. We particularly welcome the opportunity to speak to you about a subject in which the engineering profession and the Bank have an equal interest.

None of us can today fail to be aware of the very large sums of money—much of which comes from our own pockets by way of taxes—which are being made available to aid the economic progress of the under-developed countries. We have some grounds for suspecting that in the past some of this money has not been as well spent as it might have been. The efficiency and economy with which foreign development projects are carried out depend in large measure on the professional engineers associated with the projects, and the World Bank concerns itself very much with the same problem. You and we alike are interested to see that aid is not waste. We are concerned not only in the quantity of aid which is made available to the under-developed countries; we are also vitally concerned with the quality of that aid.

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It is true, of course, that the responsibility for the success of development projects in underdeveloped countries lies in the first place with those countries themselves, but unfortunately exactly because they are underdeveloped, they are frequently not able by themselves efficiently to plan and execute economic development projects. So, much of the responsibility for the soundness of projects has in fact to be borne by national and international financing agencies, such as the World Bank, and also by the professional engineers who are concerned with the planning and implementation of the projects.

During the last fifteen years we have been constantly impressed by the importance of the part played by the engineering professional in this field. We are very much aware of the way in which the costs of a project depend on the quality of the engineering work. The time required to get a project under way, how smoothly and how promptly it can be brought to the operating stage, how efficiently its operations can contribute to the economy—all these depend on the engineer. His work on feasibility studies bears closely on the possibility of obtaining finance for the project.

We have therefore thought it worth while to review our experience, and to set out some of the conclusions we have reached; conclusions which show that this responsibility which we share is a real challenge to our professional ingenuity and skill. As far as the engineering profession is concerned, we hope to show that this challenge requires the engineer to widen his horizon beyond the areas with which he is normally most intimately concerned; to be prepared to go beyond the study, planning and advisory efforts he might normally perform and even beyond those which he has contracted to perform; and to advance his profession by research and development. Finally, to meet successfully this challenge of work in underdeveloped countries, the engineer will need to muster all the patience, tact, diplomacy and understanding at his disposal.

THE WORLD BANK AND ITS ACTIVITIES

Before I comment on the challenge to the professional engineer, I want to speak briefly about the World Bank, in order to explain our activities and objectives in our work with underdeveloped countries, and to show how we are brought into contact with the engineering profession.

The World Bank, or to give it its full name, the International Bank for Reconstruction and Development, was established as an affiliate of the United Nations as the result of the Bretton Woods Conference. It is set up like a corporation, in which the member countries hold shares in proportion to their economic importance. Its membership (including some countries which have applied but are not yet members) includes most of the countries of the free world.

After making some initial loans for the post-war reconstruction of European countries—a task which was then handled under the Marshall Plan—the Bank has since 1948 devoted its energies and resources to the economic development of its member countries by financing specific projects. We do our best not to lend to any one country more than that country can afford to borrow, and not to finance any project unless we are satisfied that it has a high development priority and that it is soundly conceived.

Much of our lending is for what the economists call the economic infra-structure of our member countries—for transportation and power—but we also lend for agriculture and industry. The total amount of our loans is now about \$6.5 billion, but since our borrowers usually contribute more towards the costs of the projects than we do, the aggregate investment in which we are interested is probably of the order of \$20 billion. At present, the annual lending rate of the Bank and its affiliates is approaching \$1 billion a year. I am glad to say that not all of the \$6.5 billion that we have lent comes out of the pockets of the taxpayer. As a matter of fact, only about \$1.7 billion represents subscriptions of our member countries. The rest has been raised by the sale of the Bank's bonds in the financial markets of the world, by the sale of portions of our loans to private investors, by repayments of loans, and from our earnings, which by now approach \$700 million. Our loans carry interest (at present at the rate of $5\frac{3}{4}\%$), which is a little higher than the rate we pay on our borrowings. The term of our loans corresponds in general to the economic life of the projects they finance, varying for different types of project from 10 to 25 years. Our borrowers must repay their loans in foreign exchange.

You will understand from what I have said that the Bank is far from being a give-away organization. We are a bank, and we are proud of the fact that we have built up a reputation for doing sound business which is reflected by the fact that our bonds are rated

AAA. But we are not an ordinary bank, and in fact we are much more than a bank. While we take pains to ensure that the projects which we finance will yield a good return, we are not only interested in the prospects of the repayment of our loans. The center of our interest is in finding projects to finance that will make the best contribution to the development of our member countries.

I have said enough to show you that we are indeed concerned with the quality of the help which we give to our member countries, and not just with the quantity. If we had a motto, it might well be: "Sound projects, soundly planned, implemented and operated." You will notice that this includes the words "implemented and operated," and this refers to the fact that we keep in close touch with the projects we finance during the entire life of our loans. Our relation with our borrowers is not simply that of creditor with debtor, but much more that of partners bound together by a common interest in the success of the project.

THE INTERNATIONAL DEVELOPMENT ASSOCIATION

So much for the World Bank. Now I want to refer briefly to the International Development Association. This institution—commonly known as IDA—is an affiliate of the Bank which has been operating a little more than a year. It was brought into being to meet a need which the Bank could not fill. There are some countries which through no fault of their own cannot afford to repay foreign currency loans on conventional terms; these countries need capital for their development; they have sound projects to be financed; but the Bank is unable to help them.

IDA was therefore established in order to fill this gap. It lends to governments on long term (all its credits so far have been for fifty years), and charges no interest on its credits. All the borrower has to pay is a small service charge of $\frac{3}{4}\%$ per annum. These are "soft" terms; but there is nothing soft about the projects which are financed. They are subjected to the same searching scrutiny as Bank projects; they have to measure up to the same criteria; they are expected to pay their way in the same way; and they are appraised by the same hard-headed investigators—since IDA has no separate staff.

Whether we are working for the Bank or for IDA, we have to satisfy ourselves that the project has high priority for the borrowing country, that its feasibility has been completely demonstrated, that it

is complete in itself and that its proposed financing is sound. So in fact we investigate each project from six different aspects, economic, technical, managerial, organizational, commercial and financial. I will not say more about the Bank's methods of appraisal tonight, but would refer you to the paper which will be presented on this subject to the Inter-American Sanitary Engineering Association (AIDIS) at its Washington meeting early in June, which no doubt some of those present will be attending.

Now how does our work in financing projects bring us into contact with professional engineers? In the first place, our staff includes a number of engineers, of various nationalities, experienced in the specialized fields of engineering. Secondly, we engage consultants from time to time to assist our staff in appraising projects, either to meet a peak in our work-load or to provide specialized qualifications not available among the staff. But our most frequent contact is with the engineers who are employed by our borrowers to perform services connected with their projects—from feasibility studies right through to initial operating advice. I might add that in any case where we are in doubt about the ability of our borrowers to do his own engineering work, we insist as a condition of our financing on his employing engineering consultants. We also come into contact with the engineering staffs of construction companies and suppliers.

As far as our experience in sanitary engineering projects is concerned, since we began work in this field with IDA money, little more than a year ago, only a few projects have reached the point where a credit agreement could be signed. But we are engaged in the study of a number of projects in about ten countries, and it looks as though this would be a substantial activity in the future.

So it is with some trepidation that I speak to you about the engineering problems that arise in this field. While we have learned a lot in the past year, a good deal of what I have to say is in fact the application to sanitary engineering projects of what we have learned in our work with all kinds of projects in many lands over the last fifteen years.

THE CHALLENGE TO THE ENGINEERING PROFESSION

The challenge of civil and sanitary engineering work to which reference is made in the title of this paper really refers to two different things. The first is the challenge presented by the tremendous volume

of work which faces the profession in the coming years. The second is the unusually severe responsibilities that must be faced by professional engineering firms working in underdeveloped countries.

There is little need to underline the tremendous volume of work coming up in this connection. I have already said that the Bank's current lending is at the rate of about \$1 billion a year. But the Bank is not by any means the only, or the largest, provider of finance for the underdeveloped countries. The American Government and European Governments, the Inter American Development Bank, and many other public and private agencies all play a part in this field. Aid to India alone is likely to be of the order of \$2 billion in the next five years. Aid to Pakistan may reach almost \$1 billion in the next two years. On the other hand, the need for such projects may be even greater than the amount of finance available. If we take urban water supply projects alone, for example, a recent study shows that by 1975 \$4¼ billion could be spent on water projects alone in Asia, Africa and Latin America.* In the general field of water resources, there are of course in addition rural water supplies, water supplies for industry, irrigation projects and multi-purpose projects. The expansion of urban and industrial water supplies will create need for sewage and waste disposal works.

The value of engineering services connected with Bank projects alone has been estimated to approach \$50 million a year. The total amount spent on engineering services for all projects in the underdeveloped countries must be several times this amount.

The need is not only for a very great volume of engineering services, but also for the very highest quality of services, and it is here that the challenge and the responsibility can most clearly be seen.

Those of you who have had experience only in this country have, I am sure, sometimes been faced with great difficulty in discovering the basic data necessary for your work. Municipal records are sometimes disorganized and out of date. It is difficult to be sure what facilities actually exist, how what has been constructed differs from what was planned, on which side of the street distribution pipes are laid, how many service connections there are and so forth.

* "Report on Global Urban Water Supply Program Costs in Developing Nations, 1961-1975," by John M. Henderson, Sanitary Engineering Consultant, International Cooperation Administration, Washington 25, D.C. June 1961.

All these difficulties fade into insignificance compared with the difficulties you may meet in underdeveloped countries.

In a city in one of these countries you may find that nobody knows how many of the meters are working properly. Perhaps there may be IBM machines for preparing the bills—but the figures fed into the machines may be no more than figments of the meter-readers' imagination. So you have no reliable record of past consumption, and no reliable information about water losses in the system. You may not be able to find out how many houses there are, let alone how many people or how many connections.

And if, for instance, you wish to make a reasonable estimate of future water consumption, you cannot take as a guide the kind of consumption levels which are common in the U.S. or other highly developed countries. This may sound obvious, but we have seen this sort of thing done, by engineers who have a good reputation, as a basis for design in cities where less than half the population is served by the existing system, and in which most of the people could not afford to have modern plumbing for their dwelling much less to purchase water-using appliances at least during the design period.

Another difficulty in designing the expansion of the water supply and distribution systems in a city in one of the underdeveloped countries is to decide for how many years in the future, the additional facilities should be adequate. In this country, you may design without hesitation for 30 or 40 years to come. You can count on the project being financed at a low rate of interest, and on the city being able to afford the corresponding debt burden. The situation in the underdeveloped countries is quite different. The uncertainty about future demand, the poverty of the people, the fact that local interest rates may be as high as 12% or even 18%, must all be taken into account. The people cannot afford to pay now for facilities that may not be fully used for 25 years.

Additional uncertainties enter the calculation. It is difficult to tell how demand may develop if water rates are raised to the level of the real cost of supply. If people have been used to using very small quantities of water, how much will they use when plenty is available? In a city where the pressure is irregular, and people have been filling tanks and oil drums to tide them over periods of low pressure, will they use more water or less if the pressure is maintained?

Another difficult problem in design is to decide how far to include

up-to-date practices and control mechanisms. The client will always want the latest and best; but can he use it, and does it make any sense for him to have it? Many of the latest advances in mechanization make sense where labor costs are high, but are an extravagance where labor is cheap. A man on a bicycle may cost a great deal less than a telemetering system, but may serve the same purpose sufficiently well. Moreover, if the telemetering system gets out of order, no one may be able to repair it. Spare parts have to be imported from a supplier thousands of miles away. Since capital is limited, decisions have to be made as to the relative merit of expenditures for modern treatment works which would provide water of the best quality and of expenditures to improve and expand seriously inadequate distribution systems.

In addition to facing all these problems in design, the engineer may have to cope with complications in estimating the cost of a project and developing construction schedules. He must decide what are the most economic methods and materials of construction. How far should earthmoving machinery be used? Would it be cheaper to move all the earth by hand? Steel, cement, even timber may have to be imported. Climatic conditions must be taken into account. The investment in spare parts may need to be much greater than in a city where suppliers are within easy reach. Finally, local prices may not be stable, since many underdeveloped countries suffer from some degree of inflation.

The client may not speak English. He may be importing his equipment from several different countries. Business ethics and practices may be unfamiliar. Problems of culture and custom, even religious habits must be taken into account. All these difficulties accentuate the demand made on the engineer during the design and construction of a project, and face him with many judgements between alternatives of an unfamiliar kind. I do not need to stress that in these circumstances one cannot rely on the routine use of rules of thumb which may have become almost second nature in design work in a developed country. But in fact this is sometimes forgotten. We have seen many cases in which some or many of the factors I have described were not properly taken into account.

Another thing which must be recognized is that in working with underdeveloped countries, consulting engineers cannot usually confine themselves to "pure engineering." Often the contracts defining their

scope of work may be drawn up by inexperienced clients. Not infrequently, the client wants to build a bigger or better project than one of his neighbors, simply to gain prestige. I recognize of course the tendency to build monuments is not confined to underdeveloped countries; but in these countries capital is short and the demand upon it so large that economy is of overriding importance. Many of the elements of planning necessary in order to prepare a project satisfactory to a financing agency, and these include a number which are beyond the normal scope of engineering, may never have been considered at all by the client. Another thing which you may well meet with in these countries is a lack of understanding of the principles of efficient operation and management.

Of course I do not wish to scare you away from this kind of work by listing all the difficulties that you may meet, and it is not common to find all these different difficulties combined in any given project. Some of you may have had experience in foreign cities where there was a surprisingly high level of statistical information and professional ability. But it seems worthwhile to draw your attention to all the difficulties that you may be faced with in order to illustrate what we mean by the challenge of this sort of work in underdeveloped countries.

If there is one thing that we have learned from our experience, it is that every situation, every project, has its own peculiar characteristics and requires a fresh and open-minded approach. From this point of view, the work provides the maximum of stimulus to our ingenuity and ability as professional people.

In the face of these challenges, there is an urgent need for really competent and ethical consultants such as yourselves to become actively involved in this kind of foreign business. Otherwise, there is a risk of a great deal of business falling into the hands of the inexperienced and incompetent. Now we know that it is not easy to break into this field. The business will not come to you. You have to go and get it; get it by making yourselves known in the face of competition from other firms in the U.S. and Europe. You may ask, how do we find out about what business is in prospect in the foreign field? Well, I am afraid that we cannot help you directly here, since our own negotiations are confidential until we announce the signature to a loan or credit, and by that time, the consulting engineering arrangements have often been made. But you may hear of

the opportunity for this type of business through contact with the embassies of the underdeveloped countries in Washington, through the appropriate services of the U. S. Government, and in the case of sanitary engineering projects through the World Health Organization, the Pan American Health Organization and other such bodies. This requires some international, nose-to-the-ground techniques, and you would be surprised how grateful many potential borrowers are to know the names of good consulting firms. They often really have no idea how to find reliable consultants, and making yourselves known to them can be a surprisingly valuable service.

The Bank itself does not keep any list of approved consultants, and does not suggest the names of consultants to its borrowers. However, we do keep particulars of the qualifications and experience of consulting firms from a number of countries in our files, and we frequently have to advise our borrowers whether a particular firm or list of firms would be satisfactory from our point of view.

At this point, I would like to say something about professional ethics. International engineering competition is becoming more severe, but this can be no reason for lowering standards, which could do great harm both to the engineering profession and to the underdeveloped countries. In our experience we have from time to time gained the impression that when some firms go abroad they seem to think that the normal ethical standards no longer apply. Many foreign clients, for lack of experience, or simply because they are used to bargaining for everything they purchase, will ask for proposals in which the price of engineering services will be an important element in their decision. We take every possible step to discourage this practice, because we know that there are always some firms who cannot rely on their merits in competition, and so try to get the business by quoting a low price. If you are placed in the position of being asked to compete for business on the basis of price, it is not enough just to send a polite refusal to submit a proposal. You should be careful to explain exactly why. If this happens in connection with any project which the Bank or IDA is financing, we would always wish to be advised at once of any such unethical proposal. We are your allies in this respect. I should add, however, that we have in some cases seen unjustifiably high fees charged, and we are also anxious to avoid this possibility.

While I am talking about professional ethics, I should mention

that in this work with underdeveloped countries, it is very necessary for the engineer to concern himself most scrupulously for his client's best interest. From the very outset, in negotiating a contract, you should be sure that its terms permit you to do all the things necessary for the project. To accept a contract where a client, without adequate preliminary engineering studies, instructs you to design a 300 mgd treatment plant, assuming an adequate water supply from a certain source, may be very far from serving a client's best interest. You must be prepared to give a client unwelcome advice; to recommend rejection of a project which has no merit.

Now I come to another point of particular interest to us in the Bank in connection with water supply projects. I refer to research, and the publication of its results concerning problems common to the underdeveloped countries. We have found that there are many areas of study about which little published research is available. For example: the relative effectiveness of different water treatment processes in the removal of certain disease organisms common, for instance, to tropical countries; the relative importance of contaminated water and hand-to-mouth contact in disseminating water and filth-borne disease; and in general the question of practical water quality standards suitable to underdeveloped countries. More carefully documented and analyzed statistics of water use and waste disposal requirements and practices, and research on standards of design, construction and costs would be most valuable; better information concerning the relation between improved water supply and decreased incidence of disease would also be useful.

Publication of the results of such research in national and international professional publications would be well worth the effort involved. We ourselves hope from our own experience in due course to make some contribution this way.

One additional thing that you should bear in mind is that in order to meet the challenge of work in underdeveloped countries it may be necessary to broaden the qualifications of your staff. To prepare adequate feasibility studies, and to provide the client with all the advice that he needs, it will be sometimes necessary to bring economic and financial abilities to bear. In addition, you may well have to employ in some cases people with experience in administration, management and operation. A well-rounded study, covering the proposed project from these different points, may speed considerably the

obtaining of the necessary finance. It is certainly valuable to the client for the engineer to become acquainted with the requirements and procedures of the agency or agencies who will be asked to assist in financing the project. In this connection, we have ourselves worked out a questionnaire covering the different aspects of water supply projects about which we need to have information in considering whether to finance them.

I want to end by extending to all of you a most hearty invitation to visit the Bank when you are in Washington, and to keep us informed of your experience and the particular interests of your firms on a current basis so that we may be in a position as expeditiously as possible to answer questions from our borrowers about the suitability of particular firms for employment by them.